Corporate Social Responsibility (CSR) :
A Challenge for Business Decisions

July 22-26, 2012
Chiang Mai, Thailand

Organized by
- Dhurakij Pundit University
- School of Applied Statistics, National Institute of Development Administration
- Thammasat University
- Maejo University
- College of Management, Mahidol University
- The Engineering Institute of Thailand Under H.M. The King’s Patronage
# Table of Contents

Message from APDSI President ................................................................. 6
Welcome Address by Co-Chair ................................................................. 7
Keynote Speaker and Panelists ................................................................. 8
Conference Committees ........................................................................... 9
Host Institutions ...................................................................................... 13
Conference Sponsors ................................................................................ 14
List of Participants ................................................................................... 15
Full Papers ............................................................................................... 17

## Accounting/Finance
- Energy Price Shocks and Economic Activities in Texas Cities
  - Shekar Shetty, Zahid Iqbal, and Mansour Alshamali (Abstract Only) ... 19
- Effects of Ethical and Moral Judgments on Internal Auditors’ Decision Intention
  - Ming-Tien Tsai, and I-Chan Fang ....................................................... 20

## Business
- Entrepreneurial Orientation Effects on Thai SMEs’ Growth
  - Sutheera Atawongsa ........................................................................... 31
- A Proposal of Simultaneous Business Design Method Utilizing G-RD
  - Tetsu Saito, Kingo Udagawa, and Koshichiro Mitsukuni ....................... 45
- Entrepreneurial Perspective and Entrepreneurial Intention: A Test
  - Poompichai Tarndamrong, Terrence C. Sebora, and Ronda M. Smith-Nelson ................................................................. 66

## Corporate Social Responsibility
- Corporate Social Responsibility and Globalization
  - Bahaudin G. Mujtaba, and Frank J. Cavico ......................................... 89
- Corporate Social Responsibility and Corporate Performance: A Panel Quantile Regression Analysis
  - Kang, Hsin-Hong, and Liu, Shu-Bing ............................................... 109

## Economics
- Analyzing International Tourist Flows from US to Taiwan on Macroeconomic View
  - Yen-Hsun Chen, and Hsin-Hong Kang ............................................. 128
- Impulse Response Analysis of Tourist Flow from Hong Kong to Taiwan
  - Yen-Hsun Chen, and Hsin-Hong Kang ............................................. 149
Continuous Improvement in Vietnam: What Works, What does not, and What the Future Holds
- Phuong Anh Nguyen, and Alan G. Robinson

Human Resource
- Cohesiveness-Performance Effects in Work Groups-Work Patterns as a Moderator
  - Hsi-An Shih, and Hsu-yao Chen
- Intellectual Diversification and Competitive Advantage
  - Kwa Tran, and Peng Chan

Information Technology 1
- Satisfaction of Internet Banking in Bangkok and Metropolitan Areas
  - Chirasil Chayawan, Nithinant Thammakoranonta, and Wisakha Kosom
- How to Utilize the New 4 P’s with E-marketing Strategies
  - Sophea Chea, Jashen Chen, and Chao-Lung Chang
- How Do Web Events Impede E-service Use
  - Margaret Meiling Luo, Jashen Chen, and Pei-Ying Lin

Information Technology 2
- Problems with Inter-Organisational Information Systems: A Case Study from a United Kingdom Training Organisation
  - Don Kerr, and Kevin Burgess
- Uncertainty and Online Information Seeking
  - Margaret Meiling Luo, Sophea Chea, and Jashen Chen
- Value-based Adoption Intention of Cloud Computing Service
  - Jae Bum. Park, Jung Hoon Lee, and Ho Jin Jeon

Information Technology 3
- Pricing Telecommunications Network Services by U.S. State Network Organizations
  - Jongsawas Chongwatpol, and Ramesh Sharda
- A Study of Information Asymmetry and Relationship Quality
  - Ming-Tien Tsai, and Hsin-Cheng Chang
- A Framework for Identifying Influential Groups in Social Question Answering Sites
  - Yu-Hsuan Chen, and Duen-Ren Liu

Information Technology 4
- Computer and Service Online Shopping Management System
  - Yatha Jukkapong, and Sinthupuan Somnuek
A Study of Partner Relationship Management within e-Procurement Platform by System Simulation
- Eldon Y. Li, HsiuJu Rebecca Yen, Juan-Wen Ruan, and Larry F.K. Chang

Analysis of the Importance and Classification on PMO role; Using the Delphi
- Ho Kyung park, Chaerin Lee, and Eun Young Kim

A Study on the Types of Organizational Culture and IT Governance Implementation Level
- Yang Pyo. Park, Jung Hoon, Lee, and Young Joo. Lee

Innovation
The Effects of Business Environment and Competitive Strategies on the Adoption of Technological Innovations in the Thailand Context
- Teerasak Khanchanapong

Diffusion of Organizational Innovations: An Empirical Test in Thailand
- Jayanth Jayaram, Keah-Choon Tan, and Tritos Laosirihongthong

International Comparison on the Relationship between Quality Management and Innovation Performance
- Jing Zeng, Chi Anh Phan, and Yoshiki Matsui

Marketing
When does Price Matter in Green Product Preference?
- Chamaiporn Fung-Fuang, and Warat Winit

A Study on the Long-Term Collaborative Sales Contract with Considering the Risk of Price Fluctuation for Rapidly Growing Component Market
- SiDi Wu, Seung-Jin Ryu, Yasutaka Kainuma, and Hisashi Onari

The Effect of Firms' Competitive Advantage Creations on Beyond Sufficiency-Economy Consumption Behaviors
- Chanchai Rattanaprakarn, Bhubate Samutachak, and Priyanut Piboolsravut

Quantitative Analysis 1
Simple Formula for Estimating the Parameter of Zero-Truncated Poisson Distribution
- Krisana Lanumteang

Investment for Improving the Performance in Multistage Production Systems
- George C. Hadjinicola, and Andreas C. Soteriou
• Development of Scrap Cost Forecasting Model: A Case Study in Hard Disk Drive Industry
  - Phattarasaya Tantiwattanakul, and Athakorn Kengpol .......................... 553

Quantitative Analysis 2
• A Note on Three-Parameter Buy-Back Contract in Newsvendor Setting
  - Kannapha Amaruchkul ........................................................................ 566
• A Model to Locate Local Blood Bank with Emergency Referral
  - Phongchai Jittamai, and Jarupong Banthao ......................................... 576
• Intensify Avatars’ Immersion in the Virtual Worlds through a Novel Friend Prediction Model
  - Hsiuyu Liao, Guanyu Chen, and Duenren Liu .................................... 583
• Using of Tobit-Piecewise Regression Model
  - Titirut Thipbharos ................................................................................ 597

Service Management
• Focal Determinants of Service Fairness and Service Recovery Satisfaction in Cloud Computing
  - Montri Lawkobkit, and Phanasan Kohsuwan ...................................... 611
• Lifestyle Segmentation for Boutique Accommodation in Relation to the Service Quality and Customer Satisfaction
  - Tidti Tidtichumrernporn ................................................................... 623
• The Impacts of Co-production and Dynamic Capabilities on Service Innovation
  - Russell Ching, and Jashen Chen ......................................................... 646
• Revenue Management as an Emerging Management Routine: A Research Proposal
  - Hanno Roberts, and Vanlapa Wongchan ........................................... 656

Supply Chain 1
• A Closed-loop Supply Chain Model for Product Recovery and Remanufacturing Planning Under Uncertainty
  - Nasr-Eddine Dahel ............................................................................... 671
• Improvement of Shipping Process in Warehouse Operations Management: A Case Study
  - Chompoonoot Kasemset, and Chutcharit Rinkham ............................... 684
• Analysis on Determining Replenishment Lot Size and Shipment Policy in an EPQ Model with Delivery and Quality Assurance Issues
  - Hung-Chi Chang .................................................................................. 693
Supply Chain 2

• Integration of Supplier Selection and Order Quantity Decisions: A Multiobjective Approach
  - Nasr-Eddine Dahel

• Achieving Time-based Operational Performance through Supply Chain Integration and Knowledge Management: A Theoretical Framework and Measurement
  - Yuwapan Chaturapitpornchai, and Sakun Boon-itt

Author Index
Message from APDSI President

Don Kerr
President of APDSI
Faculty of Arts and Business
University of the Sunshine Coast,
Australia

Dear DSI and APDSI colleagues and friends,

It is with great pleasure that I welcome you to the 17th International Conference of the Asian-Pacific Decision Science Institute (APDSI 2012). This conference will be held at the Le Meridien Hotel, Chiang Mai, Thailand and it promises to be a delightful experience for all of us.

The theme for this conference is “Corporate Social Responsibility (CSR): Challenge for Business Decision”. I hope this theme will provide a platform for discussion and learning about CSR and the challenges facing organizations with respect to decision making in this vital area.

This conference could not have been possible without the tireless efforts of the conference chairs, Anumongkol Sirivedhin and Somboonwan Satyarakwit as well as the program chairs, Pachitjanut Siripanich, Tritos Laosirihongthong, Kodchaporn Siripokakit and Prattana Punnakitikashem. We owe a depth of gratitude to all of them for this effort. I would also like to thank the organizing committee and all those involved in preparing for this conference.

On a sad note I would like to pay homage to our late colleague, Professor Russell Ching and hope that we can all remember Russell for his good humour and dedication to APDSI. Finally, I hope that this conference is enjoyed by all and will inspire us to work towards a continuation of the APDSI tradition well into the future.

Sincerely,

Don Kerr
Welcome Address by Co-Chair

Anumongkol Sirivedhin
Conference Co-Chair
Dhurakij Pundit University
Council Member and
National Institute of
Development Administration
Council Member

Committee members, distinguished speakers, participants,

As a Co-Chair of this seventeenth Conference of the Asia Pacific Decision Sciences Institute, I am pleased, honored and privileged to extend the warmest welcome to all of you, conference participants, to this beautiful city of Chiang Mai, our capital city of northern Thailand.

The theme of this conference, "Corporate Social Responsibility (CSR): A Challenge for Business Decision", provides an avenue for businesses to explore their appropriate roles and responsibilities beyond their core business, to meet the demands and expectations of twenty-first century society. There will be, as usual, a keynote speaker and one panel discussion session to stimulate and provide the background of CSR activities and practices in the region, especially in Thailand. The conference is promised to be well attended.

I would like to take this opportunity to thank numerous people who have been working hard for many months to organize this conference. I thank the APDSI Board members for their confidence and contributions in promoting this conference. I thank the conference committee members, sub-committee members and reviewers for their dedication and tireless effort to bring this conference to fruition. I thank the keynote speaker and all panelists for kindly lending their service to the conference. I also wish to thank all the authors for submitting their papers and all distinguished participants for attending this conference. Last but not least, I thank Dhurakij Pundit University, the National Institute of Development Administration, Thammasat University, Maejo University, Mahidol University, The Engineering Institute of Thailand and all our sponsors for their valuable support.

This is the third time that I co-chair this conference, the other times were when the conference was held in Bangkok in 2002 and 2007. In those two conferences, one prominent individual who was always a strong supporter was Professor Russell Ching. In fact, he was one of the past presidents and had always been a strong proponent of APDSI. It was also his idea to hold this conference in Chiang Mai. I, therefore, felt a great loss when I learnt of his recent, untimely passing. May his soul rest in peace.

Once again, I welcome and wish you all a gratifying conference. I also strongly urge each of you who does not live here, to take advantage of this fascinating and enchanting city of Chiang Mai, before making a safe journey home.

Anumongkol Sirivedhin
2012 Conference
Keynote Speaker and Panelists

Keynote Speaker

Songkiert Tansamrit
Secretary-General, Sustainable Energy Foundation and Director of Green Globe Institute

Panelists

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Full Papers
Accounting / Finance
Energy Price Shocks and Economic Activities in Texas Cities

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Abstract

It is not known how exogenous shocks in oil price impact city economies. This study examines unemployment rates in Texas cities in relation to oil price movements during the period 1995-2008. We find that unemployment in the bigger cities, namely, Austin, Dallas, and Houston is not related to oil price in a significant way when compared to unemployment in the smaller border cities especially in Laredo. Although Texas economy has become more diversified and less vulnerable to oil price movements in the last two decades, smaller border cities still experience the effect of oil price shocks possibly through the neighboring economy of Mexico. Our data indicate significant variations in the unemployment rate in Laredo due to movements in oil price. We observe improvements in the unemployment rates in Laredo as oil price increases.

The full paper is not published by the request of the author
but the review process was based on the full paper.
Effects of Ethical and Moral judgments on Internal Auditors’ Decision Intention

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Abstract

Business ethical scandals are regulatory occurred and become a serious issue. Therefore, the role of internal auditors becomes more and more important. Previous studies of internal auditors’ decision making process have been focused on external ethics effects but few discuss about internal moral effects. Thus, this study broadly investigates the effects of both external ethics and internal morality on internal auditors’ decision making.

Here we develop a new model using both theory of reasoned action and four-component model. Incorporate the ethical intensity and personal value to establish the internal auditors’ decision intention model. This study uses questionnaire to collect data from the internal audit members in Taiwan. Data is further statistical analyze, factor analyze, reliability analyze, regression analyze and structural equation modeling by using SPSS and AMOS software.

Finalize some important components may affect the internal auditors’ decision intention and establish a relative perfection auditing standard. Our findings may lower the business ethics scandals and improve the organization morality through internal auditing.

Key words:
Ethical Intensity, Moral Judgment, Internal Auditors, Personal Value
1. Introduction

In recent years, frequently around the world came Serious ethical scandals storm, causing concern about global business issues of corporate governance, business ethics has become the primary face of the new century the core of business management issues, more enterprises can create a major competitive advantage key (Russell, Marc, & Douglas, 2008). Security from the U.S. Enron bankruptcy case to protect the ability of domestic tyrants in recent years, so electricity companies of the Group have been incidents of fraud emptied, the private interests of individuals in order to strike hurt the company itself has been at the image and reputation, not only interested person a huge serious losses, but also to the prestige of the government agencies are no longer facing the situation. Amassing a growing corruption of corporate ethics, internal auditors relative to making the corporate governance mechanism in the role, function becomes increasingly important.

Selim & McNamee (1999) pointed out that internal audit is as important pillars of corporate governance, internal control system of its design and execution of the effectiveness of the functioning of the internal audit is closely related to the degree. Because of the internal audit of the professional scope of work in-depth internal control structure, across organizations, departments and levels of higher management authority to implement corporate governance effects, and the company's business ethics, corporate culture and promote the maintenance, and moral environment of the shape to create, take very important key part (Schneider, 1970; Ward & Robertson, 1980; Krogstad, Ridley, & Rittenberg, 1999). Therefore, whether an enterprise implement execution of internal control and strengthen the internal audit system for business continuity is very important.

Fishbein & Ajzen(1975) the theory of rational action and the Rest (1986) four-stage model of moral behavior research framework for the foundation, and joined the management issues surface (Ethics intensity) and individual surface (personal values) and other two dimensions, the establishment of decision-making within the organization auditor behavior intention model. The past, rational action theory more than is used in doing science and technology
system, the use of behavioral intention research, this study according to Dubinsky & Loken (1989) ethical decision-making model that rational action theory more clearly explain the ethical dimensions of individual acts of decision-making influence, but in the past few ethical issues to be used in behavioral decision research.

In this study, rational action theory (Fishbein & Ajzen, 1975) and the moral behavior of four-stage model (Rest, 1986) as the basis to discuss the ethical strength, moral judgments, moral awareness, ethical behavior and attitude, subjective ethics, personal values and Behavior of the relationships between the decision-making intentions.

2. Literature Review

(1) What is Ethical or Moral

Ethics and moral in our real life, awash, but the relationship between the differences and the meaning is often confusing, and this study found that over the past number of relevant documents, are often the ethical and moral This is not the same two words to each other substitution mix. Accordingly, the present study the definition of ethics and morality, hoping distinguish the difference between the two.

According to Taylor (1975) pointed out that the group norms but ethical, and moral character and virtue for the individual, that ethical behavior is emphasized that the results generated among populations, while the moral reasons for the emphasis on individual behavior and motivation. And George (1995) argued that ethical thinking is right and wrong behavior and habits of affairs, as well as standardize the criteria for these acts, and includes such acts and habits associated with the values, ethics means in the pursuit of quality of life, its center of gravity create good living conditions for people to help people distinguish between matters of right and wrong and decided to engage in proper behavior.

Buchhoiz & Rosenthal (1998) further suggested that the norms of ethics of the individual and between individuals, between individuals and groups, between groups and organizations such as the interaction between each other,
the corresponding code of conduct. Rue & Byars (2000) also agree with this view that ethics should be an individual or group decision making and behavior guidelines. The Wimalasiri (2004) also endorsed the ethic is not equivalent to moral, ethical norms should be focused is the behavior of groups in the results between groups, but the individual character and virtue ethics, stressing the reasons and motives of individual behavior, that ethics is outside In the code of conduct; and moral virtue is the inner self.

Therefore, this study decided to macro point of view, with internal and external to the moral principles of behavior with the internal auditor making the relationships between intention, to make up for the past more than just a single aspect of the literature of the deficiencies.

(2) Theory of Reasoned Action, TRA

Fishbein & Ajzen (1975) on the theory of rational action in the various constructs are defined as follows:

a. Attitude Toward the Behavior

"Attitude Toward the Behavior" for the individual to perform a target behavior by showing a negative or positive perceptions, positive or negative evaluation, the reaction order to the individual people, events, objects or behaviors good malignant feeling (Fishbein & Ajzen, 1975).

Therefore, this study on ethical behavior and attitude are classified outside surface; and "attitude toward ethics" defined as a Personal Trait from the internal auditors believe that this approach will bring some influence to organize groups, and after an assessment of these effects is positive.

b. Subjective Norm

"Subjective norm" for individuals whether to adopt a particular behavior, the pressure felt by the community (Ferrell & Gresham, 1985). Means in predicting the behavior of others too, those of individual behavior has an impact on decision-making ability of individuals or groups for the individual whether to take a particular behavior of the role played by (Ajzen & Fishbein, 1980).

Therefore, this study will be classified as subjective norms in the ethical side out; and "subjective norm about ethics" is defined as the internal auditor of
subjective decision making that work in a particular group will be recognized by organizational level, the stronger ethics on behalf of subjectivity behavior of individuals engaged in a particular group recognized by the organization or the degree of expected stronger.

c. Behavior Intention

Behavioral intention is that individuals are willing to engage in certain behaviors intention of intensity, to take a particular subjective probability determined behaviors (Fishbein & Ajzen, 1975), reflects the individual behavior of a willingness to adopt specific behaviors; which individuals engaged in some kind of behavior, its willingness to try or the degree of effort to pay.

Therefore, this study defines "decision intention" for the internal audit staff from the personal nature of the impact on individuals and organizations, the more intense, its internal auditors to make decisions on organizational behavior intentions will benefit the stronger.

d. Actual Behavior

Taken by a person actually acts. But because the measurement of the actual behavior of individuals less likely to correct the non-adoption of this study the dimensions.

In conclusion, this study used theory of reasoned action to explore the ethical issues of decision-making of individual behavior. Ethics group norms from the outside look "attitude toward the behavior" and "subjective norm" in internal auditors’ decision intension, theory of reasoned action is the first application of internal morality and external ethics on internal auditors’ decision intention.

(3) Four-Component model of moral behavior

Personal moral decision-making process (Rest, 1986), the main order of the following four stages:

a. Recognizing Moral Issues

In various decision-making process, aware of the problem is the decision-making process of the first, Forrest (1996) said "the moral intention and behavior had occurred, was due to personal perception of moral problems,
rather than the actual production of the issue of timing.

Therefore, this study will be included in the moral awareness of moral and classified; and "moral recognition" is defined as the internal auditor circumstances of the case will go to understand the problem, identify the conditions may be caused by the behavior of programs and the results of the program, and understand who the decision-making to be affected, and to what extent the expected impact.

b. Making Moral Judgments

Moral judgments are based on personal ethical and moral points of Judgement is a breach of ethical behavior (Gifford & Norris, 1987; Reidenbach & Robin, 1990). In addition, the majority of personal moral judgments is the core of development of moral decisions, to judge what is right or wrong decision (Schwepker, 1999), which means to judge what is moral and what is immoral. That is, moral judgments or acts mainly through the concept of faith, and then to a certain human behavior requirements or restrictions.

Therefore, this study will be classified, including moral judgments in moral plane; and "moral judgment" is defined as the internal auditor will be an ethical point of view, from a number of programs to choose from that program of ethical behavior, that individuals from all sides information, to make moral judgments on this issue, and then produce moral intent.

c. Moral Intent

The moral judgments are not the same as followed by action, decision-making should be to establish a moral intent. Moral intent that individuals perform (or not perform) an act of the tendency of the individual intention to exercise (or non-exercise) of the act is the direct determinants of individual behavior (Ajzen & Fishbein, 1980).

Therefore, this study defines "decision intention" done for internal audit staff after the moral judgments to the moral basis of their knowledge, to determine their own how to do and what to do.

d. Moral Behavior

Finally, ethical decision-making process is the final stage in the establishment of moral intent, the individual will be put to really have a real
ethical behavior.

In conclusion, this study used four-stage model of moral behavior to explore the ethical issues of decision-making of individual behavior. From the perspective of ethical behavior within the individual "moral perception" and "moral judgments" on the internal audit staff intention of behavioral decision, was the first use of four-stage model of moral behavior with rational behavior theory of ethical decision-making within and outside Intentions study.

(4) Ethical Intensity

In order to avoid sensitive subjects or moral nature of the question, it is often avoided or deliberately and with the proper code of ethics to answer the general tendency to easily cause of deviations (Reidenbach & Robin, 1988).

Furthermore, Jones that the Rest (1986) four-stage model of moral decision-making at every stage of the process will be subject to ethical strength, its density will show the different ethical different ethical decision-making. Therefore, this study decided to include "ethical intensity" variables to facilitate understanding of the internal audit staff to face violation of their code of ethics cases, the individual decisions made by action. In this study, "ethical intensity" is defined as the perception of internal auditors in the case itself, subject to external code of ethics will have some degree of influence.

(5) Personal Values

According to the literature that personal values affect individual behavior whether ethics and moral decision-making, managers will also affect the development of enterprise strategies (Carman, 1978; Moser, 1988; Ajzen, 1991). It can be seen when the individual acts of decision making, different people will have different behavior decisions.

In the past, many of the personal values of the study, in the case of Rokeach (1973) theory of value is the most famous, the integration of the value of a number of theoretical researchers to develop a comprehensive theory of human values.

Therefore, this study in understanding the behavior of the internal audit staff, while decision-making intention, decided together with discussion of
values, hopes the move will affect the behavior of internal auditors have a better understanding of decision-making intentions and master.

3. Research methods

(1) The data analysis

The study used Statistical Package for the Social Science 17.0 and the Analysis of Moment Structures 7.0 tools for empirical analysis, based on the research and hypotheses need to take the data analysis is as follows:

a. Descriptive Statistics
b. Factor Analysis and Reliability Analysis
c. Regression Analysis
d. Structural Equation Model (SEM)

(2) Sampling and questionnaires

The object of study for internal audit staff, the research variables are designed to make subjects read the violation of code of ethics Scenario-Based Vignette, and then ask key respondents based on the script to understand the internal audit staff in the face of violation of code of ethics case situation, making their behavior intention model. Explore the "ethical intensity", "moral recognition", "moral judgment", "attitude toward ethics", "subjective norm about ethics" and "personal value" in "decision intention" of the relationship between variables, and using likert five-point semantic scale test facilities.

4. Expected completion of the work and achievements of the project

First, the expected completion of the work items:

(1) Understand the theory of reasoned action and the moral behavior of the four-stage model applicability in the field of business ethics.
(2) The establishment of decision-making within the organization auditor behavior intention model.
(3) Of the inner and outer face of the ethical and moral decision-making behavior of internal auditors have a significant impact on intention.

Second, for academic research, national development and the expected
contribution of other applications:

(1) The contribution of academic research
   a. The establishment of internal audit staff conduct policy intention model.
   b. Explore the inner and outer surface is in the ethical conduct of internal audit staff intention to affect the decision-making.

(2) The expected contribution of the enterprise
   a. To help organizations identify the impact of the internal auditor decision behavior intention model.
   b. Of providing organizations to develop codes of conduct of internal auditors when the reference material.

References
Business
Entrepreneurial Orientation Effects on Thai SMEs’ Growth

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Abstract

This study aims to investigate the entrepreneurial orientation effects on Thai SME’s growth, by studying the related theories and researches. The data were collected through in-depth interviews with the experienced experts who are involved with the Thai SME, and other 46 entrepreneurs who are successful in their businesses. The obtained data were then analyzed by comparing, categorizing and summarizing into descriptive essay. The results of the study are categorized into 3 main points: 1) the effects of the entrepreneurial orientation toward Thai SME’s growth were caused by the entrepreneurs’ personal characteristics, for example, managerial knowledge and competency, innovation, pro-active behavior, patience, learning behavior, determination, marketing and competitive analysis skills; 2) the entrepreneurial orientation is related to outsiders, for instance, networking; and 3) the relationship with business owners which allows their employees to express their opinions and to make decision on work.

Keywords: Entrepreneurial Orientation, Small and Medium Sized Enterprise

Introduction

The competition in globalization era drives up all businesses to seek for effective strategies for their business growth and survival. The competition is mainly caused by a limited number of consumers and increasing number of producers, especially in small and medium sized enterprise (SMEs). It is widely recognized that SMEs are crucial for developing economy, communities, social well-being, and employment. They are also considered as the economic foundation and really important for supporting the world economic development (Lowe and Talbot, 2000; Morrison and Ali, 2003). These are witnessed by a great number of the studies presented in many countries on the operation of business strategies affecting SMEs business growth (Evans, 1978; Kangasharju, 2000; Kaikkonen, 2006) and SMEs efficiency (Priyanto, 2006). All of the studies showed that SMEs still have
some problems and limitations in their business growths, such as the employees’ abilities and skills. Only a few SME businesses can develop rapidly comparing to the industry average. Most of other business growth is stable, implying that the number of employees is not increased within a year, and there is a positive relationship between their business plan and their growth (Morrison and Ali, 2003).

The definition of Thai SMEs, small enterprises classified as production industries and service industries employ fewer than 50 persons and which have total fixed assets do not exceed 50 million baths, wholesale industries employ fewer than 25 persons and which have total fixed assets do not exceed 50 million baths and retail industries employ fewer than 15 persons and which have total fixed assets do not exceed 30 million baths. Medium enterprises are defined as production industries and service industries employ between 51-200 persons and which have total fixed assets between 51-200 million baths, wholesale industries employ between 26-50 persons and which have total fixed assets between 51-100 million baths and retail industries employ between 16-30 persons and which have total fixed assets between 31-60 million baths. In Thailand, SMEs have become the major components in economic system, due to their large numbers, 99 percent of the total numbers of registered businesses are SMEs. The businesses also provide more than 77 percent of employment for the entire country, and play an important role in creating value added for 39 percent of GDP (Report of SMEs’ Circumstance from Year 2010 and 2011, 2010 : 1-1 – 1-9) Even though the ratio of the SMEs number is higher when comparing to all businesses, there are two problems occurred:

1) many SMEs are the new businesses;
2) many SME owners are not competent to run their businesses and to develop them in the long run. This can be evident from the failures faced by many businesses. The failure is mainly caused by the lack of entrepreneurs’ knowledge and skills in transferring their specialization to the employees, excessive operating costs, lacking fund and other operation skills (Boonlar, 2007; Report of SMEs’ Circumstance from Year 2007 and 2008, 2008; Chonnaphasathit, 2009).

Regarding to the study of the Office of Small and Medium Enterprise Promotion, and the Faculty of Administration Sciences of Mahidol University (Report of SMEs’ Circumstance from Year 2007 and 2008, 2008 : 6-1) the operation of entrepreneurs in 40 countries around the world has decreased in terms of their competitive ability rank in general from 29th to 30th, because the Thai entrepreneurs’ lack of knowledge and skills in business management,
innovative skills, and product differentiation skills. The studies also indicated that, the Thai entrepreneurs in their initial stages, have lower ratio of exported goods than their counter-partners in other countries in Asia, for example, China and India.

According to the aforementioned reasons, the entrepreneurial orientation effects on the Thai SMEs’ growth is significant to warrant a further in-depth study. There are a large number of the studies conducted by businesses on the entrepreneurial theory, but most their focuses are on various fields, such as social sciences, economics, psychology, history and others related to business operation. One of the studies conducted by Fereira and Azevedo (2007) indicates that entrepreneurial orientation is an important factor affecting economic development.

Previous researches focusing on the studies of the factors affecting services, and how the quality of services impact the consumers’ satisfaction revealed that there were not many studies on the effects of entrepreneurial orientation (Lim, 2009). Therefore, it is reasonable to examine the entrepreneurial orientation effects on the Thai SMEs with the purposes to find out how the entrepreneurial orientation affects the growth of Thai SMEs. The results may offer the entrepreneurs an overview of essential elements of how to operate and assist them to understand the characteristics of successful entrepreneurial businesses.

**Literature Review**

There appeared some suggestions and recommendations from the academicians who worked on the entrepreneurial orientation (EO) as follows.

Miller (1983) provided that the EO concept is a combination of various dimensions to succeed the entrepreneurial orientation, for example, innovation, risk taking and proaction.

Covin and Slevin (1991) expanded Miller’s concept and stated that the entrepreneurial orientation consists of the following aspects:

1. risk taking is unavoidable by entrepreneurs when making decision on the investment or when there occurs uncertain conditions;
2. the frequency and scope of product innovative development which is related to the executives’ level of technological applications;
3. the executives’ natural competitive responses when facing with the competitive intensity in the industrial track.
Lumpkin and Dess (1996) stated that EO was involved with the intention and action of the key players functioning in dynamically generative process who aimed at generating the new-venture. The key dimensions that characterize an EO include a propensity of autonomous action, a willingness to innovate and take the risks, and an aggressive tendency on the competitors and proactive relation to market place opportunity.

Entrialgo (2002) provided that innovation, risk taking and proaction were the entrepreneurs’ orientations in their business operation.

Allen (2006) stated that EO was related to risk taking, especially in the big businesses, and the entrepreneurs had to develop and seek for effective strategies in order to operate their businesses successfully.

The study of EO in other countries has found that the academics applied Millers’ concept comprised innovation, risk taking and proaction. However, Lumpkin and Dess (1996) added two more suggestions on the EO: autonomy and aggressive competition. The researches on EO mostly accept the concepts made by many academicians, for instances, Mintzberge (1973), Miller and Friesen (1984), Miller (1983), Lumpkin and Dess (1996), and Lumpkin and Covin (1997). These experts similarly mentioned that EO was the major factor for business growth and it was the effect on the business development and efficiency (Entrialgo, 2002; Quince and Whittaker, 2003; Krauss, Frese, Friedrich and Unger, 2005; Ferreira and Azevedo, 2007; Lim, 2009; Amran et al., 2009; and Kreiser and Davis, 2009). Besides the general qualifications of the entrepreneurs, there are other factors influential to the development. These factors are: sex, age, educational level, working experience, business size, business networks, and length of business operation (Evans, 1987; Kangasharju, 2000; Hashim et al., 2001; Kaikkonen, 2006; Priyanto, 2006; and Fuller, 2008).

Additionally, the researches synthesized by Rauch, Wiklund, Lumpkin and Frese (2009) stated on the factors affecting entrepreneurial orientation and business efficiency that the entrepreneurs had to be innovative, risk taking and proactive. Most of the researches on EO conducted in America, and then in European countries respectively. In Asian countries, there appeared few studies, particularly in China, Korea, Malaysia, and Vietnam. In Thailand, there are some studies about this conducted, but they cannot represent the whole country. Most of the samples in all of the studies covered a wide range of industries. Rauch, Wiklund, Lumpkin and Frese (2009) also suggested that the future study needs to seek for other factors related to the business
efficiency in order to obviously extend holistic knowledge about entrepreneurial orientation.

The researches on entrepreneurial orientation conducted in other countries from 1983 to 2009 on the measurement of EO, it can be summarized as in the following table.

**Table 1.** The measurement factors of the entrepreneurial orientation.

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<td>Miller (1983)</td>
<td>Innovation, Proaction and Risk taking</td>
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<td>Covin and Slevin (1989)</td>
<td>Innovation, Proaction and Risk taking</td>
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<tr>
<td>Lumpkin and Dess (1996)</td>
<td>Innovation, Proaction, Risk taking, Autonomy and Competitive aggressiveness</td>
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<td>Innovation, Proaction and Risk taking</td>
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<tr>
<td>Krauss, Frese, Friedrich and Unger (2005)</td>
<td>Learning, Achievement, Autonomy, Competitive aggressiveness, Innovation, Risk taking and Personal initiative</td>
</tr>
<tr>
<td>Ferreira and Azevedo (2007)</td>
<td>Innovation, Proaction and Risk taking</td>
</tr>
<tr>
<td>Lim (2009)</td>
<td>Innovation, Risk taking, Autonomy and Competitive aggressiveness</td>
</tr>
<tr>
<td>Amran et al. (2009)</td>
<td>Innovation, Proaction, Risk taking and Competitive aggressiveness</td>
</tr>
<tr>
<td>Kreiser and Justin (2009)</td>
<td>Innovation, Proaction and Strategic Renewal</td>
</tr>
</tbody>
</table>

In Thailand, the studies on entrepreneurial orientation can be found in many researchers, for example Silpcharu (1992); Noppornphitak (1999); Srichattaphimuk (2001); Cheasakul (2001); Parkthin (2003); Thepharannot (2005); Jongwisarn (2005); Jediwong et.al. (2006); Runglertkriengkrai et.al. (2006); Runglertkriengkrai et.al. (2007); Tanvisuth (2007); Tonesakulrungruang (2007); Promkhun (2008); and Institute for Small and Medium Enterprises Development (2011). These studies focused on the factors related to entrepreneurial achievement, entrepreneurial orientation, the relationship between entrepreneurs and international commerce, business direction setting, and marketing strategies under globalization of the enterprises, trends of
laboring needs, desired qualifications of industrial engineers in the industry, leadership and internal motivation, and new direction for developing Thai entrepreneurs. All of these studies are correlative to the notion that the successful entrepreneurs must be honest and patient and having leadership ability.

The studies in foreign countries on EO mostly focused on autonomy, innovation, proactiveness, aggressive competition, and risk taking. These works are different from those of the Thai studies. However, it does not mean that they are limited only on five orientations, as there are other issues related to the EO, based on individual’s orientation, different life styles and cultural contexts.

Research Objective

To investigate the entrepreneurial orientation effects on the Thai SMEs growth.

Research Methodology

Population and Sample

The populations of this study comprised the experts and executives from both governmental and non-governmental sectors, and Thai SMEs entrepreneurs. The informants as the sample group were purposively selected and these included 16 experts and executives from both governmental and non-governmental sectors, who have knowledge and experience in EO, and 30 Thai SMEs entrepreneurs in production, trading and service sectors. The total samples were 46 participants.

Research instruments

The study conducted in-depth interview form which was divided into two parts:

- Personal data. This part drew on the information of the participants about their working position, duration while being in the position, and enterprise category.
The details on assessing the participants’ opinions on entrepreneurial orientation effects on the Thai SMEs growth, and the evaluation of the expected factors affecting the Thai SMEs growth.

The interviews method used consisted of face-to-face interviews and the conversations through telephone by the researcher, together the interviewees were asked to fill in the information in the forms provided.

Data analysis

The analysis processes of this study conducted constant comparison. After transcribing the interview data from the tape records, the transcribed data were then categorized and summarized into descriptive essay. Then the data were compared with those from various studies.

Research Result

The interviews with the entrepreneurs who were successful in their businesses, the return of the interview forms were only 16 series out of 30.

The interviews with the experts in entrepreneurial orientation from both governmental and non-governmental organizations, the return of the interviews forms were only 10 out of 16. These 10 specialists consisted of: 1) the former Governor of the Bank of Thailand, 2) the former Deputy Director General, the Department of Industry Promotion, Ministry of Industry, 3) the Director of Social Entrepreneur Institute, Entrepreneur Development Institute, Department of Industry Promotion, 4) the Director of Strategy and Planning, Department of Industry Promotion, Ministry of Industry, 5) the Director of Business Trade, Office of Industry Promotion, Department of Business Development, Ministry of Commerce, 6) the Academic specialists, Office of Industry Promotion, Department of Business Development, 7) the Director of Institute for Small and Medium Enterprise Development, 8) the Deputy Chairman of the Board of Trade of Thailand, 9) the Director of Skills Development Center, and 10) the Director of Business Incubator and Intellectual Property Center, Ramkhamhaeng University.

Most of these experts have had working experiences in this field for 5 to 30 years. They have dealt with the works on food, fashion, energy, electricity, printed matter, casting, textile, wooden furniture, ceramics, and ‘Sa’ paper in the production industry. Their experiences are also involved with services, retailing and wholesale industries. Most of the entrepreneurs have experienced
for 3 to 40 years in the fields of: production industry, service industry, retail and wholesale industry which were ranked respectively.

**Table 2.** Entrepreneurial Orientation (EO) from the interview

<table>
<thead>
<tr>
<th>Entrepreneurial Orientation</th>
<th>Experts</th>
<th>Entrepreneurs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethics and Honesty</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Learning</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Love and Skills in doing business</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Knowledge and Competency</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Autonomy of expressing opinions and making decision</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Business Network</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Determination</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Opportunity in seeking for doing business</td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

From Table 2, it illustrates that most of the experts had different opinions from the entrepreneurs in the factors affecting the Thai SMEs growth. Most of the experts thought that ethics and honesty, learning, love and skills in doing business, knowledge and competency, autonomy of expressing opinions and making decision, and business network played more important roles, while the entrepreneurs thought that determination and opportunity in seeking for doing business, autonomy of expressing opinions and making decision and ethics and honesty were the crucial factors for SMEs development.

Apart from the data collected through the interviews with the experts and the entrepreneurs, the researcher also collected the data on the evaluation of the expected factors of the entrepreneurial orientation effects on SMEs’ growth by ranking them from 0 to 10. The following table shows the results at the average scores.

**Table 3.** Entrepreneurial Orientation (EO): From the evaluation of the expected factors of entrepreneurial orientation effects on the SMEs’ growth.

<table>
<thead>
<tr>
<th>Entrepreneurial Orientation</th>
<th>Ranking of Average Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Expert</td>
</tr>
<tr>
<td>1. Ethics and Honesty</td>
<td>1</td>
</tr>
<tr>
<td>2. Innovation and Creative</td>
<td>2</td>
</tr>
<tr>
<td>3. Determination of Achievement and Attempt</td>
<td>2</td>
</tr>
<tr>
<td>4. Knowledge and Competency in Management and Leadership</td>
<td>2</td>
</tr>
<tr>
<td>5. Proaction</td>
<td>3</td>
</tr>
<tr>
<td>6. Marketing and Competitors Analysis</td>
<td>4</td>
</tr>
</tbody>
</table>
From Table 3, the experts thought that the ethics and honesty were the primary factors on the entrepreneurial orientation which affected toward the SMEs' growth, followed by innovation, determination of achievement, knowledge and competency in management and leadership, which were ranked respectively. The entrepreneurs thought that ethics and honesty were the most important factors for the entrepreneurial orientation which affected on SMEs' growth, followed by self-management and innovation, which were ranked respectively.

However, the entrepreneurial orientations which were discovered from the interviews and evaluations, they showed that some of the entrepreneurial orientations are similar and some others are different between the two groups of interviewees. The entrepreneurial orientations appeared diverse and different from those in the concepts and based theories, as identified in various studies both from Thailand and abroad.

To assure and confine the consistency of the conclusions reaching on the entrepreneurial orientations, the researcher selected only those which are related to the data collection and analysis from 3 sources: 1) the concepts on entrepreneurial orientation from related theories and researches, 2) the opinions from the experts, and 3) the opinions from the entrepreneurs. The following criteria were utilized for selecting the variables:

- the entrepreneurial orientations which appear in the conceptual frameworks and related theories and researches which are related to the experts’ opinions or the entrepreneurs’ interviews and evaluation;
- if the selected entrepreneurial orientations were not corresponsive to the conceptual frameworks, related theories and researches, the researcher
considered only those which were related to the experts’ opinions and the entrepreneurs’ responses from the interviews and evaluations;

- the selected entrepreneurial orientations from the evaluation were those ranked from top 5 high ranking score of each point, and the average score must be more than 8.

The following tables present the selections of the entrepreneurial orientations effects on the Thai SMEs’ growth.

**Table 4.** EO effects on Thai SMEs’ growth from concepts, theories and related researches.

<table>
<thead>
<tr>
<th>EO from concepts, theories and related researches</th>
<th>Experts</th>
<th>Entrepreneurs</th>
<th>EO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge and Competency and Skills</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Innovation</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Proaction</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Learning</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Patience</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Ethics and Honesty</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Entrepreneur Network</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

**Table 5.** EO effects on Thai SMEs’ growth from the interview

<table>
<thead>
<tr>
<th>EO from the interview</th>
<th>Experts</th>
<th>Entrepreneurs</th>
<th>EO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autonomy in Expressing Opinion and Making Decisions</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Determination in Achievement and Attempt</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Marketing and Competitors Analysis</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
Fig. 1. EO’s Consistency from the opinions of the experts and the entrepreneurs

From Table 5, on the EO effects on the Thai SMEs’ growth from the interviews, it appeared that both the experts and the entrepreneurs agreed at autonomy in expressing opinions and making decision, but not in the determination in achievement and attempt in which found only with the entrepreneurs’ opinion. For the evaluation results, there appeared similar in both groups.

The 10 characteristics of the entrepreneurial orientations (See Table 4 and Table 5) can be summarized in Figure 1. It illustrates that the most outstanding entrepreneurial orientations are ethics and honesty. This is because the data was corresponsive with various studies as well as the experts’ and the entrepreneurs’ opinions. The followed factors which were also important but ranked lower respectively included: patience and determination in achievement and attempt. Moreover, the factors on innovation and proaction also played the crucial roles for the growth of SMEs and this is corresponsive to Miller (1983) and Lumpkin and Dress (1996). Finally, other entrepreneurial orientations appeared in the study are different from those of the foreign studies can be possible since the precedence given to the entrepreneurial orientations depends on business environment, cultural context and entrepreneurs’ styles in each country.
Conclusion

This study aimed to investigate the entrepreneurial orientation effects on Thai SMEs’ growth through the study of related theories and researches, including in-depth interviews with the experts who have experiences on the field, and the entrepreneurs. The results of the study showed that there were 10 characteristics of the EO that affected on the Thai SMEs growth. The study can be summarized as follows:

1) The entrepreneurial orientations have affected toward the Thai SMEs’ growth and they are caused by the entrepreneurs’ characteristics. These include: knowledge and competency in management, innovation, proaction, patience, learning, honesty, determination, marketing and the analysis of competitors.

2) The entrepreneurial orientation is related to the external factor, such as entrepreneurial networks.

3) The entrepreneurial orientation is related to business owners that allow their employees to express their opinions and make decisions.

The study is mainly based on the data obtained from related theories and researches coupled with the interviews with the experts who involved in this field and the entrepreneurs. Further study is suggested to analyze the data applying statistic tool in order to create confidence to assure that the EO affects the Thai SMEs’ growth. In addition, statistical analysis can also help in identifying the direction, influence and magnitude of EO, so as to compare the differences of the entrepreneurial orientation, which may be caused by business characteristics.

Acknowledgements

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A Proposal of Simultaneous Business Design Method Utilizing G-RD

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Abstract. This paper proposes a new Simultaneous Design Method that is called Global Relations Diagram of function and demarcation (G-RD). When enterprises aim to perform BPR, not only the breakdown of business functions but also the design of the relations between businesses is required. Generally, BPR projects perform focusing on the breakdown of business functions but the relations between businesses are not fully designed by conventional design method, Sequential Design Method, in many cases. In order to solve these problems, the modeling approach which details not only the business functions but also the relations is required. This paper introduces several case studies which this Simultaneous Design Method was applied to the BPR projects, and the effectiveness of Simultaneous Design Method utilizing G-RD is evaluated.

Key words: G-RD, BPR, Activity Sequence, Interaction, Goal-oriented, Modeling Approach, Function Point Practices

1 Introduction

Enterprises renovate management strategy and business structure in order to correspond to change of business environment. In recent years, an organizational renovation involving other enterprises is increasing due to merger & acquisition. A Business Structure Renovation is executed toward their own organizational renovation. In the meantime, the needs for these renovations are increasing, and to achieve business objectives, enterprises continuously execute a Process / Operation Renovation. Generally such a Process / Operation Renovation is accompanied by an IT System Renovation. Thus, enterprises must execute continuously three kinds of renovation, Businesses Structure Renovation, Process / Operation Renovation and IT System Renovation.
To design business structure, business process / operation, and IT system, it is necessary to define and break down business functions in detail. It is also necessary to design various relations, such as information or data, among business functions. The knowledge, skill and technology necessary to execute three layers of renovation are different. Moreover the required talent of leaders and members who promote the renovation are also different between layers. When the layer changes, the knowledge, skill or technology transfer will usually lack or change, therefore the objective or designed contents of renovation tend to alter. Also, in the designing and definition phase of renovations, breakdown tends to focus on business functions, and there are many cases that relations are not broken down enough compared to business functions. In order to solve these problems, it is needed that the definition method of business functions which can be applied to three kinds of renovations, and it is needed that the design method to break down in detail but functions and relations.

In this paper, a new business design method which breaks down functions and relations simultaneously is proposed using modeling approach called G-RD (Global Relations Diagram of Function and Demarcation) [1-6]. At the same time, the evaluation criteria is defined to measure what kind of effect is expectable, when this simultaneous design method is applied to several types of BPR (Business Process Reengineering) [7]. To confirm the effects of this simultaneous design method, the study presents some case studies which actually applied this method.

2 The problems of design method utilizing conventional modeling approach

2.1 Three modeling approaches utilized for BPR

There are various modeling approaches which are utilized for BPR. Firstly, Activity Sequence defines activities, then improves and evaluates the sequence of activities. This modeling approach is applied to improve routine a work in one section. As an example for this modeling approach, there is DFD (Data Flow Diagram). This modeling method enables to describe activities and sequence of activities in detail, so usually utilized to analyze business processes. Secondly, Interaction considers operation as an interaction between the requester and conductor. This modeling approach is applied to improve operation between several sections. As an example for this modeling approach, there is Use Case. This modeling method is effective to grasp the roles of human and events of operation, so usually utilized to analyze IT system. At last, Goal-oriented defines the business goals to various processes and improve
processes. This modeling approach is applied to improve business processes drastically in cooperate level. As an example for this modeling approach, there is BSC (Balanced Scored Card). This modeling method is effective to reveal the improvement initiatives in cooperate level. These representative modeling approaches can be classified in three groups according to the objectives and the applied scope as shown in Table 1. [8].

Table 1. The feature of three modeling approaches

<table>
<thead>
<tr>
<th>Modeling approach</th>
<th>Activity Sequence</th>
<th>Interaction</th>
<th>Goal-oriented</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>Improve and evaluate the sequence of each activity under the obvious goal and constraints.</td>
<td>Improve the interaction between the requestor and conductor of the operation, and improve the customer satisfaction.</td>
<td>To achieve the business goals, define goals to various processes and improve processes.</td>
</tr>
<tr>
<td>Applied scope</td>
<td>To improve a routine work in one section.</td>
<td>To improve value provided to customer through renovating cross-functional operations.</td>
<td>To improve business processes drastically in cooperate level.</td>
</tr>
<tr>
<td>Key data of Modeling</td>
<td>Inputs / outputs, activity sequences</td>
<td>Roles and Operational events additionally to left item.</td>
<td>Goals additionally to left item.</td>
</tr>
<tr>
<td>Evaluation criteria</td>
<td>Speed, cost, quality</td>
<td>Customer Satisfaction</td>
<td>Various business goals</td>
</tr>
<tr>
<td>Conventional modeling methods</td>
<td>Integrated DEFinistion methods (IDEF), Data Flow Diagram (DFD), Activity Diagram</td>
<td>Use case, CN model</td>
<td>BSC (Balanced Scored Card) Model, Unified Modeling Language (UML), Goal Model</td>
</tr>
</tbody>
</table>

Activity Sequence modeling approach is effective to analyze and improve process / operation and IT system by breaking down the objects. However, it is difficult to describe the relationships between activities, since this modeling approach mainly focuses on the activities and sequence.

On the other hand, Interaction modeling approach is effective to analyze and improve process / operation and IT system by breaking down the relationship between requestor and conductor. However, it is difficult to aggregate the activities as Activity Sequences, since this modeling approach mainly focuses on the relationship of activities, and thus each activity is described in various places.

As mentioned above, Activity Sequence has a disadvantage in describing the overview of relationships. On the other hand, Interaction has a disadvantage in describing the overview of activities. When designing the business operation, it is necessary to break down both business functions and business relationships. The business functions are broken down utilizing Activity Sequence modeling approach. As the breakdown proceeds the layer gets deeper and the number of charts increases. This makes it more difficult to grasp the linkage with original
business described in upper layer. Meanwhile, the business relationships are 
broken down utilizing Interaction modeling approach. As the breakdown 
proceeds the process flow gets longer and becomes impossible to describe in 
one sheet. This makes it more difficult to trace the whole processes. Therefore 
it is difficult to describe the overview of both business functions and business 
relationships simultaneously by one modeling approach.

Generally, multiple modeling approaches are combined for business design, 
the conversion among multiple modeling approaches must be done by hand. As 
the scope of modeling gets bigger, communication between members (i.e. stake 
holders such as project leader, project members, engineers, architects and users) 
gets insufficient, causing a lack or duplication of information during the 
conversion.

2.2 The flow of business design and modeling approach

Business design usually is accompanied by IT system development as a 
following step. Assuming to advance to IT system development, business 
design is executed in sequence of eight steps utilizing optimal modeling 
approach in each step as Fig. 1. [9].

The first step of business design, “Theme Definition” is executed to achieve 
business goals based on business strategy. In this step, Goal-oriented modeling 
approach is utilized. The following step is “Business Requirement Definition”.
“Business Requirement Definition” focuses on functions and relations. Thus in 
this step, Interaction modeling approach is utilized. Then, this step is followed 
by “System Requirement Definition” which breaks down the business 
functions. Thus, Activity Sequence modeling approach is utilized in this step.
“System Design” and “Program Development” succeed the step of “System 
Requirement Definition”. Activity Sequence modeling approach is also utilized 
in these steps. “Integration Test” is executed for both broken down functions 
and interfaces between different functions to verify both of them. In this step 
Activity Sequence and Interaction modeling approaches are utilized. “System 
Test” succeeds “Integration Test” which verifies interfaces. In this step, 
Interaction modeling approach is utilized. At the last in “Employment”, 
Process / Operation and IT system are utilized to achieve the business goal 
deﬁned in the ﬁrst step, “Theme deﬁnition”. Hence, the Goal-oriented 
modeling approach is utilized in this step.
2.3 The problems of conventional modeling approach

Business and IT requirement definitions are usually performed in sequence as the following, after the business design theme definition. (1) Design main interactions of business processes, (2) Aggregate main activity sequences of business functions, then (3) Break down the aggregated activity sequences as a design unit. At each design step, the most suitable design modeling approach is selected and designed in sequence. As the design step proceeds the utilized modeling approach changes. For example, to design the Sales order processing / Delivery process, conventional design is performed as Fig. 2. Business process is designed by DFD (Data Flow Diagram) which is one of the Interactions modeling approach. The function is designed by SDF (Structured Data Flow) which is one of the Activity Sequence modeling approach [10].

In this design method, the linkages between business processes outside of SDF, are disconnected during the breakdown of function. The newly designed linkage inside one SDF is not reflected toward outside of that SDF. As the result, broken down linkage is not designed as an interaction. It will be never broken down without going back to business process design. By this, the newly designed linkages are left without being reflected into business processes. In this Sequential Design Method, even the most suitable modeling approach is selected for each design step, when the design step proceeds and the modeling
approach changes, the broken down contents of current step are not reflected in the outcomes of previous step. This causes a step back to business process redesign after the breakdown is executed.

(1) Design main Interactions (Business Processes)

(2) Aggregate main activity sequences (Business functions)

(3) Break down the aggregated activity sequences as a design unit

Fig. 2. The procedure of Business and IT requirement definition
3 The perspective of the new business design method

3.1 The perspective of the design method utilizing G-RD

The new business design method executes “Business Requirement Definition” and “System Requirement Definition” simultaneously after “Theme Definition” as shown in Fig. 3. The feature of G-RD is breaking down functions and relations simultaneously using layers. This design method allows the detailed design to be described in one chart. In this way, the problem of the conventional design method is solved. (i.e. the information on the chart broken down at a step is not reflected in the chart of the preceding step) Consequently, the problem that lack of the contents of the design or duplication of the contents of a design occurs at the time of design steps, which is caused by insufficient communication when the design step proceeds. And the problem of deterioration of design contents can be prevented with this design method.

Fig. 3. The new flow of business design utilizing G-RD
3.2 Validity evaluation of the Simultaneous Design Method

The efficiency of the design method which breaks down Activity Sequences and Interactions simultaneously utilizing G-RD is evaluated by comparing the estimation in the development scale of an information system, by using the Sequential Design Method and by Simultaneous Design Method proposed in this paper.

Generally, the development scale of an information system is estimated by accumulating the development scale required for each activity in the viewpoint of an Activity Sequences. In Sequential Design Method, designing a business process / operation is performed by focusing on Activity Sequences. In this case, it is thought that activity is performed by input from external activity and cooperates to another external activity. This is the design method generally called IPO (Input Process Output).

An activity is exchanged into the system processing unit called FP (Function Point). An activity is broken down into three processes as shown in Fig. 4. Three processes are the entrance process which receives the input from the outside, main processing of the activity containing an algorithm, and exit process which sends the output to the outside. In the Function Point method (FP method) which Albrecht advocated, function points are estimated using three transaction functions, an input, output and enquiry, and two data functions, an external interface file and an internal logic file [11].

In general, since the FP method is used in the stage which detailed functions is determined, such as a screen of an information system and a database, these five items are used for measurement. On the other hand, the development scale of the information system estimated at business design phase is performed when none of detail function, such as a screen of an information system and a database, is determined. Therefore, in this stage, it won’t be enough assure as original FP method, but it is utilized as an estimation to compare the efficiency of Simultaneous Design Method.

Here, an external interface file is included in an external input or an external output, and external enquiry is included in an external input. Therefore, FP is used to three items, an external input, an external output, and an internal logic file.

The number of relations will be 6 times of the number of activities as Fig. 4, if relations to the exterior, relation to the entrance processing and relation to the exit processing are included. In the estimation by an Activity Sequences, since the track record of the number of relations is not clear, the number of relations is assumed to be 6 times of the number of activities. This figure is used as a standard unit of the estimation of the Sequential Design Method.
The Simultaneous Design Method carries out the design which breaks down functions as well as the Sequential Design Method. So the number of activities is same, which is the standard unit of FP related to the development scale of information system.

Instead, if the number of relations is estimated by the Design Method using G-RD, the number of relations is clearly acknowledged and it will become the designed number of relations itself. Comparing to this, in Sequential Design Method, the number of relations is estimated to 6 times of the number of activities. This number of relations designed by utilizing G-RD and the number of assumption designed by an Activity Sequence are compared and evaluated. The validity of the Simultaneous Design Method which utilized G-RD is evaluated by considering the number of elements and relations by difference of the design method.
4 Business Design Method utilizing G-RD

4.1 The concept of G-RD

G-RD is a modeling approach that defines Element as the roles or functions of business operation / process and IT system. The linkages among Elements are defined as Relation, any structure such as structure of businesses, structure of organizations or structure of information systems can be dealt as a same object. When Elements are plotted in the diagonal of square matrix, Relations are described at the intersections of the column and the row of two Elements. As a result, the position of intersection expresses the in-element and out-element at the same time.

Focusing on Elements, outbound from one Element will be expressed in vertical direction and inbound will be in horizontal direction as Fig. 5, thus the direction of Relation is determined. To say it in another way, the column number of Relation expresses in-Element and the row number of Relation expresses out-Element. This means that Relations are able to be expressed in one-way as counterclockwise and an arrow or line is not necessary. Based on these concepts G-RD, utilizes Square matrix, Elements and Relations.

Fig. 5. The rule of expressing Relation in G-RD
4.2 The description method of G-RD

4.2.1 The concept of G-RD

G-RD is generated by the following design step shown in Fig. 6. As mentioned before, Square matrix, Elements, and Relations are utilized to form G-RD to describe the structure of business and linkage efficiently. First of all, prepare Square matrix as Step1. Then, Step2, define Elements and plot Elements as a heading of Square matrix. In Step3, plot Elements on diagonal line from the heading set in Step2. At last in Step4, fill Relations into cells that connect Elements. After these Steps, confirm that there is no lack or duplication.

**Fig. 6. Design step of G-RD**

4.2.2 Square Matrix

Square Matrix: M(y, x) is a base work-sheet to create G-RD. M(y, x) is a square matrix of y=x. y and x are equal to maximum values n of the number of Elements. G-RD can be shown with M(y, x) as Fig. 7. The column of the matrix is called y-axis and the row is called x-axis. Each arbitrary intersection on the matrix is called cell C. The cell can be described by its position with two axes such as C(y=1, x=1), C(y=2, x=2) ... C(y=n, x=n). As first, this Square Matrix is created as Step1.

**Fig. 7. Sample of Matrix M(y, x)**
4.2.3 Elements

The Element expresses the allotment of the role. The Element can express organization, functions or resources. The user defines and utilizes the kind of the Element arbitrarily.

Elements : \(E(e), e=1, 2, \ldots, n\)

Element number ”e” only expresses the position of the Element, and it does not express the meaning of the Element. \(n\) describes the maximum number of elements and the user determines its definition arbitrarily. Elements are arranged as header of y-axis and x-axis. (Step2). For instance, matrix \(M(26, 26)\) is shown in Fig. 8 when the user allocates the function(A to Z) to the elements \(E(e): e=1\) to 26. First, the Elements are arranged from left to right of x-axis, such as \(C(y=0, x=1) = E(1)\), \(C(y=0, x=2) = E(2)\), \(C(y=0, x=3) = E(3)\), and \(C(y=0, x=26) = E(26)\). Next, the same Elements are arranged from the top to the bottom of y-axis as well as x-axis such as \(C(y=1, x=0) = E(1), C(y=2, x=0) = E(2), C(y=3, x=0) = E(3)\), and \(C(y=26, x=0) = E(26)\).

Finally, the user stores the Elements in each cell on the diagonal line of \(M(26,26)\) such as \(C(y=1, x=1) = E(1), C(y=2, x=2) = E(2), C(y=3, x=3) = E(3)\), and \(C(y=26, x=26) = E(26)\). As a result, these cells become the same contents as header. A layout of Elements is showed as Fig. 8. (Step3)

4.2.4 Relations

Relations connect and explain the relationships between Elements. Relations can express follow items, knowledge, information, direction, instruction, report, response, approval, authorization, license, permission, publication, physical existence(for example, materials, products, goods), etc. The user defines and utilizes Relations according to the purpose of the linkages.

Relations : \(R(r), r=1, 2, \ldots, m\)

The number of Relations, “\(r\)”, only shows uniqueness in the mark, and it does not show the meaning of the Relations. The user arbitrarily defines \(m\) by the maximum number of Relations. The Relation has an in-Element and out-Element. The description rule of Relations is defined that the direction of y-

---

Fig. 8. Layout of Elements
axis (vertical direction) is an in-Element of the Relation. Moreover, it is
assumed that the direction of x-axis (horizontal direction) is an out-Element of
the Relation.

Therefore, the Relation can be expressed by one-way as counterclockwise.
A Relation can be plotted in the cell where an in-Element’s column and out-
Element’s row intersect. When the Relations between Elements are expressed,
Relation R(m) from Element E(x) to Element E(y) is described in cell C(y, x).
Relation from a certain Element to another Element utilizes the y-axis cell
(vertical direction).

According to this rule, when the user takes out all the Relations written in
the same row of y-axis (vertical direction), all Relations of the Elements
written in the row heading can be expressed as a list. These Relations (vertical
direction) show the Relations that should be accumulated in the data base such
as ledgers, vouchers, invoices and reports.

As well as above, Relation from a certain Element uses the x-axis cell
(horizontal direction). By this rule, when the user selects all the Relations
written in the same column of x-axis (horizontal direction), all the Relations of
the Elements written in the column heading can be expressed as a list. These
Relations (horizontal direction) express the transaction such as noticing,
sending and receiving, which occurs to each Element.

This rule is illustrated in Fig. 9. There are two cells, C(y=3, x=3) and C(y=6,
x=6). C(y=3, x=3) becomes E(3). C(y=6, x=6) becomes E(6). Relation R(1)
from element E(3)= C to element E(6) = F is described in cell C(y=6, x=3).
Similarly, Relation R (2) from element E (6) = F to element E(3) = C is
described in cell C(y=3, x=6). (Step4)

Multiple Relations of a different meaning can be plotted in cell C(y, x). For
instance, as shown in Fig. 10, two Relations, R(3) and R(5), is related from
Element B to Element C in cell C(3, 2). Moreover, R(r) which has the same
content may cooperate with multiple Elements E(e). And Relation R(2) of the same content is related from Element F to Element B and Element C.

4.2.5 Breakdown method utilizing Level

Elements and Relations are able to break down in multiple levels. The sorts of level both exist for Elements and Relations.

Elements at each level : E(e, le)
Relations at each level : R(r, lr)

The level of Elements : (le), le = 1, 2,..., j
The level of Relations : (lr), lr = 1, 2,..., k

Level numbers (le) and (lr) do not express the absolute level but expresses the relative level. The level of Elements and Relations can be defined individually. Even if the number of level is same, it does not mean that Element and Relation are in the same level. The user defines and utilizes Level of Elements and Relations, according to the maximum depth of level to analyze. However, the level utilized for Elements or Relations should be defined as same degree of depth. For example, Elements, E(1,1) and E(2,1), should be broken down in the same level. In this chapter, an example of breaking down E(e, le) into one lower Level is shown.

Fig. 11 illustrates the procedure to breakdown level of Element C. First add rows and columns as the number of broken down Elements C1, C2 after Element C. In Fig. 11, two rows and columns are added. Then next, add Element C1 and C2 into diagonal line. Fill in Relations, R(m), that Element C receives in each row in expanded Matrix, in Fig. 11, R(2), R(3) and R(5) are
added. As well as this, fill in Relations that Element C sends toward expanded Matrix. For this example, R(1) is added in C1 column. Repeat this procedure in order to break down Element, E(n). Through this procedure, breakdown can be conducted by capturing whole Relations.

When any new Relation was found through breaking down Elements, add the new Relation, R(m), at the same time of expanding the Matrix. In Fig. 11, the R(6) that Element D is sending to Element C1 is added, and this R(6) is also copied to column of Element C. R(7) that Element C1 is sending to Element D is copied to row of Element C as well. Adding Relations into row or column of original Element means that moving back to breaking down Interaction from breaking down Activity Sequence, that was rarely hard to conduct in conventional method, Sequential Designing Method. By this feature, it is possible to reduce the risk that missing Elements or Relations as designing phase. Additionally, it enables adding new Elements and breaking down Relations by confirming the in-Element and out-Element. As mentioned above, the breakdown method utilizing G-RD with level enables breaking down Interaction and Activity Sequence in simultaneous, which was difficult in Sequential Designing Method.

![Fig. 11. Sample of breakdown utilizing G-RD](image-url)
5  A case study of new business design method

5.1  A case study of food-service company A

At the BPR project of the food-service company A, the functions and relations of business were designed simultaneously using G-RD. The new business operation of company A was launched as planned. The businesses of company A were broken down by structurizing the business operation as shown in Fig. 12 in the business design step.

First, whole business operation / process were classified into Staff business operation, such as head office business, and Line business operation, such as store operation. Staff business operation such as store location analysis, management operation such as store budget control, and basic operation such as foods and material purchasing at stores were broken down to the practical level.

Line business operation was classified into two business area by their function, Planning business and Execution business, and operating relations were designed. The relations of business based on this level were designed by G-RD. The number of Elements of G-RD was 61 and the number of Relations was 415.
Fig. 12. Business Structure of company A
5.2 Application effect of new design method and consideration

The development estimation can be summarized as shown in Table 2, if the estimation method of the development scale shown in Section 3.2 is applied to this case study of food-service company A. The number of Elements is 61, the number of Relations is 415 designed utilizing G-RD as mentioned Section 5.1, and the number of Relations was 6.80 times the number of Elements.

If the numbers of Elements and Relations are estimated by modified FP method shown in Section 3.2, the number of Elements will be 61 and the number of Relations will be 366, 6 times as much as the number of Elements. There are more 49 relations designed using G-RD than estimated by modified FP method. The ratio of the number of Relations is 415/366=1.13. This has suggested that there is possibility of the omission in a design in the early stage of the information system design, when breaking down the businesses by the conventional Sequential Design Method focusing on Activity Sequence.

Moreover, if it were estimated and developed by the Sequential Design Method, 13% of shortage of workload would have occurred. A case study of company A is application of G-RD to improve the business efficiency. As well as company A, a case study of company B is application of business integration after M&A, and a case study of company C is application of G-RD to large scale ERP implementation. The result of these cases is also summarized in Table 2. For any case, there was more Relations designed utilizing G-RD than those estimated by modified FP method.

The ratio of the number of Relations was 1.33 at company B and 1.25 at company C. It is suggested that Table 2 shows the effect of the Simultaneous Design Method which utilized G-RD in the promotion step of each business structural renovation. (Business Structure Renovation, Process/Operation Renovation and IT System Renovation)

<table>
<thead>
<tr>
<th>Items</th>
<th>Company A</th>
<th>Company B</th>
<th>Company C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>Business efficiency improvement</td>
<td>Business integration after M&amp;A</td>
<td>Large scale ERP implementation</td>
</tr>
<tr>
<td>Result of Simultaneous Design Method</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The number of Elements (1)</td>
<td>61</td>
<td>97</td>
<td>40</td>
</tr>
<tr>
<td>The number of Relations (2)</td>
<td>415</td>
<td>773</td>
<td>300</td>
</tr>
<tr>
<td>The ratio of standard unit (3)=(2)/(1)</td>
<td>6.80</td>
<td>7.97</td>
<td>7.50</td>
</tr>
<tr>
<td>Estimated by Sequential Design Method</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The number of Elements (4)=(1)</td>
<td>61</td>
<td>97</td>
<td>40</td>
</tr>
<tr>
<td>The number of Relationship (5)=(4)*6</td>
<td>366</td>
<td>582</td>
<td>240</td>
</tr>
<tr>
<td>The ratio of standard unit (6)=(5)/(4)</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

Evaluation

| Deviation of Relations (7)=(2)-(6) | 49 | 191 | 60 |
| Comparison of standard unit (8)=(3)/(6) | 1.13 | 1.33 | 1.25 |
Next, case studies of applying G-RD to ten companies are considered. These case studies are divided into two groups by five each, one is the Business Requirement Definition and the other is System Requirement Definition. The track record of five companies which applied the Simultaneous Design Method to Business Requirement Definition phase is shown in Table 3. For all cases, it is shown that the ratio of the number of Relation has exceeded 1 and the Simultaneous Design Method is effective. The track record of five companies which applied the Simultaneous Design Method to the System Requirement Definition phase is shown in Table 4. For four of five cases, it is shown the ratio of the number of Relation has exceeded 1 and the average ratio of five cases of Relation is 1.05, so it can be suggested that the Simultaneous Design Method is effective.

Moreover, the average ratio of the number of Relations is 1.26 for Business Requirement Definition and it is larger than that of System Requirement Definition. It can be suggested that Simultaneous Design Method is more effective to apply to early stage of designing phase by utilizing Simultaneous Design Method.

Table 3. The evaluation of effectiveness for Business Requirement Definition

<table>
<thead>
<tr>
<th>Items</th>
<th>Company A</th>
<th>Company B</th>
<th>Company C</th>
<th>Company E</th>
<th>Company F</th>
<th>Average</th>
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<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>The number of Elements (1)</td>
<td>61</td>
<td>97</td>
<td>20</td>
<td>47</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>The number of Relations (2)</td>
<td>415</td>
<td>773</td>
<td>187</td>
<td>287</td>
<td>226</td>
<td></td>
</tr>
<tr>
<td>The ratio of standard unit (3)=(2)/(1)</td>
<td>6.80</td>
<td>7.97</td>
<td>9.35</td>
<td>6.11</td>
<td>7.53</td>
<td></td>
</tr>
<tr>
<td>Estimated by Sequential Design Method</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The number of Elements (4)=(1)</td>
<td>61</td>
<td>97</td>
<td>20</td>
<td>47</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>The number of Relationship (5)=(4)*6</td>
<td>366</td>
<td>582</td>
<td>120</td>
<td>282</td>
<td>180</td>
<td></td>
</tr>
<tr>
<td>The ratio of standard unit (6)=(5)/(4)</td>
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<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Evaluation</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deviation of Relations (7)=(2)-(6)</td>
<td>49</td>
<td>191</td>
<td>67</td>
<td>5</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td>Comparison of standard unit (8)=(3)/(6)</td>
<td>1.13</td>
<td>1.33</td>
<td>1.56</td>
<td>1.02</td>
<td>1.26</td>
<td>1.26</td>
</tr>
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</table>

Table 4. The evaluation of effectiveness for Business Requirement Definition

<table>
<thead>
<tr>
<th>Items</th>
<th>Company C</th>
<th>Company G</th>
<th>Company H</th>
<th>Company I</th>
<th>Company J</th>
<th>Average</th>
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</thead>
<tbody>
<tr>
<td>Result of Simultaneous Design Method</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The number of Elements (1)</td>
<td>40</td>
<td>44</td>
<td>64</td>
<td>55</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>The number of Relations (2)</td>
<td>300</td>
<td>266</td>
<td>386</td>
<td>331</td>
<td>330</td>
<td></td>
</tr>
<tr>
<td>The ratio of standard unit (3)=(2)/(1)</td>
<td>7.50</td>
<td>6.05</td>
<td>6.03</td>
<td>6.02</td>
<td>5.79</td>
<td></td>
</tr>
<tr>
<td>Estimated by Sequential Design Method</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The number of Elements (4)=(1)</td>
<td>40</td>
<td>44</td>
<td>64</td>
<td>55</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>The number of Relationship (5)=(4)*6</td>
<td>240</td>
<td>264</td>
<td>384</td>
<td>330</td>
<td>342</td>
<td></td>
</tr>
<tr>
<td>The ratio of standard unit (6)=(5)/(4)</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Evaluation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deviation of Relations (7)=(2)-(6)</td>
<td>60</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>-12</td>
<td></td>
</tr>
<tr>
<td>Comparison of standard unit (8)=(3)/(6)</td>
<td>1.25</td>
<td>1.01</td>
<td>1.01</td>
<td>1.00</td>
<td>0.96</td>
<td>1.05</td>
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</table>

For renovation projects utilizing the conventional Sequential Design Method, there are many cases that must move backward, as the breakdown proceeds and the lack of designing found. As a result of this, workload shortage or delay in
delivery has occurred, it prevents lack of design and the accuracy of estimation will be higher, it can be suggested that it is effective method for designing Business operation / process.

6 Conclusion

It is possible to break down the Activity Sequence and Interaction at the same time by utilizing Simultaneous Design Method. In this proposed Simultaneous Design Method, it is possible to grasp the number of function and clarify the number of relationships simultaneously from the early stage of designing phase. So it is possible to prevent or decrease the risk of lacking design at the Business Requirement Definition step which positioned at the early stage of System Requirement Definition step. Through several case studies, it is suggested the G-RD is effective method to each designing phase of Business Structure Renovation, Process/Operation Renovation and IT System Renovation. The functions and relationships that must be designed in three stages are equal with the whole role that cooperation possesses and the width between internal and external of operation / process. Therefore, G-RD is expected to expand its capability and application area, as one of the effective modeling approaches to promote business designing.

References

Entrepreneurial perspective and entrepreneurial intention: a test

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Abstract. 389 nascent entrepreneurs in Bangkok, Thailand who were participating in a government sponsored entrepreneurship training program responded to a survey to examine the influence of role models of venture founders on subsequent entrepreneurial perspectives and intention to found their own business. Results indicate that the new construct, Entrepreneurial Perspective significantly explains more than thirty percent of the variance in entrepreneurial intention among training program participants.

1. Introduction

The primary goal of all entrepreneurship education is to increase new venture creation, which means more people choosing entrepreneurship as a career. The current research provides a theoretical basis and initial validation of a construct, Entrepreneurial Perspective, which reflects the psychological basis of entrepreneurship career choice behavior. Research indicates that one’s perceptions of entrepreneurship, in addition to one’s career choice, are impacted by several factors. The proposed Entrepreneurial Perspective construct synthesizes factors, which are directly involved in career choice in general and the choice to become an entrepreneur specifically and which can be affected by formal education.

2. Entrepreneurship Education

Entrepreneurship education/training program is the process of providing individuals with the concepts and skills to recognize opportunities that others have overlooked and to have the insight, self-efficacy and knowledge to act where others have hesitated. It includes instruction in opportunity recognition, marshaling resources in the face of risk, and initiating a business venture. It also includes instruction in business management processes such as business planning, capital development, marketing, and cash flow analysis.

Realizing its importance, academics and politicians have sought to identify effective devices of economic development that professionals might make
available to entrepreneurs. In this regard, entrepreneurship education in the form of training programs has been one of the most popular components (Bisk, 2002), which have been in operation since the early 1990s. It is not a degree or academic credit program; instead, it is an economic development program that oriented toward the provision of actual practical experience in developing quality business plans which are capable of implementation. Entrepreneurship education is crucial. Wan (1988) stresses that moving from a resource-based economy to a technology-based economy can only be accomplished by training entrepreneurs who are capable of developing successful and innovative businesses. Tambuna (2007) contends that training in entrepreneurship has become an important part of development government-supported programs for the development of SMEs.

Kuratko and Hodgetts (2004) argue that the “essential ingredients,” for those who would be entrepreneurs include: the “vision to recognize opportunity where others see chaos, contradiction, and confusion”, a willingness to take calculated risks (time, equity, or career), creativity in the acquisition and allocation of resources, and the ability to assemble an effective venture team. “Entrepreneurial Perspective” is proposed in this research to include entrepreneurial self-efficacy, entrepreneurial attitudes and beliefs, and knowledge of entrepreneurial skills. Each contributes to attaining these important essential ingredients. Dimensions included within the Entrepreneurial Perspective construct subscribe to three key criteria. First, each dimension of the proposed construct directly impacts intention in some way. Second, each has been deemed relevant to entrepreneurship and one’s choice to become involved with it. Finally, the proposed dimensions all can be developed through education and are susceptible to change initiated by outside forces. When focusing on a desired end, it is important to understand the impressionable variables which constitute appropriate means. Below the theoretical foundations for the inclusion of these factors are laid out.

3. Theoretical Foundations of Entrepreneurial Perspective

3.1 Social Cognitive Career Theory

Entrepreneurial Perspective is rooted in the idea that individuals will not choose something with which they are unfamiliar and in which they are, therefore, uninterested. Social Cognitive Career Theory (Lent et al., 1994) stems from Bandura’s (1986) general social cognitive theory and includes complex reciprocal interactions between people, their behavior, and their environments provides a foundation for understanding the importance of establishing interest as a component of career choice. Bandura’s theory included elements of symbolizing, forethought, vicarious learning, self-
regulation, and self-reflection. With the understanding that individuals must believe they have the capabilities to affect their environment and control their actions in ways that produce desired outcomes, Bandura (1986) advanced the concept of self-efficacy out of his SCT model.

Social Cognitive Career Theory (SCCT) applies SCT to career development and emphasizes the complex reciprocal interactions of three “person variables” for purposes of career development: self-efficacy beliefs, outcome expectations, and personal goals (Lent, 2005; Lent et al., 1994). Self-efficacy beliefs encompass an individual’s assessment of his/her capacities to organize and implement courses of action required for a designated performance level. These beliefs are crucial to behavior and may be acquired and modified through four sources of information: 1) Personal performance accomplishments, 2) Vicarious learning, 3) Social persuasion, and 4) Psychological affective states. Outcome expectations surround beliefs about the outcomes or consequences of carrying out specific behaviors. Personal goals refer to one’s intention to engage in a specific activity or produce a specific outcome (Lent, 2005).

In SCCT, three conceptually distinct, interlocking models are included: 1) the development of academic and career interests, 2) the formation of educational and vocational choices, and 3) the nature and results of performance in academic and career spheres (Lent, 2005). The interest model is of primary consideration for this study. In the interest model, self-efficacy and outcome expectations about specific behaviors help shape career interests (among many other things in the model). “Interest in an activity is likely to blossom and endure when people view themselves as competent (self-efficacious) at the activity and anticipate that performing it will produce valued outcomes (positive outcome expectations)” (Lent, 2005: 106). The choices model is also of interest for this inquiry, as an individual’s choice is the eventual object of influence in this study. In SCCT’s choices model, career choice is preceded by numerous sub-processes, which make certain career path options available and attractive. Because the choice process is dynamic in nature, it is continually subject to change as a result of individual experiences. The SCCT model holds that career selection is a process of revelation comprised of multiple influences and several decision crossroads (Lent, 2005).

3.2 The Theory of Planned Behavior

The Theory of Planned Behavior is also a foundational theory for this research (see Figure 1). This theory and its root theory, the Theory of Reasoned Action, draw ties between intention and action. Both theories maintain that behavior can be impacted to the degree that intentions are influenced. Thus, intentions are our closest measurable link to behavior. The Theory of Planned
Behavior has been applied to nearly all voluntary behaviors in very diverse fields, including professional career choice (Ajzen, 2001; Kolvereid, 1996) and entrepreneurship (Krueger et al., 2000). In this study, Entrepreneurial Perspective is hypothesized to impact entrepreneurial career intentions.

**Fig. 1. The Theory of Planned Behavior**

The Theory of Reasoned Action (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975) proposes attitudes (evaluations of behavior) and subjective norms (perceived social pressure from significant others) determine individual intentions. This theory is rooted in Fishbein’s (1967) early work on the summative model of attitudes, which proposes that while individuals may hold vast and various beliefs about a particular behavior, only a subset of these beliefs are likely to be relevant at any one given point in time. Thus, both determinants of intention, attitudes and subjective norms, are developed from salient underlying beliefs.

In the model, behavioral beliefs consisting of two components – an outcome belief and an outcome evaluation – determine attitudes, which impact intentions. An outcome belief surrounds the likelihood of a certain outcome occurring, while outcome evaluation deals with the value assigned to each outcome. Beliefs and evaluations are weighted and combined to for behavioral beliefs (Armitrage & Christian, 2004). Similarly, subjective norms are the product of an individual’s referent beliefs and motivation to comply. Referent beliefs concerning subjective norms deal with the perception of the social influence on an individual, while motivation to comply refers to the degree to which one values the social influence. The two sets of beliefs, then, interact to impact behavioral intention.

A criticism of the Theory of Reasoned Action was that it failed to include some sort of individual control over behavior. To address the issue, the Theory of Planned Behavior (Ajzen, 1988, 1991) expanded the theory of Reasoned
Action to include perceived behavioral control. The logic behind this inclusion was that the greater perceived control, the greater the chance of successfully carrying out the behavior. In addition, the theory also proposes that to the extent that perceived behavioral control reflect actual control, perceived behavioral control will directly influence behavior. Perceived behavioral control is an indication of both actual control and confidence in one’s abilities. Remaining consistent with the Theory of Reasoned Action, a salient set of individual beliefs (in this case, control beliefs) underlie perceived behavioral control (Armitrage & Christian, 2004). Thus, the theory of planned behavior includes the impact of attitudes (as determined by behavioral beliefs), subjective norms (as determined by normative beliefs), and perceived behavioral control (as determined by control beliefs) on behavioral intention, which work together to impact behavior.

The augmentation of the Theory of Reasoned Action has proven to be of value. The Theory of Planned behavior has received a great deal of empirical support in the past decade, or so (Ajzen, 1991; Armitrage & Conner, 2001). A recent meta-analysis demonstrated that the theory of planned behavior accounted for 27 percent of the variance in behavior, and 39 percent of the variance in intentions (Armitrage & Conner, 2001). The new and improved version of the theory accounts for a considerable proportion of variance in intention and behavior. Armitrage and Christian (2004) argue that this theory is one of the most dominant models of behavior.

3.3 Shapero’s Entrepreneurial Event

Entrepreneurial Perspective is also grounded in the theory of the entrepreneurial event (see Figure 2). (Shapero, 1981) considered the environmental factors associated with increasing the number of potential entrepreneurs, which would thereby increase what he calls, economic resiliency. Shapero proposed that fertile ground for this resiliency was impacted by the social and cultural support, information and tacit knowledge, and amount of tangible resources, which would increase or decrease the potential for action when and where an individual perceives a worthwhile, viable opportunity.
Shapero (1982) proposed inertia as a behavioral guide to the point of interruption. This displacement (caused by the inertial interruption) precipitates a change in behavior, as the decision-maker seeks the best opportunity from among his/her sanctioned set of alternatives. The choice of behavior is dependent upon the relative credibility of the alternative behaviors, in addition to a propensity to act. In this case, credibility refers to the degree of desirability and feasibility associated with the behavior(s) in question. While it is the environment (inertial interruption) that thrusts an individual into a new decision-situation, the evaluation of opportunities (in terms of credibility) is influenced via perceptions of desirability and feasibility, which are proposed to be dimensions of Entrepreneurial Perspective.

### 3.4 Krueger and Brazeal’s Entrepreneurial Potential

The theories of Reasoned Action and Planned Behavior (Ajzen, 1988, 1991; Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975) incorporate attitudes and beliefs as fundamental aspects of intention formation, which is indicative of behavior (see Figure 3) and a dimension of Entrepreneurial Perspective. As such, they are a necessary part of any model that seeks to understand influences on intentionality – one must know how one feels about something prior to deciding whether or not they will act on it.
Fig. 3. Krueger and Brazeal’s Model of Entrepreneurial Intention

From this Theory of Planned Behavior and Shapero’s (1982) Entrepreneurial Event, Krueger and Brazeal (1994) advanced the conceptual framework of Entrepreneurial Potential, which proposes that entrepreneurial potential is developed by increasing knowledge of entrepreneurship, building confidence and self-efficacy, and presenting entrepreneurship as a highly regarded, socially acceptable, personally rewarding career choice. The model of entrepreneurial potential focuses on three crucial elements: perceived desirability, perceived feasibility, and propensity to act. In the model, perceived desirability and perceived feasibility work together to impact Shapero’s concept of credibility, which directly impacts potential as moderated by one’s propensity to act. Potential gives rise to intentions, as moderated by Shapero’s precipitating event (causing “displacement”). Perceived venture desirability encompasses one’s beliefs and attitudes about the behavior, as well as the associated social norms, which can be influenced by education.

3.5 Entrepreneurial Perspective and Entrepreneurship Intention

Entrepreneurship is known to be a very intentional process – starting a new venture requires planning and acting. In the history of the literature, examination of entrepreneurial intentions has been the most effective at explaining and predicting entrepreneurial behavior (Krueger et al., 2000). Entrepreneurship researchers have included both individual and situational factors separately to find poor predictive and low explanatory power. Intentions models have started to fill the gap presented by the two ends of the spectrum, as they typically combine both individual and situational (social) factors.

According to Rivis and Sheeran (2003: 218), intentions “summarize a person’s motivation to act in a particular manner and indicate how hard the person is willing to try and how much time and effort he or she is willing to devote in order to perform a certain behavior.” According to Krueger and
Brazeal (1994), the stream of research on intentions firmly validates two crucial notions. First, intentions facilitate focus on a target behavior and consistently confirm that they are the single best predictor of the target behavior. Research has revealed that, due to the predictive nature of the relationship between attitudes/beliefs and intentions, outside forces may impact intentions via attitudes and beliefs. This gives way to the second notion, which is, the key attitudes and resulting intentions are perception based, indicating that they are learned and learnable, varying across individuals and circumstances.

In a grounded theory exploration, Bird (1988) proposes a framework for entrepreneurial career intentions, including elements of temporal tension (how entrepreneurs deal with time – internally and externally), strategic focus (an entrepreneur’s goal-directedness), and intentional posture (the positioning of the entrepreneur in relation to personal internal and external factors: alignment of goals within one’s entrepreneurial team, and attunement to external resources) (see Figure 4). In proposing her “case”, Bird presents a contextual model of entrepreneurial intentions, including the impact of personal and social contextual factors on rational and intuitive thought processes, which directly impact actions via intentionality. Bird proposes an iterative intentional process that begins with a focus on specific individual needs, values, wants, habits, and beliefs. From there, she proposes that creating and maintaining temporal tension, sustaining strategic focus, and developing a strategic posture are at the core of intentional and behavioral outcomes and crucial to the creation of new businesses, which, in turn, impacts the entrepreneur’s needs, values, wants, habits, and beliefs.

![Fig. 4. Bird’s Foundational Framework for Intentionality](image-url)
In explaining the process of developing an intentional posture, Bird advances the concepts of alignment and attunement. Alignment consists basically of the alignment of internal factors, such as values and needs, with the outer world. Bird proposes that entrepreneurs are more likely to be successful when the new venture concept aligns with their concepts of career, work, risks, rewards, and family. Attunement has to do with an individual’s readiness send and receive information, influence and meaning from external sources. Bird applies this concept in the context of receiving and applying relevant economic information and forming effective networks of bankers, venture capitalists, accountants and others. Bird’s research suggests that, by seeking to promote alignment with the general concepts associated with new venture creation (i.e., impacting things such as values and beliefs to be more favorably oriented toward a career in entrepreneurship) and attunement to general information concerning entrepreneurship (i.e., causing ears to perk up when information about starting new ventures is in ear-shot), educators have the power to increase potential entrepreneurial outcomes.

In the quest to find the best predictors of entrepreneurial intention, researchers have embarked on this task from various perspectives. Some researchers have emphasized situational (i.e., employment status or informational cues) or individual (e.g. demographic characteristics or personal traits) variables even though they have been proven to be poor predictors of behavior. Others have emphasized attitudinal variables (i.e., attitudes/beliefs and self-efficacy) of intention (Ajzen, 1991; Shapero, 1982) and it has been supported that attitude influences intention and, in consequence, behavior (Krueger et al., 2000).

4. Entrepreneurial Perspective

In studying intention-based models, Shapero’s model of the entrepreneurial event postulates that entrepreneurial intentions depend on three elements (i.e., perception of personal desirability, feasibility, and propensity to act) (Krueger et al., 2000) while the theories of reasoned action and planned behavior (Ajzen, 1988, 1991; Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975) incorporate attitudes and beliefs as fundamental aspects of intention formation, which is indicative of behavior. Krueger et al. (2000) proposed that individual’s entrepreneurial intention in general depends on another three perspective elements comprising of perception of personal attractiveness toward entrepreneurship, social norms regarding career option, and perceived entrepreneurial self-efficacy or feasibility. This study suggests that Entrepreneurial Perspective, encompassing entrepreneurial understanding, knowledge of entrepreneurial skills, entrepreneurial attitudes/beliefs, and entrepreneurial self-efficacy mediates the effect of exposure to venture creation
founder role model on an individual’s entrepreneurial intention to found new business. Each of the dimensions of Entrepreneurial Perspective is discussed below.

Following these theoretical foundations, Godsey (2006) proposed the construct Entrepreneurial Perspective that incorporates these individual perceptions as they relate to starting a business. As a means to better understanding what influences entrepreneurial intentions, this study examines the influence of Entrepreneurial Perspective (Godsey, 2006) on entrepreneurial intentions in a sample of Thai nascent entrepreneurs.

4.1 Entrepreneurial Understanding

Entrepreneurial understanding (EU) serves to assess the development of knowledge of entrepreneurship, which involves the awareness of new venture creation as a career choice and fundamental concepts associated with starting a business (Godsey, 2006). A greater knowledge of different entrepreneurial aspects will surely contribute to more realistic perceptions about the entrepreneurial activity (Ajzen, 2002), thus influencing intentions indirectly. In this aspect, the importance of understanding entrepreneurship as a career and concept has been a common theme throughout entrepreneurship education research.

4.2 Knowledge of Entrepreneurial Skills.

Entrepreneur skill (KS) refers to the awareness of the skills required to start a new venture such as willingness to take calculated risks (time, equity, or career), creativity in the acquisition and allocation of resources, specific opportunity recognition and evaluation and the ability to assemble an effective venture team (Kuratko, 2005). They played a major role in the successful rate of venture creation that it helps those not previously exposed to venture creation associate a set of acquirable skills with this potential career option. Therefore it has been the focus of recent educational development efforts on EK development demonstrates (Godsey, 2006).

4.3 Entrepreneurial Attitudes/Beliefs

According to Ajzen (2002) and Kolvereid (1996) attitude towards the behavior refers to the degree to which the individual holds a positive or negative personal valuation about being an entrepreneur. It would include not only affective, but also evaluative considerations. Similarly, Godsey (2006) believes that attitudes and beliefs encompass the associations and contentions a person maintains regarding a given element. Entrepreneurial attitudes and
beliefs (EAB) are part of the Entrepreneurial Perspective construct as attitudes because beliefs developed through experiences have the power to influence education and training aspirations and future career decisions (Fedoryshyn & Tyson, 2003). This denotes that incorporating a successful venture creation role model in an introduction to entrepreneurship may positively alter participants’ perceptions of new venture creation, generating interest in seeking out more information regarding a career in entrepreneurship (via courses, future role model interactions, new venture creation, etc.).

4.4 Entrepreneurial Self-efficacy

Self-efficacy (ESE) is also a component of entrepreneurial perspective that it generally refers to an individual’s evaluation of whether s/he possesses or is capable of acquiring the skills required to perform a task or fulfill a role (Hackett & Betz, 1981; Krumboltz et al., 1976). Specifically, it is the conviction that one can successfully execute the desired behavior (e.g., successfully launch a business) required to produce an outcome (Bandura, 1982); therefore, the perceived level of feasibility for successfully starting a new business is an important precursor to the formation of entrepreneurial intentions (Krueger, 1993). In line with this, as individuals become more aware of the skills and roles required of entrepreneurs via exposure to relatable entrepreneurial role models, they can become more confident in their abilities to acquire and use these skills to embark on a career in entrepreneurship. The self-efficacy is often discussed in relation to expectancy theory, which is also cognitive and based on estimates, particularly, the expectation of probability that effort will lead to a performance level and an outcome. However, self-efficacy is concerned with action rather than outcome. Both are self-assessment of people’s own ability and concerned with performance. In expectancy theory, low probability means less likely that effort will lead to a performance level means, while low self-efficacy means one cannot execute the behavior because one does not acquired required cognitive and emotional abilities to capitalize the effort (Chen et al., 1998).

5. Entrepreneurial Intention

In the context of entrepreneurship, entrepreneurial intentions are the intentions to start a business and are the first step in the process of new venture creation. Entrepreneurial intentions influence the effort that the person will direct towards starting a business (Liñán, 2004). By understanding entrepreneurial intentions, we have a means to better explain and predict entrepreneurship (Krueger et al., 2000). The study of entrepreneurial intentions is based in the theory of planned behavior (Ajzen, 1991) which contends that
the best predictor of behavior is the person’s intention or decision to act, that intentions are determined by an individual’s evaluation of performing the a behavior, and that external variables have only an indirect effect on the behavior (Abraham & Sheeran, 2003).

Intention is postulated to be the immediate antecedent of an individual’s behavior (Fishbein & Ajzen, 1975). Intentions are a function of three independent determinants: 1.) the person’s attitude, the overall positive or negative evaluation of performing the behavior of interest; 2.) the subjective norm, the perceived social pressure associated with the behavior; and 3.) the perceived behavioral control, the extent to which a person feels volitional control over the behavior (Ajzen, 1988). According to the theory of planned behavior, individuals make decisions rationally by systematically using accessible information, hypothesizing that the causal antecedents of behavior are a logical sequence of cognitions. In the history of the literature, examination of entrepreneurial intentions has been the most effective at explaining and predicting entrepreneurial behavior (Krueger et al., 2000).

An intention may be affected by needs, values, wants, habits, or beliefs (Bird, 1988; Lee & Wong, 2004); by cognitive influences such as personal attitudes towards a behavior, perceived social norms, or perceived behavioral control (Ajzen, 1991); as well as situational factors such as time constraints, task difficulty, or the influence of others through social pressure (Lee & Wong, 2004).

Entrepreneurship intention has been measured in various ways in previous studies. Krueger and colleagues (2000) used a single item, Kolvereid (1996) used a belief-item-based measure of attitude, Zhao et al. (2005), Kickul and Zaper (2000), and Krueger et al. (2000) used an unconditional measure of intention, while Kolvereid (1996), Fayolle and Gailly (2004), and Erikson (1998) forced participants to state their preferences and estimated likelihoods of pursuing a self-employment career. Godsey (2006) on the other hand, introduced a more comprehensive measure, one that assessed not only intention towards starting a business, but also intentions towards an entrepreneurial career.

6. Entrepreneurial Perspective and Entrepreneurial Intention

Human action, according to theory of planned behavior, is guided by behavior beliefs, normative beliefs and control beliefs, however the effects of them on entrepreneurial intention may vary from case to case. Behavior beliefs are about the likely consequence of the behavior while normative beliefs concern the normative expectation of others. Control beliefs or perceived behavioral control, is the extent to which a person feels volitional control over the behavior. Perceived behavioral control is also defined as the presence
factors that may facilitate, or impede, the performance of the behavior or in other words, the perception of the easiness or difficulty in the fulfillment of the behavior of interest (becoming an entrepreneur).

As for the attitudes/beliefs, research has revealed that, due to the predictive nature of the relationship between attitudes/beliefs and intentions, outside forces may impact intentions via attitudes and beliefs (Krueger & Brazeal, 1994). This is in line with Kim and Hunter’s (1993) Meta-analyses that empirically show that intentions successfully predict behavior, and attitudes successfully predict intentions. Fishbein’s (1967) early work on the summative model of attitudes proposes that while individuals may hold vast and various beliefs about a particular behavior, only a subset of these beliefs are likely to be relevant at any one given point in time. Thus, both determinants of intention, attitudes and subjective norms, are developed from salient underlying beliefs. Expanding from that, the Theory of Reasoned Action (Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975), proposes that attitudes and subjective norms determine individual intentions.

The control belief concept is quite similar to perceived self-efficacy. The only little difference is that perceived behavioral control broader that it includes not only the feeling of being able, but also the perception about behavior controllability. That is, the extent to which performing it or not is up to the person. Opportunity recognition depends on situational perceptions of controllability and self-efficacy (Krueger et al., 2000) which is predictive of entrepreneurial performance and important to entrepreneurial intention. Focusing on self-efficacy, it can be inferred that the more easiness in fulfillment of the behavior (i.e., starting new business) one perceived the more likely that one would have the intention to take the action (Zhao et al., 2005) and on contrary low self-efficacy expectations lead individuals to avoid embarking on that behavior (Wood & Bandura, 1989). Therefore entrepreneurial self-efficacy is to have an impact on entrepreneurial intention to found new business. This is in line with Chen et al. (1998), who report a positive relationship between entrepreneurial self-efficacy and entrepreneurial intentions. In relation to entrepreneurial intention, attitudes influence behavior by their impact on intentions while intentions and attitudes depend on the situation and person. Collectively, it is proposed here that elements that comprise the entrepreneurial perspective construct (entrepreneurial understanding, knowledge of entrepreneurial skills, entrepreneurial attitudes/beliefs, and entrepreneurial self-efficacy) will impact entrepreneurial intention. This leads to the study’s hypothesis:

*Hypothesis: Entrepreneurial perspective will be positively associated with entrepreneurial intention to found new business.*
7. Methods

7.1 Population and Sample Selection

In Thailand, the SME Promotion Action Plan calls for the promotion and encouragement of new SME establishment and assistance to existing SMEs to survive, grow and compete, and the education of entrepreneurs and SME personnel. The Ministry of Industry Department of Industrial Promotion has asked universities and other institutions to organize education and training program for potential and nascent entrepreneurs by focusing on enabling individuals and prospective entrepreneurs to comprehend change in the nation and global economies. This program is designed to incubate unemployed persons, newly graduated students, people who quit their jobs, people who prepare to take over business from their predecessors, people who are in all kind of professions and nascent entrepreneurs to identify business opportunities arising from economic circumstance, assist individuals and prospective entrepreneurs in developing necessary skills to pursue business opportunities, and promote the adoption of information and communication technology (ICT), particularly internet access in communities and villages.

Participants were recruited from the 2008 Class of the NEC, an entrepreneurial training program offered by the Thai Government. A list of these training programs was obtained from the Department of Industrial Promotion, Ministry of Industry (http://nec.dip.go.th). Participants were recruited by the researcher via announcements and site visits on the last day of the training program. A total of 389 participants participated from 12 institutions in Bangkok, Thailand. Participants were asked to respond to a survey assessing their entrepreneurial perspective, and their intention to found a new business during the last day of their training program. Participants in this study reported their age in the following categories (under 21 years = 1.3%, 21-30: 31%; 31-40: 38%, over 40 years old 30%) of which 53% male, 37.5% married, and 31% had children. The majority of participants had a Bachelor’s degree (58%) or higher (25%), 65% reported that their family started or owned their own business. In addition, the majority had at least one year of work experience (92%), and 72% had some previous management experience.

7.2 Survey Process and Data Collection

In preparation for survey administration the survey items were pre-tested and pilot tested consistent with recommended rigor in the behavioral sciences for collecting date with new instruments (cf. Straub, 1989) and for the purpose of clarifying the constructs (cf. Achjari, 2003; Adcock & Collier, 2001). Sample demographics were not statistically significantly different between
samples. In addition, the items were evaluated by three native Thai speakers with strong English language skills (having earned doctorate degrees from English speaking institutions). Evaluators were given the survey items in both English and Thai to assess for clarity and understanding and asked to verify the translations.

7.3 Variables and Measurement

7.3.1 Entrepreneurial Intention

Entrepreneurial intention was measured using an adaptation of Godsey’s (2006) measure which measured not only intention towards starting a business, but also their intentions towards an entrepreneurial career on a six point likert scale of agreement (1 = Strongly disagree; 6 = Strongly agree). Sample items included “I have prepared to start my own business” and “I plan to search for more information on how to start my own business.” Reliability of the five item scale was acceptable (α = .815).

7.3.2 Entrepreneurial Perspective

Entrepreneurial perspective is a higher order construct developed by Godsey (2006) that includes the dimensions of entrepreneurial understanding (EU, 7 items), knowledge of entrepreneurial skills (ES, 14 items), entrepreneurial self-efficacy (ESE, 18 items), and entrepreneurial attitudes and beliefs (EAB, 7 items). Entrepreneurial understanding (EU) measures basic knowledge of entrepreneurship such as the role of entrepreneurs and profit in the economy. Knowledge of entrepreneurial skills (ES) assesses the individuals’ awareness of skills associated with becoming an entrepreneur and starting a new venture. These skills include: leadership, persistence, creativity, problem solving, business plan development, market opportunity identification and assessment, ability to form a venture team, and resource management. Entrepreneurial Attitudes and beliefs (EAB) encompass the associations and contentions a person maintains regarding starting a new venture. Sample items include, “I would enjoy a career in entrepreneurship” and “Careers in entrepreneurship have high social status.” Entrepreneurial Self-efficacy (ESE) as part of entrepreneurial perspective in this study was assessed using DeNoble et al.’s (1999) eighteen item measure. Participants responded to the perceptions they have about their abilities to successfully carry out activities related to new venture creation. Questions ranged from the identification of business opportunities; development of new business ideas, new methods of production, marketing and management; as well as addressed assembling a team, and
managing risk. The reliability of the forty-five item Entrepreneurial Perspective measure was acceptable ($\alpha = .940$).

### 7.3.3 Control Variables

The following variables served as controls in this study: age, gender, marital status, education and experience in a family business.

### 8. Analyses

#### 8.1 Correlation Analysis

Means, standard deviations and correlations among the variables are presented in Table 1.

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>EntIntent</th>
<th>EntPersp</th>
<th>Age</th>
<th>Gender</th>
<th>Marital</th>
<th>Educ</th>
</tr>
</thead>
<tbody>
<tr>
<td>EntIntent</td>
<td>389</td>
<td>23.407</td>
<td>4.67</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EntPersp</td>
<td>389</td>
<td>220.046</td>
<td>23.16</td>
<td>.577**</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>389</td>
<td>2.941</td>
<td>0.837</td>
<td>.162*</td>
<td>.128</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>387</td>
<td>0.535</td>
<td>0.499</td>
<td>-0.03</td>
<td>0.005</td>
<td>-0.12</td>
<td>0.003</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marital</td>
<td>389</td>
<td>0.375</td>
<td>0.485</td>
<td>.166***</td>
<td>.194**</td>
<td>.461**</td>
<td>-0.012</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>389</td>
<td>3.907</td>
<td>1.078</td>
<td>-0.088</td>
<td>-0.126</td>
<td>-0.043</td>
<td>-0.047</td>
<td>-0.062</td>
<td></td>
</tr>
<tr>
<td>FamStart</td>
<td>385</td>
<td>0.652</td>
<td>0.477</td>
<td>0.039</td>
<td>-0.050</td>
<td>-0.018</td>
<td>-0.035</td>
<td>0.080</td>
<td>0.016</td>
</tr>
</tbody>
</table>

#### 8.2 Regression Analysis

The relationship of entrepreneurial perspective and entrepreneurial intention was investigated via linear regression. There was a main effect for entrepreneurial perspective in predicting entrepreneurial intent after controlling for age, gender, marital status, education and experience in a family business, suggesting that entrepreneurial perspective accounts for 35% of the variance in entrepreneurial intent. Results of the regression analysis are presented in Table 2.

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.561</td>
<td>.314</td>
<td>.301</td>
<td>4.018</td>
</tr>
</tbody>
</table>
9. Conclusion

This study introduced a new measure of entrepreneurial intention that is based on the actions of aspiring entrepreneurs to enable the start of a new venture. Most significantly, it introduced a new construct, entrepreneurial perspective, that captured dimensions of entrepreneurial self-efficacy, beliefs and attitudes, and skills as representing a holistic sense of what influences a nascent entrepreneur, that is, an individual between the stages of entrepreneurial aspiration and actual business launch who has taken initial steps to prepare for business ownership. Its results demonstrate that, controlling for the age, gender, marital status, education level, and prior family history of business ownership (all of which were not significant), entrepreneurial perspective is significantly associated with the intention to start a business, explaining more than 30% of the variance.

Construct validation results supported a single factor solution for all of the dimensions included in the construct – Knowledge of Entrepreneurial Skills, Entrepreneurial Attitudes and Beliefs, and Entrepreneurial Self-efficacy – captures a distinct aspect of high-school students who are a critical stage in making career choices. Consistent with the literature and theory presented, the construct measure of Entrepreneurial Perspective accounts for significant variance in the construct measure of Entrepreneurial Career Intentions, indicating that entrepreneurship education programs that focus on developing...
entrepreneurial self-efficacy, entrepreneurial attitudes and beliefs, and knowledge of entrepreneurial skills are likely to have a significant impact on high school students at a time when they are making choices about their careers, leading to more choosing to become entrepreneurs.

The primary focus of entrepreneurship education research and course development to date has been on the formation and expansion of skills related to starting and running a new business. Fostering skill development related to entrepreneurship is undoubtedly an important endeavor, as research indicates that such an endeavor results in various entrepreneurial outcomes. The current findings indicate that by concentrating on developing an Entrepreneurial Perspective first, that is, creating awareness of the skills associated with new venture creation, fostering positive attitudes and beliefs about a career in entrepreneurship, and enhancing student perceptions about their abilities to succeed in such a career, more students will seek the education and experiences that develop these skills. For this reason, educators should consider learning activities designed to create Entrepreneurial Perspective. Establishment of the Entrepreneurial Perspective construct has provided a new focal point for entrepreneurship educators. It is through the communication and understanding of Entrepreneurial Perspective that students will be encouraged into action.

The results of this study may have the most significant effect in the area of future research as they point out that a combination of self-efficacy, belief about the value of business ownership, and the skills to start and operate a business should be considered together when assessing the antecedents of business startups.

There continues to be much interest among federal, state and local government officials in the role of small business in the economy. There is a general agreement that two of the main reasons for business failure are the lack of management expertise and under-capitalization (Roure & Keeley, 1990). As a result of the belief by many public and private officials that new ventures make significant contributions to the economy, a number of federal, state, and local government-sponsored intervention programs have been introduced to facilitate the survival and growth of small start-up businesses. Intervention in the context of new business ventures has been defined as the actions of an agency external to ventures that comes between the entrepreneurs and the environment in ways designed to modify the extent to which the entrepreneurs address critical success factors. The purpose of the intervention is to increase the rates of new venture formation, survival and success.

The sample for this study was drawn from participants in a government-sponsored education program. Its results might also inform educational programs similar to this. Because all of the items used in measuring the construct can be influenced and have been shown in combination to be associated with entrepreneurial intention, such programs might be able to
develop curriculum designed to enhance these dimensions and might be served by testing students in these areas before and after the study program to demonstrate personal improvement.
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Corporate Social Responsibility
Corporate Social Responsibility and Globalization

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Abstract:
Business sustainability is all about serving the needs of one’s customers, clients, and stakeholders across the globe in a socially responsible and, thus, concomitantly an economic efficacious manner. Business is expected to achieve its core economic value in conformity with the values of morality and legality. That is, business must act in a profitable, legal, and moral manner. Today, moreover, above and beyond the responsibility to act legally and morally in the pursuit of profit is the notion of social responsibility, which typically is called “corporate social responsibility” (CSR). The law defines legal accountability; ethics determines moral accountability, but ascertaining the definition, nature, extent of, and rationales for the value social responsibility emerges as an even more challenging task. This article provides a philosophical as well as practical review of social responsibility by explaining and illustrating the concept of social responsibility in the global business environment through a business sustainability continuum. Suggestions and recommendations for business leaders, managers, and their organizations are provided to achieve success in a legal, moral, and socially responsible manner.

Key Words: Corporate social responsibility, values, ethics, morality, philanthropy.

1. The Building Blocks of Social Responsibility

Every safe building stands on a strong foundation. Similarly, every sustainable business should stand on a foundation that has strong values, legal compliance, and high ethical standards. Values are rankings or priorities that a person establishes for one’s norms and beliefs. Deeply held values can drive behavior. Moral values are generally held to be intrinsic. Accordingly, if one holds morality to be an intrinsic value, then one must be moral regardless of the circumstances and consequences. Ethics is the theoretical study of morality. Ethical theories are moral philosophical undertakings that contain bodies of formal, systematic, and ethical principles that are committed to the view that an asserted ethical theory can determine how one should morally think and act. Moral judgments are deducible from a hierarchy of ethical principles. Morality, therefore, properly and accurately should be understood as a development of the ethical, which is part of the philosophical. Social responsibility, however, is not part of ethics, not an ethical theory, not an ethical principle, and is not a means to determine morals, morality, or moral precepts (Cavico and Mujtaba, 2012a). As such, it is important to keep the concept of social responsibility distinct from morality and ethics, which are philosophy based, as well as legally, which, of course, is based on the law. The traditional purpose of business, moreover, is the profitable production, distribution, and sale of goods and services, albeit in a legal and moral manner, but not social welfare or philanthropic endeavors. Yet, today, since the issue of the social responsibility of business is frequently
raised, business is forced to concern itself with the "social" dimension of its activities.

Accordingly, one must define the key term "social responsibility.” At a basic philanthropic level, social responsibility may be defined as a business taking an active party in the social causes, charities, and civic life of one's community and society (Cavico and Mujtaba, 2012b). For example, Newman’s Own is a private sector company praised for its philanthropic mission since it donates all of its profits and royalties after taxes for charitable and educational purposes (Mickels, 2009). The social responsibility of business can also be thought of in a broader constituency or stakeholder sense. Tyagi (2011, p. 29) states that social responsibility encompasses “…a person’s obligation to consider the effects of his decisions and actions on the whole social system”; and adds that “the fundamentals of CSR management is to understand the values and principles of those who have a stake in the business operations – the stakeholders.” Harish (2012) takes a “strategic” as well as stakeholder approach to corporate social responsibility:

Corporate social responsibility (CSR) is a concept whereby organizations consider the interests of society by taking responsibility for the impact of their activities on customer, suppliers, employees, shareholders, communities and other stakeholders, as well as the environment. CSR is a way firms integrate social, environmental and economic concerns into their values, culture, decision-making, strategy and operations in a transparent and accountable manner and thereby establish better practices within the firm, create wealth and improve society. CSR is certainly a strategic approach for firms to anticipate and address issues associated with their interactions and others and, through those interactions, to succeed in their business endeavors (p. 521).

The strategic implications of corporate social responsibility will be explicated further later in this work. Harsh (2012, p. 521) also adds that corporate social responsibility by purposefully including the public interest into corporate decision-making results in the “…honoring of the triple bottom line: people, planet, profit.” Millon (2011) explains that a constituency or stakeholder approach to corporate social responsibility “requires management to balance shareholder and non-shareholder interests. Strict shareholder primacy…Socially responsible leadership therefore necessitates that management temper its pursuit of profit with regard for such considerations” (p. 525).

The Business Roundtable views the corporation as an entity “chartered to serve both their shareholders and society as a whole” (Mickels (2009, p. 274). The World Business Council for Sustainable Development explains social responsibility in a corporate context as a company’s continuing commitment to act legally and morally and also to contribute to the economic development of society while improving the quality of life of their employees and their families as well as the local community and society as a whole (Holmes and Watt, 2004). This definition evokes another, and even more expansive, concept of the “social responsibility” of business – “sustainability.” The sustainability approach to corporate social responsibility is premised on the idea that a company must remain economically viable in the long-term, and that in order to be viable the company must take into consideration other stakeholders beyond the shareholders. Millon (2011) explains the sustainability approach to corporate social responsibility “as simply the realization that the corporation’s long-run prosperity depends on the well
being of its various stakeholders, including workers, suppliers, and customers...Sustainability also requires ongoing availability of natural resources and a natural environment in which the corporation and its various constituencies can survive and flourish...Sustainability CSR looks beyond the current quarter or year and factors in long-run benefits as a potential offset to short-term cost” (pp. 530-31).

Social responsibility, at least to some reasonable degree, may be in the long-term self-interest of business. Munch (2012) explains that “some corporations have long supported social initiatives as a means of enhancing their own profits and long-term viability. Through charitable donations, community programs, or holistic decision-making, corporations have pursued tangible goals, such as improving workforce comfort or engendering customer goodwill, arguing that these actions align with the corporation’s ultimate profit-making interests” (p. 178). Significantly, Munch (2012) adds that “there is some evidence that these strategies are successful” (p. 178). Afsharipour (2011), furthermore, reported on an Indian study that revealed a positive relationship between company performance and corporate social responsibility. A corporation cannot long remain a viable economic entity in a society that is uneven, unstable, and deteriorating. It makes good business sense for a corporation to devote some of its resources to social betterment projects. To operate efficiently, for example, business needs educated and skilled employees. Education and training, therefore, should be of paramount interest to business leaders. A corporation, for example, can act socially responsible by providing computers to community schools and by releasing employees on company time to furnish the training. British Petroleum (BP), for example, marketing itself in Europe as “Beyond Petroleum,” before the disastrous Gulf oil spill was regarded as a very socially responsible firm, especially for its environmental and alternative fuel efforts (Cavico and Mujtaba, 2009). Another illustration involves the web-search company, Google, Inc., which has committed almost one billion dollars in stock as well as a share of its profits to combat global poverty and to protect the environment (Delaney, 2005). Starbucks Corporation, in addition, has been engaged in a variety of socially responsible activities in Guatemala, such as building health clinics, and also promising to pay its coffee suppliers a premium price if they adhere to certain labor and environmental standards (Homes, 2002). The Coca-Cola company has teamed with the World Wildlife Fund to protect the arctic habitat by releasing $1.4 billion redesigned white Coke cans each showing a polar bear, which the company hopes will raise awareness of this cause. Coke made an initial donation of $2 million to the World Wildlife Fund, and Coke will match up to $1million that Coke drinkers will be able to donate to the campaign (Business Briefing, 2011). McDonald’s is so extensively involved in charitable activities and civic affairs in local communities throughout the United States that it produces through its corporate charitable division, Ronald McDonald House Charities of South Florida, special multi-page advertising supplements to local newspapers to describe the company’s many socially responsible activities – from grants, “Wish Lists,” scholarships, volunteer work to, of course, the Ronald McDonald House itself (Ronald McDonald House Charities of South Florida, 2012).

Business is part of society and subject to society's mandates; and if society wants more "responsibility" from business, business cannot ignore this "request" without the risk of incurring society's anger, perhaps in the form of higher taxes or more onerous government regulation. Over a decade ago, a Business Week/Harris poll (Taylor, 2011;
Editorials, *Business Week*, 2000) found that only 4% of the public believed that the sole purpose of corporations is to make profits for shareholders; rather, some 95% believed that corporations should sometimes sacrifice some profit to do more for employees, communities, and society. Sir John Brown, former chief executive officer of BP, astutely comprehended that society wants and expects business to be socially responsible, and that to be so is in the long-term self-interest of BP and business. Then, BP stood for not only “British Petroleum” but also “Beyond Petroleum” for all the alternative energy and social responsibility efforts that the company was engaging in under his stewardship. An egoist will surely see the value of a prudent degree of social responsibility in today’s global business marketplace. Obviously, superior product and service quality and competitive pricing are essential for business success. Yet another strategic factor to success has emerged in the present business environment – social responsibility. The idea is not “only” to make profits but then to “give back” to the community by means of civil, social, and environmental efforts. Yet a strategic approach to social responsibility would combine profits and social activism; that is, the smart and social company will deliver products and services that naturally are profitable but that also serve society by, for example, by saving energy and improving the environment. The idea for a strategic business approach is to incorporate the value of social responsibility into the firm’s business model. Such an approach will enhance opportunities, increase profits, and expand the firm’s market share. In essence, the ultimate goal is not only to contribute in a socially responsible manner to the community, but also to bring new socially responsible products and services into the marketplace. That degree of social responsibility is the egoistic business model for today’s astute business leaders. Exxon-Mobil for example, recently launched a social responsibility campaign to build schools in Angola, which (perhaps not coincidentally) is an emerging oil power. Coca-Cola Co. is very extensively involved in providing clear drinking water to the “developing world,” for example, by furnishing water purification systems and lessons to local communities. This meritorious social responsibility effort is designed also to promote “Coke’s” reputation as a global diplomat and local benefactor. “Coke,” by the way, uses a great deal of water in producing its products.

Another example of “smart” social responsibility concerns Microsoft’s “wellness” efforts to help its overweight employees. The company, which already provides free medical coverage to its employees, now has created a weight management benefit for employees. The software company will pay for 80% of the cost, up to $6000, for a comprehensive, clinical, weight loss program for employees. The program, intended for employees who are obese or clinically overweight, includes up to a year’s worth of sessions with a personal trainer, behavioral and nutritional counseling, support groups, and medical supervision. Microsoft in the long-run expects to obtain a return on its health care investment for the formerly obese and overweight employees due to cost savings from less prescription drugs and fewer doctor and hospital visits (Cavico and Mujtaba, 2009). Similarly, Million (2011, p. 532) relates that Johnson & Johnson has invested substantially in employee health through its Wellness & Prevention program; but the company has received an excellent return-on-investment, because the program has been estimated by the company to have saved $250 million in employee health care costs over the past decade, with the savings representing a return of $2.71 for every dollar spent. Million (2011) concludes that “the whole point is to generate net gains in the future from
expenditures incurred in the present – benefits to nonshareholders come not at the expense of shareholders but rather are deployed for their ultimate advantage” (p. 533). Millon (2011) labels this corporate social responsibility approach “strategic” (p. 533).

HR Magazine (Fox, 2007) in a human resources context underscored the egoistic and strategic rationale for a company to be rightly perceived as a socially responsible one. In a constrained and highly competitive global labor market, the shrewd corporate executive will use his or her firm’s social responsibility stance to attract new employees, especially top talent, as well as to engage and retain highly skilled and highly motivated current employees. To bolster its argument, HR Magazine (Fox, 2007) pointed to a 2003 survey where 70% of North American students surveyed stated that they would not even apply for a job in a company that was deemed “socially irresponsible.” Afsharipour (2011) related the thoughts of high-level executives of Indian companies who believe that companies with corporate social responsibility programs, particularly employee-driven ones, will increase employee pride, satisfaction, loyalty, retention, and productivity. Christopher and Bernhart (2009) reported on studies that demonstrated the recruitment and retention benefits of social responsibility, for example, a study indicating that 64% of employees indicated that corporate social responsibility (CSR) activities increased their loyalty, and that 90% of employees would choose an employer viewed as more socially responsible. Christopher and Bernhart (2007) also reported that a “meta-analysis of over 50 studies found CSR social components, including treatment of employees, significantly affected financial performance measures. In addition, objective CSR performance ratings were significant predictors of employer attractiveness to potential applicants” (p. 9). Accordingly, corporate social responsibility can be a key recruitment and retention strategy for the global organization, which business leaders and managers can use to attract, develop, and keep a highly engaged, motivated, and productive workforce.

However, a socially responsible firm must also be a realistic one, HR Magazine (Fox, 2007) counseled. That is, socially responsible and environmental efforts must be sustainable economically and should have some relationship to the firm’s business. Employees should also be engaged directly in the company’s social responsibility activities so as to engage them, inspire them, motivate them, and thereby enhance morale and productivity. Moreover, a firm’s social responsibility program does not have to be a multi-million dollar effort; rather, something as simple as an employee social responsibility “suggestion box” or as straightforward as a recycling or energy saving program will do to promote employee involvement as well as to promote and give credence to employee social values. Nonetheless, despite the size, a firm’s social responsibility efforts should be publicized widely within the company, for example, in company newsletters, as well as externally, for example in company annual “social responsibility” reports. Being socially responsible, therefore, advises HR Magazine, is a smart and sustainable business strategy, especially in a human resource context. An actual illustration of HR Magazine’s social responsibility recommendation is the PepsiCo. The company’s chairperson and CEO, Indra Nooyi, has urged companies to follow her company’s approach to being a “good” global company; and by “good” she means that in addition to having a strong financial performance, a firm must value and take care of its employees and also the public’s health and the environment. For example, PepsiCo has expanded its product lines to include more juices and waters as well as introducing low-sugar versions of its popular “fitness drink,” Gatorade. The
company is also promoting energy management, for example by reducing its water usage and creating more environmentally “friendly” packaging. One major benefit of being a socially responsible firm, PepsiCo has discovered, is that its employees are inspired and energized, thereby helping the company to retain employees.

_Business Week_ published a very revealing Social Responsibility Special Report (Engardio, 2007.) that enumerated and extolled the socially responsible practices of many companies today; and then asked the seminal question as to whether these laudatory socially responsible efforts positively contributed to the companies’ “bottom-line.” _Business Week_ (Engardio, 2007) listed these companies in a chart, grouped by sectors of the economy, and then detailed their social responsibility as well as “eco-friendly” activities, and under a very revealing chart sub-title, “Who’s Doing Well by Doing Good.” For example, Unilever, the British-Dutch multinational, has opened a free community laundry in Sao Paulo, Brazil, provides financing to help tomato growing farmers to convert to more environmentally sensitive irrigation systems, and has funded a floating hospital that provides free medical care to people in Bangladesh. In Ghana, Unilever provides safe drinking water to communities; and in India, the company’s employees assist women in isolated villages commence small entrepreneurial enterprises. As related by _Business Week_, Unilever CEO, Patrick Cescau, views the company’s social responsibility effort as one of its biggest strategic challenges for the 21st century. Cescau explains that since 40% of the company’s sales come from consumers in developing countries, assisting these countries to overcome poverty and to safeguard the environment is vital to the company’s sustaining its competitive advantage. In order for the company to maintain its leadership role, it must be concerned about the impact its policies have on society, local communities, the environment, as well as future generations. Cescau’s rationale for social responsibility underscores the ethically egoistic justification that “good deeds” will produce strategic and competitive advantages and thus inure to the benefit of the company in the long-term. Another example given by _Business Week_ was General Electric, which is taking the lead in developing wind power and hybrid engines. Even Wal-Mart, perennially criticized by labor and human rights groups, was praised for its efforts to save energy and to purchase more electricity derived from renewable sources. GlaxoSmithKline was given credit for investing in poor nations to develop drugs. Moreover, the company was praised for being one of the first major pharmaceutical companies to sell AIDS drugs at cost in 100 countries worldwide. _Business Week_ (Engardio, 2007) pointed out that such socially responsible behavior by the large pharmaceutical company worked in its favor as the company is working much more effectively with these governments to make sure its patents are protected. In addition, as noted in _Business Week_ (Engardio, 2007), the company’s CEO, Jean-Pierre Garner, explained that the company’s social responsibility efforts produce other egoistic advantages, such as motivating top scientists to work for the firm, as well as enhancing the overall morale of the company’s workforce, which gives the company, stated Garner, a competitive advantage. Another example was Dow Chemical, which is developing and investing in solar power and water treatment technologies. Also as noted by _Business Week_ (Engardio, 2007), Dow CEO, Andrew N. Liveris, explained that there is a “100% overlap” between the company’s business values and its social and environmental values. Toyota was cited as another illustration of a socially responsible firm due to its work with hybrid gas-electric cars. Such practices have given Toyota a very good reputation as a
company that makes clean-running and fuel efficient vehicles; and *Business Week* (Engardio, 2007) related that this “green” reputation has given Toyota a competitive edge. Another example involves PepsiCo and its charitable-giving program, called Refresh, where Pepsi drinkers can vote online, using votes obtained from the company’s products, for “refreshing ideas that change the world” (Bauerlein, 2011). Winners will have their socially responsible projects funded by the company. Past winners of grants have included cheerleading squads for the disabled students, a project to make school bus windshields more aerodynamic. The Refresh program has been extensively advertised by the company in order to give consumers a “voice” in the company’s charitable giving, and also, significantly, to engage consumers, enhance the company’s image and brand as a socially responsible one, and in the long-term to increase sales and profits (Bauerlein, 2011). Business “sustainability” and success emerge as the very practical instrumental reasons given by the companies for their social responsibility efforts. Furthermore, social responsibility is certainly not just a concept applied in the United States; rather, U.S. multinationals doing business overseas as well as foreign companies in their own countries are now engaged today in social responsibility activities.

2. Corporate Social Responsibility—A Global View

Today, corporate social responsibility (CSR) “debates are not just occurring in developed economies...Countries around the world are engaging in rich and nuanced reforms in the corporate governance and CSR arenas” (Afsharipour, 2011, p. 996). Mickels (2009) adds that “directors all over the world are questioning whether corporations should exist solely to maximize shareholder profit” (p. 271). The Society of Human Resource Management (SHRM) (*Workplace Visions*, 2007) found that a majority of Human Resource professionals (United States, Australia, India, China, Canada, Mexico, and Brazil) reported that their organizations had corporate social responsibility practices in place. SHRM put forth a number of reasons for the extent of corporate social responsibility (Cavico and Mujtaba, 2012a/b). First, companies realize that they need to respond to large scale social problems before they become a threat to business. Second, SHRM contends that solutions to major social problems can increasingly be viewed as new sources of business opportunities. That is, providing goods and services to the people of developing nations may be a way to enter into potentially vast markets of consumers. Similarly, “going green” and investing in environmentally “friendly” technology may be a way for companies to initially establish themselves in potentially highly profitable energy sectors.

Millon (2011) calls for a “sustainability” approach to corporate social responsibility globally: “For transnational corporations doing business in developed countries, sustainability may require investment in community-level infrastructure development projects, technological innovation, education, and health care. As these investments lead to greater productivity and better product quality, workers and producers can earn higher incomes, allowing the local population to enjoy a higher standard of living” (p. 531). Millon (2011, pp. 531-32) provides two excellent examples of global “sustainable” CSR: 1) The Norwegian company, Yara International, the world’s largest chemical fertilizer company, has sponsored public/private partnerships to develop storage, transportation, and port facilities in parts of Africa with significant untapped
agricultural potential, thereby developing local agriculture, providing jobs and improved
incomes for farmers, and at the same time benefiting the company through an increased
demand for its fertilizer products. 2) The Nestle Company is working to improve milk
production in certain regions of India, by investing in well drilling, refrigeration,
veterinary medicine, and training, thereby significantly increasing output and enhancing
product quality, certainly beneficial to the company, and at the same time allowing the
company to pay higher prices for farmers and their employees, resulting in a higher
standard of living for the local community.

The United Nations now has a business initiative on corporate social
responsibility, called the United Nations Global Compact, whereby companies can join
and thus voluntarily agree to make improvements in human rights, labor, the
environment, and combating corruption (Afsharipour, 2011). The World Bank, moreover,
has an Internet course on social responsibility, called “CSR and Sustainable
Competitiveness,” offered by its educational and training division, the World Bank
Institute (World Bank, 2007). The corporate social responsibility course is designed for
“high-level” private sector managers, government officials and regulators, practitioners,
academics, and journalists. One major purpose to the course is to provide a “conceptual
framework” for improving the business environment to support social responsibility
efforts and practices by corporations and business. The course is also designed to assist
companies to formulate a social responsibility strategy based on “integrity and sound
values” as well as one with a long-term perspective. By being socially responsible,
declares the World Bank, businesses not only will accrue benefits, but also civil society
as a whole will benefit from the “positive contributions” of business to society. Although
it is beyond the scope of this book to discuss in detail the World Bank’s very laudable
CSR educational effort, a few key elements in the course must be addressed. First and
foremost, as the World Bank points out, correctly so, there is no single, commonly
accepted, definition of the critical term “CSR.” Nonetheless, the World Bank offers its
definition, stating that CSR generally refers to: 1) “a collection of policies and practices
linked to the relationship with key stakeholders, values, compliance with legal
requirements, and respect for people, communities and the environment; and 2) the
commitment of business to contribute to sustainable development.” The World Bank also
explains the key term “Corporate Citizenship,” which is “the concept of the corporation
as a citizen” and which is a term often used when referring to CSR. As a matter of fact,
the World Bank notes, again quite correctly, that the terms “CSR” and “Corporate
Citizenship” are at times used interchangeably. The World Bank, moreover, in order to
fully explicate CSR, indicates several material components to that concept, to wit: 1)
environmental protection, 2) labor security, 3) human rights, 4) community involvement,
5) business standards, 6) marketplace, 7) enterprise and economic development, 8) health
protection, 9) education and leadership development, and 10) human disaster relief. The
World Bank also offers several decision-making frameworks for companies to plan,
implement, and measure CSR. An important part of the World Bank course is a segment,
eminently practical for business, called “Benefits of CSR.” There are, according to the
World Bank, “many reasons why it pays for companies, both big businesses and small
and medium enterprises…to be socially responsible and be conscious about the interest of
key stakeholders.” The Bank pointed to a survey conducted by its Institute that indicated
that 52% of its respondents had either “rewarded” or “punished” businesses by either
buying or not buying their products based on the perceived social responsibility performance of the companies. Other reasons for being a socially responsible firm are, according to the Bank, as follows: 1) obtaining a “social license” to operate from key stakeholders; 2) ensuring “sustainable competitiveness,” 3) creating new business opportunities, 4) attracting and retaining quality investors and business partners, 5) securing cooperation from local communities, 6) avoiding difficulties due to socially irresponsible behavior, 7) obtaining government support, and 8) building “political capital.” These reasons make the “business case” for being a socially responsible company.

Corporate social responsibility is being promoted in the European Community. Mickels, 2009, p. 275) relates that in 2000 the European Council in Lisbon formally encouraged companies to become more socially responsible, for example, by taking into consideration sustainable development. Moreover, “the European Commission has recognized that shareholder value is not achieved merely through maximizing short-term profits, but also through ‘market-oriented yet responsible behavior’” (Mickels, 2009, p. 277). Furthermore, Mickels (2009, p. 276) reports that in 2006, the European Commission enacted a Resolution, titled “Corporation Social Responsibility: A New Partnership,” which proclaimed that corporate social responsibility has become an increasingly important topic for the European Community and that CSR is in integral “part of the debate about globalization, competitiveness, and sustainability.” Mickels (2009, pp. 276-77) explains that “according to the European Commission, CSR is ‘a concept whereby companies integrate social and environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis.’” Mickels (2009, p. 277), however, points out that both the British and American definitions of corporate social responsibility are “vague”; but nevertheless, “…both embody a conviction that a corporation’s existence should not relate solely to making money for the sake of making money but that a corporation has a social responsibility to contribute and improve the community in which it operates.”

In China, Hai-yan and Silva (2012) relate that due to the scandals regarding product safety and environmental damage as well as a concern over workers’ rights, the concept of corporate social responsibility is developing as an issue for Chinese companies and their executives. Hai-yan and Silva (2012, pp. 61-62) conducted a survey of the executives of 206 companies, mainly engaging in trade, in the Beijing area, and they found an awareness of social responsibility among the executives, and specifically found that these executives believed that a company could best be a socially responsible one by complying with the law, providing customers with safe and reliable products, improving the quality of the education system in China, and protecting the environment. Hai-yan and Silva (2012) cite egoistic “market” reasons for this development of corporate social responsibility internationally as well as now encompassing China: “…We have seen the expansion of the concept of CSR from large to small and medium enterprises as well as an increase in corporate awareness, knowing that their performance in the market depends on the market demands, the society in which they operate, and the socially responsible actions which they perform” (p. 58). To further make the point, a survey conducted by Cone Communications and Echo Research (Chu, 2012) of more than 10,000 consumers in 10 countries found that three out of four respondents in China stated that they were very likely to change brands to those associated with a good cause
(assuming there was an alternative in the same price range and of similar quality). Furthermore, 83% of the respondents in China stated that they refused to purchase a company’s product when they became aware that the company acted in an irresponsible manner (Chu, 2012).

India emerges as a country in the vanguard of corporate social responsibility developments – both legally as well as practically. Regarding stakeholder corporate social responsibility (CSR), Afsharipour (2011) states that:

The stakeholder model of CSR recognizes that companies have responsibilities to not only their shareholders, but also to their employees, customers, surrounding communities (including the environment) and society as a whole. According to a broad survey of Indian executives, many Indian firms have a sense of a social mission and purpose. These executives do not see shareholder wealth maximization as their primary goal. Instead, ‘they take pride in enterprise success—but also in family prosperity, regional advancement, and national renaissance’ (p. 1014).

Harish (2012) lists in detail the social responsibility activities of multinational as well as Indian companies in India. Examples include Bajaj Auto, which has created a Trust to help promote development among the rural poor so as to raise rural living standards; Infosys Technologies, Ltd, which has a Foundation to support and promote underprivileged sections of society, such as training poor women in tailoring and donating sewing machines; and the Indian Oil Company, which has adopted as part of its strategic plans several environmental initiatives, especially the development of cleaner fuels (Harish, 2012). In India, moreover, the government is now involved legally in corporate social responsibility. Afsharipour (2011) indicates that in 2009 the Indian government, specifically the Ministry of Corporate Affairs (MCA), promulgated in 2009 Voluntary Guidelines for Corporate Social Responsibility. The Guidelines, relates Afsharipour (2011), are premised on a “fundamental principle,” to wit: “Each business entity should formulate a CSR policy to guide its strategic planning and provide a roadmap for its CSR initiatives, and that should be an integral part of overall business policy and aligned with a company’s business goals...the policy should be framed with the participation of various level executives and should be approved and overseen by the board” (p. 1019). Moreover, “according to the CSR Guidelines, the CSR policy should cover the following core elements: (i) care for all stakeholders, including shareholders, employees, customers, suppliers, project-affected people, society at large...; (ii) ethical functioning, transparency, and accountability; (iii) respect for workers’ rights and welfare; (iv) respect for the environment; and (vi) activities for social and inclusive development” (p. 1019).

In India, in 2009, the government mandated that public-sector oil companies spend 2% of their net profits on corporate social responsibility efforts; and there are proposals for the government to mandate that private sector companies spend 2% to 5% of their net profits on corporate social responsibility efforts (Afsharipour, 2011). However, in 2010, the Indian government “just” required that Indian companies have a CRS policy which “targets” a 2% spending allocation on CSR; and that companies provide disclosure and details of their CSR efforts and suitable reasons for these efforts.
(or the lack thereof) in an annual report (Afsharipour, 2011). Afsharipour (2011) criticizes the 2009 Indian law because “the CSR Guidelines...provide little concrete guidance on how companies are to implement the guidelines or what legal changes need to be made to ensure that socially responsible practices will be part of a firm’s way of doing business” (p. 1019). Afsharipour (2011), moreover, criticizes the 2010 law because “the recommendations do not explain in any detail what constitutes CSR” (p. 1021). However, Afsharipour (2011) does admit that “one important aspect of the CSR Guidelines is the move toward additional disclosure. Very few Indian companies disclose their CSR policies, so additional disclosure could be a tool NGO advocates and lawyers to work with companies and pressure them to comply with their CSR policies” (p. 1022).

As such, in order to assist companies fulfill their social responsibility obligations, Kumar, Kuberudu, and Krishna (2011, pp. 10-11) offer the following recommendations for “socially responsible” businesses in, as well as doing business in, India: 1) create and nurture an “eco friendly environment” within and outside the organization; 2) adopt poor, needy, and “sleepy” villages and bring them into inclusive growth by supplying “econ friendly” projects; 3) wage a “war” on bribery and corruption; 4) control pollution, including “social pollution,” and help build a “healthy society”; 5) provide assistance when natural calamities occur; 6) develop the “highest ethical standards” with “transparency” as the “watch word”; 7) avoid deceptive and exaggerated advertisement, be restrained by “general social acceptability” regarding advertising, and do not exploit women in advertising; 8) offer financial scholarships and financial assistance to meritorious students; assistance in education and vocational training; and adopt schools, providing for their growth and management. These social responsibility activities will naturally help Indian companies fulfill their legal obligations, but also will, as Kumar, Kuberudu, and Krishna (2011) assert, result in a more stable society, the survival of the organization, and its maximization of profits, since there is a “direct relation” between the well-being of the organization and the good will of the people in society (p. 8).

Actually, the Society for Human Resource Management (McConnell, 2006) reported on a global corporate social responsibility survey of human resource professionals from the U.S., Australia, China, and India that indicated that the respondents from India, who were surveyed before the recent Indian CSR laws, were more likely to have formal corporate social responsibility policies, such as written objectives and reports, or corporate social responsibility efforts tied to the organization’s mission and/or goals. Of course, there is a big difference between India and a country such as the United States, because in India corporate social responsibility is now legally mandated to some degree by the government, whereas in the U.S. a company may be socially responsible pursuant to state corporate “constituency” statutes, which allow directors to consider non-shareholder stakeholder interests in making decisions, and also may impose a legal obligation upon itself to be socially responsible by forming a social benefit corporation called a “B-Corp,” which requires directors to consider non-shareholder stakeholders interests in making decisions; but neither the federal government nor the state governments in the U.S. presently are mandating legally that companies be socially responsible ones.

3. Implications and Recommendations

Socially responsible business leaders and managers should always include social
responsibility goals in their articles and bylaws. Moreover, the authors long have argued that it is in the long-term, egoistic, self-interest of the corporation to be a socially responsible one, and thus to be active and engaged in community, civic, and charitable activities. Porter and Kramer (2011) use the term “shared value” to underscore the value of sustainability and for business leaders to use a decision-making criterion in business, to wit: “Policies and operating practices that enhance the competitiveness of a company while simultaneously advancing the economic and social conditions in the communities in which it operates” (p. 66). The objective is to simultaneously produce economic value for the company, but also value for society as a whole by helping to solve societal needs, particularly by improving the lives of the people (and potential consumers) who live in the communities where the company does business.

Yet what exactly is the effect of all these social responsibility efforts on the “bottom-line”? This critical fact is difficult to ascertain due to the paucity of research as well as the need for a long-term perspective. One academic study, conducted by Schnietz and Epstein (2005), found that there is value to a corporation during a crisis by having a reputation for corporation social responsibility, and, in particular that a reputation for social responsibility protects firms from a decline in share prices associated with a crisis. Sauser, Jr. (2008) points to studies that found direct financial benefits for companies who are deemed to be socially responsible; and these benefits encompass enhanced business reputation, consumer acceptance, employee loyalty, as well as better environmental management. Hemlock (2007) reported on an academic analysis of dozens of corporate social responsibility studies that found that social responsibility performance and financial performance reinforce each other; that is, companies that excel in a socially responsible manner generally excel financially and vice versa. Wang and Qian (2012) conducted a study of the philanthropic of publicly listed Chinese firms from 2001 to 2006 and found that corporate philanthropy enhances corporate financial performance by enabling firms to elicit better stakeholder responses and to gain political resources. Tyagi (2011, p. 31) reports on studies that support the proposition that corporate social responsibility positively affects “corporate attractiveness.” The aforementioned illustrations and studies demonstrate that social responsibility “pays off” for the company and its shareholders as well as for other stakeholders and society as a whole. Business Week (Engardio, 2007) reported one thought-provoking study that concluded that if Wal-Mart possessed the social responsibility reputation of its competitor, Target, Wal-Mart’s stock would be worth 8.4% more, thereby adding $16 billion to its market capitalization. The problem of determining if “doing good” translates to “doing well” is exacerbated since companies only report the value of tangible physical assets and investments in equipment and property. Social responsibility efforts are perhaps a bit too intangible for the company’s accountants to quantify; and government regulators do not mandate that social responsibility, labor, and environmental practices be quantified. Nonetheless, a company’s commitment to social responsibility could constitute a valuable intangible business asset. Moreover, Spector (2012, p. 39) emphasizes that “tough global social issues are increasingly seen as responsibilities of businesses as well as governments, and innovative business leaders are viewing these problems as growth opportunities.”

The term “sustainability” also has emerged, along with social responsibility and corporate governance, as important subject matters for business today. Spector (2012, p. 41) reports that a 2009 study of the views of chief executives, done by the Business
Roundtable and the Conference Board, “found that almost two-thirds indicated that sustainability has reached a tipping point and has become a mainstream concern for business. An even larger 81% agreed that business leadership will increasingly be judged by the ability to create enterprises that are economically, socially, and environmentally sustainable.” Furthermore, Spector (2012, p. 42) reports that a 2011 IBM Institute for Business Value study, consisting of interviews at 320 global companies, “concluded that today enterprise sustainability is a strategic imperative and ‘no longer just a matter of legal compliance or philanthropic generosity.’” The United Nations also lists environmental sustainability as one of its Millennium Development Goals, along with reducing poverty, increasing education, promoting gender equality, improving child and maternal health, and combating HIV/AIDS (Harish, 2012). It is also possible now for a company to have a “sustainability” assessment. Moreover, an independent, international, private organization, the Global Reporting Initiative, based in Amsterdam and originating as part of a United Nations environmental program, has established Sustainability Reporting Guidelines, and has published assessment reports on a wide range of industries, including pharmaceutical, automotive, and consumer product industries (Resor, 2012).

![Business Sustainability Continuum](image)

**Figure 1 – The Business Sustainability Continuum**

Sustainability, of course, encompasses legal, ethical, moral, and social responsibility values, and also is related in to corporate governance. However, as Spector (2012, p. 42) correctly points out, dealing with sustainability may be a difficult challenge for certain business executives: “One of the causes may be that the sustainability aim of creating long-term value, while balancing the business need for profit with the ethics of social and environmental responsibility, is uncharged territory for traditional compliance-oriented corporate governance practice.” In order to better illustrate as well as explicate the values of practicality, legality, morality, and social responsibility and their
relationship to sustainability, the authors have developed the Business Sustainability Continuum (BSC) model, presented in Figure 1.

The BSC illustrates that the continual success and “sustainability” of the business can only be achieved by an adherence to four core values: Economic, indicating that a business obviously must have a viable business model which fulfills a need and enables the business to make a profit; Legal, indicating that this profit must be achieved in legal manner by aligning the conduct of the business with all applicable local, national, and international law; Ethical, indicating that since there may be no law or “gaps” in the law nonetheless the business must act in a moral manner and also must act in conformity with its values, promises, and obligations; and Social Responsibility, indicating that the business must focus on the community and engage in civic, philanthropic, and charitable endeavors as part of the business’ overall strategic plan. Sustainability will help the business but also help the business help governments solve pressing social problems, and, as such, “this provides an occasion to rebuild trust that is good for business and good for society” (Spector, 2012, p. 39). Harish (2012, p. 521) adds that “CSR has been widely regarded as a positive phenomenon helping bridge the gap of social inequality and thus contributing to sustainable development.” Accordingly, adherence to these “sustainable” values will enable the business to achieve success and to sustain that success in a continual manner, thereby benefitting the business, its shareholders, the communities where it does business, and all the stakeholders affected by the business, including society as a whole.

4. Summary

Social responsibility is a very important and relevant topic for business today. Moreover, Business leaders are expected to lead by values – legal values, moral values, and now socially responsible values. Cognizance of, adherence to, and dealing with the value of social responsibility have become an imperative for business leaders today. The view today is that business should pursue profits, of course, but also that business should strive to achieve social objectives, such as philanthropy, too. Social responsibility, therefore, should now be incorporated into business values, missions, and models by business leaders. Moreover, as the authors have emphasized throughout this work, social responsibility clearly possesses instrumental value, because it can be used in a smart, shrewd, and strategic sense to help the business achieve and sustain successful performance. Social responsibility, therefore, is more than just “mere” or “pure” charity; rather, in a modern business sense, social responsibility is an integral strategic component in the company’s endeavor to achieve larger traditional business objectives. Yet, concomitantly and also propitiously, society as whole is benefitted by these social responsibility activities. So, in essence, corporate social responsibility is “smart” business and “good” business – for business, business stakeholders, and society.
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CORPORATE SOCIAL RESPONSIBILITY AND CORPORATE PERFORMANCE: A PANEL QUANTILE REGRESSION ANALYSIS

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Abstract

This paper investigates the impact of the engagement of corporate social responsibility activities on corporate performance in Taiwan and employs balanced panel data over the period 2008–2010. In view of the inconsistent empirical findings in the literature and the limitations of least squares regressions, we adopt a quantile regression method including fixed effects models. An important finding is that the sensitivity of a company's performance to the engagement of corporate social responsibility activities does not vary with the quantile location of the firm's performance level, and the engagement of corporate social responsibility activities has a insignificant relation with corporate performance across all quantiles. This study argues that the costs of social responsibility are offset by financial returns. Thus, no significant relationship exists between the engagement of corporate social responsibility activities and the corporate performance, namely that there is a neutral relationship between the engagement of corporate social responsibility activities and corporate performance.

Keywords: Corporate social responsibility, Corporate performance, Panel quantile regression, Quantile regression

1. Introduction

Corporate social responsibility (CSR) is a complex term broadly defined as the active and (sometimes) voluntary contribution of enterprise to environmental, social and economic improvement. Attention for CSR has increased significantly during the last decade. Organizations realized the strategic importance of corporate social responsibility where more than 90% of Fortune 500 firms have invested in corporate social responsibility (Kotler and Lee 2004; Lichtenstein et al., 2004). However, the effect of socially responsible practices on firm performance is still a debatable issue (Russo and Fouts, 1997; McWilliams and Siegel, 2001). We aim to address these gaps in the literature.
Academically, there are two prominent conflicting theoretical views regarding the financial impacts of CSR. The social impact hypothesis, proposed by Cornell and Shapiro (1987) and Preston and O’Bannon (1997), claims a positive relation between CSR and financial performance. Several authors have cited improved employee and customer goodwill as an important outcome of social responsibility (Davis, 1975; Soloman & Hansen, 1985). For example, a firm perceived as high in social responsibility may face relatively few labor problems, and customers may be favorably disposed to its products. Socially responsible activities may also improve a firm's standing with such important constituencies as bankers, investors, and government officials. Improved relationships with these constituencies may bring economic benefits (Moussavi & Evans, 1986).

In contrast, the shift of focus hypothesis proposed by Becchetti, Ciciretti and Hasan (2007) argue that most of the CSR activities such as building employee and community relationship, providing environmental protection and improving corporate governance cause a shift of focus from the maximization of stockholders’ value to the interests of a wider set of stakeholders and therefore increasing the firm’s costs. Previous studies also argue that high responsibility results in additional costs that put a firm at an economic disadvantage compared to other, less socially responsible firms (Bragdon & Marlin, 1972; Vance, 1975). For example, a firm may forgo certain product lines, such as weapons or pesticides, and avoid plant relocations and investment opportunities in certain locations (e.g., South Africa). Thus, firms engaging more in CSR activities result in worse financial performance.

To date, over a hundred studies have investigated the link between CSR and corporate financial performance (Margolis & Walsh, 2003). However, the literature has yielded mixed sets of results, including positive (e.g. Soloman and Hansen, 1985; Fombrun and Shanley, 1990), negative (e.g. Aupperle et al., 1985; McGuire et al., 1988), neutral (e.g. McWilliams and Siegel, 2001), or even complex (e.g. Barnett and Salomon, 2002) relationships, and hence demonstrates no agreement on whether or not high CSR activity leads to improved corporate financial performance (Margolis & Walsh, 2003; McWilliams & Siegel, 2000). In view of the inconsistent empirical findings in the literature, in this paper we try to reconcile these divergent views through the method of quantile regression. Quantile regression method allows us to analyze the separate responses of corporate performance to the CSR at different quantiles of the performance distribution. Namely, we adopt a quantile regression method to investigate whether and how the CSR affect corporate performance with different levels of corporate performance.

According to data from Taiwan, the performance measures in this study, return on assets (ROA), return on equity (ROE), pretax income to net sales (PTI), gross
pr
ofit to net sales (GP) and earnings per share (EPS), exhibit skewed distribution, so the assumption of normal distribution error terms in OLS is not guaranteed and may produce misleading results. Quantile regression can solve the above problems and also provide a more flexible and complete characterization when there is an interest in the impact of the CSR on corporate performance at both higher and lower levels of corporate performance. In addition, some studies have determined that the relationship between corporate performance and CSR is not linear (e.g., McWilliams and Siegel, 2001; Barnett and Salomon, 2002), and therefore we suspect that the sensitivity of a company's performance to the engagement of CSR activities will vary with the firm's performance level. Based on these reasons, we adopt a quantile regression method to analyze whether and how the engagement of CSR activities affects corporate performance with different levels of corporate performance.

Unlike ordinary least squares (OLS), quantile regression is applied when an estimate of the various quantiles in a population is desired. Quantile regression is used simply to get information about points in the conditional distribution other than the conditional mean (Buchinsky, 1994, 1995; Eide and Showalter, 1997), and thus it fully represents the conditional distribution. In addition, a quantile regression estimator minimizes the weighted sum of absolute residuals rather than the sum of squared residuals, and thus the estimated coefficient vector is not sensitive to outliers. Quantile regression is also particularly useful when the conditional distribution does not have a standard shape, such as an asymmetric, fat-tailed, or truncated distribution. Thus, it would not be accurate to draw conclusions based on mean regression alone, and quantile regression may perform more efficiently and robustly than OLS or fixed effects estimations.

The main motivation of the present study stems from the inconsistent findings among earlier studies and the limitations of least squares regressions. We consider that a restudy of the CSR–performance relation seems needed, and thus adopt a quantile regression method including the fixed effects model to fill this gap. It is worth investigating the separate responses of corporate performance to the CSR at different quantiles of the performance distribution.

The main contribution of this paper is applying quantile regression with the fixed effects model to analyze the separate responses of corporate performance to the CSR at different quantiles of the performance distribution for our panel data. Quantile regression is appropriate to test potential differences in parameters between firms at different segments of the distribution of performance variables because it enables us to examine the whole distribution of the performance variables rather than to only focus on a single measure of the central tendency of the distribution. Specific to the concerns of this study, the quantile regression method allows us to picture the relation
between the CSR and corporate performance separately for both more successful and less successful firms.

2. Data and variables

For the empirical analysis, this study employs a sample of 685 non-financial companies listed on the Taiwan Stock Exchange (TWSE) over the period 2008–2010. This is a balanced panel dataset that comes from the Taiwan Economic Journal (TEJ) databases. We exclude financial companies because their financial data is very different from that of other firms. Any firms in the TEJ data set without complete information are also deleted from the sample before further analysis. The final sample consists of 2,055 effective observations.

In order to understand the status of CSR awareness and fulfillment among Taiwanese corporations, and to help bring Taiwan in line with global trends in this area, one leading Taiwan’s commercial magazine, the CommonWealth Magazine (CWM), conducted its ‘‘Survey of Corporate Social Responsibility’’ since 2007. The survey criteria were based on OECD Guidelines for Multinational Enterprises, the Dow Jones Sustainability Group Index (DJSGI) as well as Global Compact. This survey revealed the Top 50 of Taiwan’s excellence in CSR enterprises, selected from 1,929 Taiwan’s public listed companies through the severe judging process, under the criteria of their corporate governance, corporate commitment, social participation, and environmental protection. This paper employs the variable “CSR_dummy” to measure CSR. The variable is a dummy variable that takes the value of 1 if its aggregate ranks of the evaluations are on the top 50, and 0 otherwise.

Following Shen and Chang (2009), this study uses return on assets (ROA), return on equity (ROE), pretax income to net sales (PTI), gross profit to net sales (GP) and earnings per share (EPS) as the corporate performance variable.

Several variables are also likely to influence corporate performance. Based on earlier studies on the subject (Agrawal and Knoeber, 1996; Florackis et al., 2009; Li et al., 2009), the empirical specification also controls for firm size, financial leverage, growth rate of sales, and growth rate of assets differences across firms by including the variables size, which is the natural logarithm of total assets, leverage, which is the ratio of total debt to total assets, salegrow, which is the annual growth rate of sales, and assetgrow, which is the annual growth rate of the assets in the model. The definitions of all the variables are presented in Table 1.

The following equation is the basic model of the empirical study:

\[
\text{performance}_{i,t} = \beta_0 + \beta_1\text{CSR dummy}_{i,t} + \beta_2\text{CSR dummy}_{i,t-1} + \beta_3\text{size}_{i,t} \\
+ \beta_4\text{leverage}_{i,t} + \beta_5\text{salegrow}_{i,t} + \beta_6\text{assetgrow}_{i,t} + \epsilon_i
\]

(1)
3. The econometric model

3.1. Quantile regression

First proposed by Koenker and Bassett (1978), quantile regression is an extension of the classical least squares estimation of the conditional mean to a collection of models for different conditional quantile functions. The traditional least squares regression only enables researchers to approximate the conditional mean and conditional median located at the center of the distribution. Such a regression analysis can only give an incomplete description of a conditional distribution (Mosteller and Tukey, 1977). However, quantile regression is used simply to get information about points in the conditional distribution other than the conditional mean (Buchinsky, 1994, 1995; Eide and Showalter, 1997), and thus it fully represents the conditional distribution. Quantile regression is applied when an estimate of the various quantiles in a population is desired. In addition, the quantile regression has several other useful features. First, the quantile regression estimator minimizes the weighted sum of absolute residuals rather than the sum of squared residuals, and thus the estimated coefficient vector is not sensitive to outliers. Second, a quantile regression model employs a linear programming representation and simplifies examination. Third, this analysis is particularly useful when the conditional distribution does not have a standard shape, such as an asymmetric, fat-tailed, or truncated distribution. The quantile regression approach can thus obtain a much more complete view of the effects of explanatory variables on the dependent variable. The basic quantile regression model specifies the conditional quantile as a linear function of explanatory variables and is given by:

\[ y_i = x_i' \beta_\theta + u_i, \quad 0 < \theta < 1 \quad (2) \]

\[ Quant_\theta(y_i | x_i) = x_i \beta_\theta, \quad (3) \]

where \( y \) is the dependent variable; \( x \) is a matrix of explanatory variables; \( u \) is the error term whose conditional quantile distribution equals zero, and \( Quant_\theta(y_i | x_i) \) denotes the \( \theta \)th quantile of \( y \) conditional on \( x \). The distribution of the error term \( u \) is left unspecified. An individual coefficient \( \beta_{\theta j} \) associated with the \( j_{th} \) independent variable in the vector \( x_i \), called \( x_{ij} \), could be interpreted as ‘how \( y_i \) in its \( \theta_{th} \) conditional quantile reacts to a (ceteris paribus) marginal change in \( x_{ij} \)’. Thus, the
quantile regression method allows us to identify the effects of the covariates at different locations in the conditional distribution of the dependent variable.

The $\theta$th regression quantile estimate $\hat{\beta}_\theta$, is the solution to the following minimization problem:

$$\min_{\beta} \sum_{y_i \geq x_i \beta} \theta |y_i - x'_i \beta| + \sum_{y_i < x_i \beta} (1 - \theta) |y_i - x'_i \beta|,$$

which is solved via linear programming. The median regression, which is a special case of the quantile regression, is obtained by setting $\theta = 0.5$. We can use variations of $\theta$ to obtain other quantiles of the conditional distribution. To convey a sense of the relationship of selected explanatory variables across the conditional corporate performance distribution, the results for the 20th, 30th, 40th, 60th, 70th, and 80th quantiles are reported. In this study, we use the bootstrap method illustrated in Buchinsky (1995) to obtain estimates of the standard errors for the coefficients in quantile regression. Also, this type of analysis is of particular importance as it is a consistent and robust estimation method, in particular when the error term is heteroscedastic and non-normally distributed.

Additionally, it is also worth mentioning that quantile regression can help with regard to the following issue. For each quantile, all sample observations are used in the process of a quantile-fitting regression. This approach is different from the conventional piecewise regressions that segment the dependent variable (unconditional distribution) and then run an OLS on the subsets. Piecewise regressions are not an appropriate alternative to the quantile regression, due to severe sample selection problems (Koenker and Hallock, 2001). Furthermore, piecewise regressions are least-squares based, and can be sensitive to the Gaussian assumption or to the presence of outliers. For more discussion on the model specification of quantile regression, refer to Koenker (2005).

3.2. Model choice

If we only use the least squares (OLS) method to analyze panel data, this will yield biased and inconsistent estimates of the parameters because of differences in the cross-section data. However, fixed effects models or random effects models can be adopted to overcome this problem. Making the choice among OLS, fixed effects (FE) models, and random effects (RE) models can be determined based on the following test methods:

(1) Making the choice between FE model and OLS can be determined based on the F-test. When the p-value is greater than 0.05, one should choose OLS, and the FE model otherwise.

(2) Making the choice between RE model and OLS can be determined based on the
Lagrange Multiplier Test (LM test). When the p-value is greater than 0.05, one should choose OLS, and the RE model otherwise.

(3) Making the choice between FE model and RE model can be determined based on Hausman test on the vector of estimated coefficients and the variance–covariance matrices derived by using different estimation methods (Hausman and Taylor, 1981). When the p-value is greater than 0.05, one should choose RE model, and the FE model otherwise.

4. Empirical results

Table 2 provides the descriptive statistics for the variables used in the analysis. The skewness for ROA, POE, PTI, GP, and EPS are respectively -5.67, -14.97, 7.25, 0.83, and 4.39. All five performance measures in this study, ROA, POE, PTI, GP, and EPS, show skewed distribution, so the assumption of normal distribution of the error terms in OLS is not guaranteed and may produce misleading results. Quantile regression can solve the above problems and also provide a more flexible and complete characterization when there is a focus on the impact of CSR on corporate performance at both higher and lower levels of corporate performance.

In Table 3, the results of the LM test show that RE models are more appropriate for the proposed data in this study as compared to OLS. However, the results of the Hausman test show that FE models are better than RE models. Therefore, an FE model is the best choice for our sample. Accordingly, the econometric method in this study, quantile regression, will include FE models. Quantile regression enables the estimation of conditional quantile functions, where each function characterizes the behavior of a specific point in the conditional distribution, and thus it fully represents the distribution. In addition, FE models can deal with inter-individual differences between firms for our panel data. The empirical results are reported in Tables 4-8 by using quantile regression, including FE models.

The empirical investigation is conducted by estimating Eq. (1) at six quantiles, namely the 20th, 30th, 40th, 60th, 70th and 80th quantiles, using the same list of explanatory variables for each of these quantiles. This allows us to examine the impact of explanatory variables at different points of the corporate performance distribution. Tables 4-8 report the results where ROA, POE, PTI, GP, and EPS are respectively used as the dependent variable. For comparison purposes, we also provide the fixed effect estimates, which are reported in the last column of Tables 4-8.

Starting from Table 4 and focusing on the CSR_dummy, the fixed-effects estimates indicate that there is no significant correlation between the CSR_dummy and corporate performance levels, and the quantile regression also shows insignificant relationship across all quantiles. Therefore, we argue that the sensitivity of the
The company's performance to the engagement of CSR activities does not vary with the quantile location of the firm's performance level. One may concern that whether lagged characteristics affect the corporate performance, for example, a firm engaging more in CSR activities this period could lead to better corporate performance in the next period. Thus, we also include lagged CSR dummy, CSR dummy t-1. The estimated coefficients of CSR dummy t-1 are also all insignificant in both quantile regression and fixed effect estimation methods. Similar results are obtained in Table 5-8, namely showing a uniform insignificant relationship across all quantiles between not only the CSR dummy and corporate performance but also the CSR dummy t-1 and corporate performance. Moreover, the fixed-effects estimates are consistent with the quantile regression estimates.

Summarizing, the estimated coefficients of CSR dummy and CSR dummy t-1 are all insignificant across all quantiles no matter what the performance variables are used. Therefore, we find a robust and insignificant relation between the engagement of CSR activities and the corporate performance. High responsibility results in additional costs that put a firm at an economic disadvantage compared to other, less socially responsible firms (Bragdon & Marlin, 1985; Vance, 1975). On the other hand, socially responsible activities may also bring economic benefits (Moussavi & Evans, 1986). Nevertheless, this study argues that the costs of social responsibility are offset by financial returns. Thus, no significant relationship exists between the engagement of CSR activities and the corporate performance. This finding is in line with McWilliams and Siegel (2001), namely that there is a neutral relationship between the engagement of CSR activities and corporate performance.

In addition, these findings suggest that the sensitivity of the company's performance to the engagement of CSR activities does not vary with the quantile location of the firm's performance level. In other words, we find a uniform insignificant relationship across all quantiles between the engagement of CSR activities and firm performance, which cannot be captured by conditional mean-focused regressions.

5. Conclusions

This paper investigates the impact of the engagement of CSR activities on corporate performance in Taiwan. In view of the inconsistent empirical findings in the literature and the limitations of least squares regressions, we adopt a quantile regression method including fixed effect models. The conditional quantile regression estimator extends the classical least squares estimation of the conditional mean to a collection of models running for different quantile functions. Accordingly, it permits the effect of a regressor to differ at different points of the conditional
dependent-variable distribution, allowing us to portray and test the relations between the engagement of CSR activities and corporate performance for better and worse performers separately. In addition, fixed effect models can deal with inter-individual differences between firms for our panel data. According to the empirical results, we find a uniform insignificant relationship across all quantiles between the engagement of CSR activities and firm performance, which can not be captured by conditional mean-focused regressions.

Moreover, the results of quantile regression can provide a complete version of the impact of the engagement of CSR activities on corporate performance. Quantile regression can thus overcome the weaknesses in the methodologies of earlier studies. The inconsistent findings on this issue might be due to the inappropriate conditional mean-focused regressions that have commonly been used in literature on this topic. Consequently, it is worth re-examining the relationship between the engagement of CSR activities and corporate performance by using this approach.

An important finding is that the sensitivity of the company's performance to the engagement of CSR activities does not vary with the quantile location of the firm's performance level. The engagement of CSR activities has an insignificant relation with corporate performance across all quantiles in Taiwan. Socially responsible activities may result in additional costs (Bragdon & Marlin, 1985; Vance, 1975) but may also bring economic benefits (Moussavi & Evans, 1986). Nevertheless, this study argues that the costs of social responsibility are offset by financial returns. Thus, no significant relationship exists between the engagement of CSR activities and the corporate performance. This finding is in line with McWilliams and Siegel (2001), namely that there is a neutral relationship between the engagement of CSR activities and corporate performance.

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Table 1
Definitions of variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Dependent variable</td>
<td></td>
</tr>
<tr>
<td>ROA(%)</td>
<td>Return on assets=the ratio of net income to total asset.</td>
</tr>
<tr>
<td>ROE(%)</td>
<td>Return on equity=the ratio of net income to total equity.</td>
</tr>
<tr>
<td>PTI(%)</td>
<td>Pretax income to net sales=the ratio of pretax income to net sales.</td>
</tr>
<tr>
<td>GP(%)</td>
<td>Gross profit to net sales=the ratio of gross profit to net sales.</td>
</tr>
<tr>
<td>EPS</td>
<td>Earnings per share= net income divided by the number of shares outstanding.</td>
</tr>
<tr>
<td>Independent variable</td>
<td></td>
</tr>
<tr>
<td>CSR_dummy</td>
<td>Equal to 1 if its aggregate ranks of the evaluations are on the top 50, and 0 otherwise.</td>
</tr>
<tr>
<td>size</td>
<td>The natural logarithm of total assets.</td>
</tr>
<tr>
<td>leverage</td>
<td>Ratio of total debt to total assets.</td>
</tr>
<tr>
<td>salegrow(%)</td>
<td>Annual growth rate of sales.</td>
</tr>
<tr>
<td>assetgrow(%)</td>
<td>Annual growth rate of assets.</td>
</tr>
</tbody>
</table>

Table 2
Summary statistics of main variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Mean</th>
<th>Median</th>
<th>Standard deviation</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROA</td>
<td>2055</td>
<td>3.899</td>
<td>4.248</td>
<td>10.162</td>
<td>-5.676</td>
<td>108.746</td>
</tr>
<tr>
<td>ROE</td>
<td>2055</td>
<td>4.472</td>
<td>7.585</td>
<td>33.799</td>
<td>-14.977</td>
<td>299.509</td>
</tr>
<tr>
<td>PTI</td>
<td>2055</td>
<td>5.493</td>
<td>5.970</td>
<td>62.919</td>
<td>7.257</td>
<td>468.453</td>
</tr>
<tr>
<td>GP</td>
<td>2055</td>
<td>19.969</td>
<td>17.760</td>
<td>16.649</td>
<td>0.837</td>
<td>12.991</td>
</tr>
<tr>
<td>EPS</td>
<td>2055</td>
<td>1.938</td>
<td>1.370</td>
<td>3.723</td>
<td>4.399</td>
<td>45.037</td>
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<td>CSR_dummy</td>
<td>2055</td>
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<td>2.760</td>
<td>121.908</td>
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<tr>
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<td>6.501</td>
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<td>7.675</td>
<td>137.324</td>
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### Table 3
Model tests

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<thead>
<tr>
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<th>Hypotheses</th>
<th>Statistics (p-value)</th>
<th>Results</th>
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<td></td>
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<tr>
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<td>Hausman</td>
<td>H0 : random effects model</td>
<td>H= 169.19</td>
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<tr>
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<td>H1 : fixed effects model</td>
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<td><strong>Model tests with ROE as the performance measure</strong></td>
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<td>Hausman</td>
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<td>H= 115.01</td>
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<td><strong>Model tests with EPS as the performance measure</strong></td>
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</tr>
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<td>Hausman</td>
<td>H0 : random effects model</td>
<td>H=116.65</td>
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</tr>
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<td>Hausman</td>
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<td><strong>Model tests with PTI as the performance measure</strong></td>
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<td></td>
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<td>H0 : random effects model</td>
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Table 4
Regression results with ROA as the performance measure.

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<th>40(^b)</th>
<th>60(^b)</th>
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<th>fixed effects model</th>
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</thead>
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<td>Quant</td>
<td>Quant</td>
<td>Quant</td>
<td>Quant</td>
<td></td>
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<tr>
<td>CSR(_{dummy})</td>
<td>-1.082</td>
<td>0.128</td>
<td>0.317</td>
<td>-0.168</td>
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<td>-1.029</td>
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<td>(0.406)</td>
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<td>(0.810)</td>
<td>(0.950)</td>
<td>(0.552)</td>
<td>(0.547)</td>
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<tr>
<td>CSR(_{dummy,t-1})</td>
<td>-0.216</td>
<td>-0.866</td>
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<td>-0.879</td>
<td>-0.910</td>
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<td>(0.000)**</td>
<td>(0.000)**</td>
</tr>
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<td>0.012</td>
<td>0.005</td>
<td>0.007</td>
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<td>(0.000)**</td>
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<td>(0.000)**</td>
<td>(0.000)**</td>
<td>(0.000)**</td>
</tr>
<tr>
<td>assetgrow</td>
<td>0.039</td>
<td>0.040</td>
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</tr>
</tbody>
</table>

Note:
1. A constant term is included, but not reported. The numbers in parentheses are p-values. ***, **, and *
   indicate significance at the 1%, 5%, and 10% levels, respectively.
2. Subscript t-1 denotes the time at t-1, those without subscripts denote time at t.
### Table 5
Regression results with ROE as the performance measure.

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<tr>
<th></th>
<th>20th Quant</th>
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<td></td>
<td>(0.668)</td>
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<td>(0.572)</td>
<td>(0.843)</td>
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<td>(0.947)</td>
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<td>(0.817)</td>
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<td>(0.000)***</td>
<td>(0.000)***</td>
<td>(0.000)***</td>
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<td>(0.000)***</td>
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<td>(0.000)***</td>
<td>(0.000)***</td>
<td>(0.000)***</td>
</tr>
<tr>
<td>salegrow</td>
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<td>0.017</td>
<td>0.019</td>
<td>0.020</td>
<td>0.019</td>
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<tr>
<td></td>
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<td>(0.000)***</td>
<td>(0.000)***</td>
<td>(0.000)***</td>
<td>(0.000)***</td>
<td>(0.000)***</td>
</tr>
<tr>
<td>assetgrow</td>
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<td>0.065</td>
<td>0.068</td>
<td>0.078</td>
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<tr>
<td></td>
<td>(0.000)***</td>
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</tbody>
</table>

Note: Same as in Table 4.
Table 6
Regression results with EPS as the performance measure.

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<td>(0.000)***</td>
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Note: Same as in Table 4.
Table 7
Regression results with GP as the performance measure.

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<th>60th Quant</th>
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<tr>
<td><strong>CSR_dummy_{-1}</strong></td>
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<td>0.720</td>
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<td>(0.383)</td>
<td>(0.790)</td>
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<td>(0.000)***</td>
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<td>(0.000)***</td>
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<td>(0.000)***</td>
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<td>(0.000)***</td>
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</table>

Note: Same as in Table 4.
Table 8  
Regression results with PTI as the performance measure.

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<td>30&lt;sup&gt;th&lt;/sup&gt;</td>
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<td>(0.611)</td>
<td>(0.846)</td>
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<tr>
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<td>(0.000)****</td>
<td>(0.000)****</td>
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<td>(0.000)****</td>
<td>(0.000)****</td>
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</tr>
<tr>
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<td>(0.000)****</td>
<td>(0.000)****</td>
</tr>
</tbody>
</table>

Note: Same as in Table 4.
Economics
Analyzing international tourist flows from
US to Taiwan on macroeconomic view

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  yhchen@cc.feu.edu.tw

Abstract. US is always a familiar economic, political, cultural, and military partner with Taiwan, so a lot of tourists frequently travel between the two countries, leading that US belongs to the top three host(origin) countries of tourists to Taiwan. For tourism policy making, the comprehension how economic factors affect US tourists’ decision of choosing Taiwan as a destination matters. This paper tried to investigate the long and short-run relationships between tourist arrivals, US PDI, cost of living, and substitute prices. In order to find relationship and impact, the cointegration test and VECM are used, respectively. Two cointegration vectors are found by the Johansen method, which means the long-run relationship between the four model variables exists. The short-run equilibrium adjustment processes are discussed by generalized impulse response analysis. The short-run result confirms the theoretical findings that tourist arrival has positive signs both with PDI and substitute prices.

Keywords: cost of living, substitute price, cointegration test, vector error correction model, generalized impulse response

1 Introduction

1.1 Background and research motives

International tourist arrivals had obviously increased from 693 million in 2001 to 980 million in 2011 according to World Tourism Organization (UNWTO), roughly 41% growth rate. Experience shows that tourism earnings,
that is income generated by tourists, generally follow the trend in arrivals quite alike, which is a figure that outpaces the world economy. Today, business volume of tourism equals or surpasses that of oil exports, food products and automobiles. Tourism has become one of the major players in international commerce, and represents at the same time one of the main income sources for many developing countries (World Tourism Organization, 2006). Along with tourism demand growth in the world, international tourism industries have developed rapidly for the past decades, as well as are prospering continually, in addition which seems to show that international tourism actually stands on an important position for the economic development of many countries through different channels. There are some reasons which Schubert (2010) generalized from the early literatures such as Andriotis (2002), Croes (2006), Fagance (1999) and Lin & Liu (2000). First, tourism is an important earner of foreign exchange, allowing to pay for imported capital goods or basic inputs used in the production process. Second, tourism plays a significant role in spurring investments in new infrastructure and competition between local firms and firms in other tourist countries. Third, tourism stimulates other economic industries by direct, indirect and induced effects. Fourth, tourism contributes to generate employment even for relatively unskilled labor and simultaneously to increase national income. Fifth, tourism can cause positive exploitation of economies of scale in national firms. Finally, tourism is an important factor of diffusion of technical knowledge, stimulation of research and development, and accumulation of human capital.

For boosting tourism industries to raise economic development, tourism demand is the foundation on which all tourism-related business decisions ultimately rely. Song & Witt (2006) proposed the following reasons why tourism demand analysis is so important for policy makers. First, companies such as airlines, ocean liners, tour agents, hotels, casinos, other recreation facility providers, and shop owners are very interested in the demand for their products. The success of many tourism-related businesses depends largely or totally on the state of tourism demand, and ultimate management failure is quite often due to the failure to meet market demand. Because of the key role
of tourism demand as a determinant of business profitability, estimates of expected future demand constitute a very important element in all planning activities. It is clear that accurate analysis and forecasts of tourism demand are essential for efficient planning by tourism-related businesses, particularly given the perishable nature of the tourism product. Secondly, tourism demand analysis is important because tourism investment requires long-run financial commitments from public finances especially for infrastructures. Hence, accurate analysis of the tourism demand situation will help governments and tourism-related industries to formulate and implement appropriate medium- to long-term strategies.

The focused destination country, Taiwan, is an island country located on the southeast of China, opposing each other across the Taiwan straits, furthermore the neighbor countries, Japan and Korea at Taiwanese north and Philippine at the south. In short, it is obvious that Taiwan almost locates on the center of the Asia and substantially occupies a significantly geographic and commercial position in Asia. In obeying traditional island economic model, the last five decades have seen sharp economic growth principally based on a great deal of export in Taiwan, and the dramatic growth of Taiwanese GDP appeared over 260 times from 1961 to 2011. Within the course of economic development, the Taiwanese gross export value mainly contributed by manufacturings has the same tendency with GDP year-on-year. (The financial database of the Taiwan Economic Journal, TEJ) Recently, especially the last decade, due to facing immense competition, principally of manufacturing industries, only manufacturing exports are not able to sustain Taiwanese economic growth completely. For stimulating the impotent economy, Taiwan must aggressively make unremitting efforts to carry out an industrial transit as rising output value of service industry like tourism.

In order to lift up the output of the tourism industry, many actions have been done by Taiwan government in the ten years. For example, the government targets various markets by promoting packages to local travel agencies as well as to potential clients via the media, in addition to the packages, special events and activities to tourists also being boosted such as recently “Tour Taiwan
Years 2008-2009: Great Quarterly Tourist Giveaway Program”, the Key-Words marketing, and the “The Best Trip in the World - Taiwan Explorers Wanted” contest. After these promotions taking place in 2009, the number of inbound visitors to Taiwan increased by 14.3% year-on-year, 29.47% of which came for sightseeing purposes (Taiwan Tourism Bureau). Moreover, in July 2008, a very important policy that the Taiwan government formally opened the gates to Mainland Chinese tourists was passed and implemented, which has contributed to the fact that Taiwanese inbound visitors in 2010 exceed five millions marking a new record. In sum, the number of tourist arrivals to Taiwan increased year-by-year by about 18 times between 2010 and 1968 along tourism evolution.

In the past, the main host (origin) countries of tourist arrivals to Taiwan were almost Japan, Hong Kong, US, Singapore, South Korea, Thailand, and so on. However, till 2010 China fleetly exceeded all countries as the top one of tourist host countries, due to the open to Chinese tourists which will get more and more important position in Taiwanese tourism. Empirical studies of the correlation between tourism demand and economic conditions of Taiwan have been done by some authors. For example, Kim, Chen, & Jing (2006), and Lee & Chien (2008) both used overall tourist arrivals to Taiwan as a proxy of tourism growth to discuss the relationship between tourism development and macroeconomic growth, but with different econometrical methods. Nevertheless, the tourism arrival changes from individual host (origin) counties responding to different macroeconomic conditions have hardly been discussed and then presented in literature. In this paper, an individual host (origin) country will be chosen to find out the relationship between its tourism demand and economic conditions, which could be effectively in favor of more detailed policy makings. However, which country is more interested? In the meanwhile China must be the answer through a structure break - the open to Chinese tourists, but lacking enough datasets to do. In addition, except US, all the top host countries are situated in Asia and close to Taiwan. Although there is not a geographical advantage existing for US tourists to Taiwan, US has been still a main resource of tourist arrivals to Taiwan for long time, which probably is due
that US and Taiwan continually keep the friendly relationship no matter in economic, cultural, military, or political affairs. Since US owns rare different specialties than other countries, we target US as an interested origin country in this research. Then, this paper is trying investigate the long and short-run relationship between international tourist arrivals from US to Taiwan and economic factors including US national incomes, tourism living cost, and substitute prices. In order to verify the relationships and impacts, the cointegration test, vector error correction model (VECM), and generalized impulse function are adopted.

The remainder of the paper is organized as follows. Section 2 reviews recent publications about tourism economies, which will provide the rationale for using the chosen research topic and methodology for this study. Section 3 describes the model, data, and results, while the last section summaries the conclusions.

1.2 Research contribution

- Empirical studies of the correlation between tourism demand and economic conditions of Taiwan have been done by some authors. For example, Kim (2006), and Lee (2008) both used overall tourist arrivals to Taiwan as a proxy of tourism growth to discuss the relationship between tourism development and macroeconomic growth. Nevertheless, the tourism arrival changes of Taiwan from “individual” host (origin) counties responding to different macroeconomic conditions have hardly been discussed. In this paper, an individual host country “US” will be chosen to analyze the relationship between its tourism demand and economic conditions.

- The results show that there exists a stable long-run relationship between the four model variables of the tourist arrivals from US, the personal disposable income of US, the cost of living, and the substitute prices. And for the short-term, the response of the tourist arrivals from US to a shock in the personal disposable incomes of US is positive but not significant.
The shock in cost of living has a negative impact on tourism demand for US and but the impact of the shock is rare small. The tourism demand for US is affected by the shock in substitute prices positively and the impact of the shock lasts about 4 periods. Overall, the short-run equilibrium adjustment process is quite fast.

2 Literature reviews

The first concern about tourism economies in related literature was argued by McKinnon (1964) that tourism brings in foreign exchange which can be used to import capital goods as to produce goods and services, leading in turn to economic growth. In other words, international tourists may provide a remarkable part of the necessary financing for the country, even though non-tourist regions will also benefit from it as a result of the distribution of a country’s wealth. Khan, Phang, & Toh in 1995 analyzed Singapore’s data and pointed out that tourist spending can have direct-multiplier and indirect-multiplier effects on the host country's economy. In addition, the studies of Kulendran & Wilson (2000) and Shan & Wilson (2001), for Australia and China respectively, their empirical analyses also observed a strong reciprocal relationship between international trade and international travel. In 2009, Chao, Hazari, Laffargue, & Yu proposed that a long-run effect also existed between Hong Kong’s economy and its international tourism by the same way.

The existing literature shows that there had been very few published papers in international academic journals concerning the relationship of Taiwan’s tourism and economy. One of the reasons is that Taiwan has not been regarded as a traditional and famous destination by international tourists. Indeed, many Americans and Europeans can not accurately understand where Taiwan is, let alone select Taiwan as a visiting destination. Until 2006 by Kim, Chen, & Jing, a paper concerning the relationship between tourism and economy of Taiwan did not appear. The paper examined the causal relationship between tourism expansion and economic development in Taiwan with the tourist arrival and
the GDP variables and indicated a long-run equilibrium relationship and further a bi-directional causality between the two factors. In other words, in Taiwan, tourism and economic development reinforce each other. However, it could be found that all these literature just concern overall tourist arrivals but of individual host (origin) countries. Dritsakis (2004) tried to investigate changes in the long-run demand for tourism to Greece by Germany and Great Britain, which used a number of leading macroeconomic variables, including income in origin countries (Germany and Great Britain), tourism prices in Greece, and transportation cost and exchanges rates between the three countries. In the same years, Lim analyzed the seasonal patterns of tourist arrivals from South Korea to Australia, and used econometric time series modeling to quantify the factors affecting the flow of international tourists between Australia and Korea. The paper in Song & Witt (2006) used VAR to forecast tourist flows to Macau from eight major origin countries, suggesting that Macau will face increasing tourism demand by residents from mainland China. Nevertheless, the tourist arrivals to Taiwan from major host (origin) countries still have not been discussed separately in academic papers. In this paper, an important host country where many tourist arrivals come from, US, will be chosen to analyze the relationship between Taiwan’s tourist arrivals from US and economic factors.

With regard to research about economy and tourism, it is important to verify which economic factor should affect tourism demand closely. Lim (1997) argued that discretionary income should be used as the appropriate measure of income in the demand model. However, this is a subjective variable and the data cannot be easily obtained in practice. Therefore, alternative income measures have to be used as a proxy for tourists’ discretionary income. Among these alternatives such as GDP, GNP, PDI, and GNI, real personal disposable income (PDI) is the best proxy to be included in the demand models that relate to holiday or visiting friends and relatives travel (Kulendran & Witt, 2001; Song et al., 2000; Syriopoulos, 1995). (Song & Witt, 2006) So, the monthly data of real personal disposable income is chosen as one of the economic factors in this paper.
The own price of tourism is another variable that has been found to have an important role determining international tourism demand. Song & Witt (2006) pointed out that this variable should contain two components in theory: the cost of living for tourists at the destination and the travel cost to the destination. However, in many studies travel costs were omitted, due to difficulties in obtaining data, so travel costs will not also be discussed in this paper. The cost of living in the destination is normally measured by the destination consumer price index (CPI) relative to the origin CPI. Another important factor that affects the cost of living in the destination is the exchange rate between the origin country and destination country currencies. Qiu & Zhang (1995) and Witt & Witt (1992) used the exchange rate between the destination and origin as well as a separate CPI variable to account for the cost of tourism, while the majority of the published studies, especially the most recent ones such as Song & Witt (2006), have employed an exchange rate adjusted relative price index between the destination and origin as the own price variable. In addition to the own price, substitute prices in competitive destinations have also proved to be important determinants. There are two forms of substitute prices that have been used: one allows for the substitution between the destination and a competitive destination as Kim & Song (1998), Song et al. (2000), Song & Witt (2006), and the other calculates the cost of tourism in the destination under consideration relative to a weighted average cost of living in various competing destinations, and this index is also adjusted by relevant exchange rates. The weight is the relative market share of each competing destination (Song & Witt, 2003). In this study, the first form is adopted by setting Hong Kong as single competing destination, because market share ratios of major competing countries are hard to obtain. In addition, Hong Kong region locates very near Taiwan and has the similar tourism and business model.

3 The model, dataset, and results

The econometric method applied to model a long-run relationship between tourist arrivals from US and economic factors is the cointegration methodology
which estimates the monthly dataset of tourist arrivals from US, the personal disposable income (PDI) of US, the own prices, and the substitute prices over the period from March, 2001 to November, 2011. In this study, the cost of living is deemed as the index variable of own prices in Taiwan normally measured by the Taiwanese consumer price index (CPI) divided by the CPI of US and adjusted by the appropriate exchange rates. The substitute price is measured by the relative CPI of Hong Kong to that of Taiwan adjusted by the appropriate exchange rate, because Hong Kong is generally regarded as the most major opponent of Taiwan in tourism industries. There are four model variables: tourist arrivals from US gotten from Tourism Bureau, Ministry of Transportation and Communications, Republic of China (Taiwan), PDI gotten from the financial database of Taiwan Economic Journal (TEJ), the cost of living and the substitute prices calculated with exchange rates and CPI of Taiwan, US, and Hong Kong also gotten from TEJ. Then, the four model variables were all transformed by the use of natural logarithms to ease interpretation of coefficients. Besides, there is a concern of removing important information while adjusting for seasonality, unadjusted data are used. Before cointegration test, the unit root of the variables must be tested firstly to know the cointegration order of the four model variables. Further, we applied the method developed by Johansen (1988) based on the Vector Autoregression (VAR) to test whether the cointegration exists among the four model variables. In addition, in order to understand the impacts of tourism demand from US responding to the change of the economic factors including the personal disposable income (PDI) of US, the cost of living, and the substitute prices, the impulse response analysis based on vector error correction model (VECM) was used.

3.1 Unit root for the order of integration

In general, the first step for economic data analysis is to study the integration order of the series by using a unit root test (Schubert, Brida, and Risso, 2010). Integration means that past shocks remaining undiluted affects the realizations
of the series forever and a series has theoretically infinite variance and a
time-dependent mean (Enders, 1995). Univariate tests for unit roots were first
proposed by Fuller (1976) and Dickey and Fuller (1979) and, in turn, were
applied to a range of macroeconomic data by Nelson and Plosser (1982).

In this paper, famous Augmented Dickey–Fuller (ADF) and Phillips–Perron
(PP) tests are made use of verifying whether the time series variable is
non-stationary or stationary. All procedures allow for fitted drift in the time
series model. The ADF test account for temporally dependent and
heterogeneously distributed errors by including lagged innovation sequences in
the fitted regression. In contrast, the Phillips and Perron procedure accounts for
n.i.i.d. (non-independent and identically distributed) processes using a
nonparametric adjustment to the standard Dickey-Fuller (DF) procedure. The
results of testing the order of logarithm variables of tourist arrivals from US
(LUSTA), the personal disposable income of US (LUSPDI), the cost of living
(LUSCL), and the substitute prices (LUSSP) are shown in Table 1. The tests
strongly sustain the null hypothesis of non-stationarity for the level variables of
the personal disposable income of US (LUSPDI) and the substitute price
(LUSSP), and reject ones for the level variables of tourist arrivals from US
(LUSTA) and the cost of living (LUSCL). Then, the first differenced series of
all four model variables are stationary because the null hypothesis was rejected
at 1% level. In short, the variables of tourist arrivals from US (LUSTA) and the
cost of living (LUSCL) are significantly belonged to the zero order of
integration I(0) whereas the personal disposable income of US (LUSPDI) and
the substitute price (LUSSP) are I(1).

The unit root test shows that there exist different orders of integration, I(0)
and I(1), for the four model variables, which means the approach of
conventional regression and unrestricted vector autoregression (VAR) is not
avail to use. When we study with nonstationary time series, the regressions
usually produce significant OLS parameter estimates yet, but the residuals are
ordinarily nonstationary, thus violating the standard assumption of classical
econometrics. This problem is known as spurious regression. The VAR model
has the same problem. In addition, Toda and Yamamoto (1995) noted that
conventional asymptotic theory is, in general, not applicable to hypothesis testing in levels VARs if the variables are integrated, I(1). Therefore, we follow the remark of Phillips (1986) that cointegration techniques have to be applied for nonstationary time series, and, for different integration orders, the Johansen cointegration test is selected here.

### Table 1. Results of unit root tests

<table>
<thead>
<tr>
<th>Variables</th>
<th>LUSTA</th>
<th>LUSPDI</th>
<th>LUSCL</th>
<th>LUSSP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test method</td>
<td>ADF</td>
<td>PP</td>
<td>ADF</td>
<td>PP</td>
</tr>
<tr>
<td>Level</td>
<td>-6.27***</td>
<td>-5.56***</td>
<td>-1.28</td>
<td>-0.72</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.6359)</td>
<td>(0.8357)</td>
</tr>
<tr>
<td>First differenced</td>
<td>-10.8***</td>
<td>-18.7***</td>
<td>-5.91***</td>
<td>-11.19***</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.00)</td>
</tr>
</tbody>
</table>

Notes: The optimal lag length determined selected on Akaike Information Criterion (AIC). Numbers without ( ) are the t-statistics for each kind of the unit root tests. Numbers in brackets ( ) are probabilities, p-values. To reject the null hypothesis of having a unit root at different significant levels 1%, 5%, or 10%, which means that a time series is stationary. *** indicates the t-statistics is at the 1% significance level, in the same way, ** and * at the 5% and 10% significance level, respectively.

### 3.2 Testing for cointegration

On the application of unit root tests in this paper, both the time series of the tourist arrivals from US (LUSTA) and the cost of living (LUSCL) are well characterized to be integrated of order zero, denoted I(0) which means stationarity that the mean and the variance of these series are constant through time and the autocovariance of the series is not time varying. However, the time series of the personal disposable income of US (LUSPDI) and the substitute price (LUSSP) are I(1) meaning that past shocks remaining undiluted affects the realizations of the series forever and either series has theoretically an infinite variance and a time-dependent mean. Since the dependent variable, the tourist arrivals from US to Taiwan, and the other three economic variables have not the same order of integration, the Johansen cointegration test is an
adequate method to verify whether the cointegration exists among the four model variables.

The Johansen test, named after Saren Johansen, is a procedure for testing cointegration. This test permits more than one cointegrating relationship so is more generally applicable than the Engle–Granger test which is based on the Dickey–Fuller (or the augmented) test for unit roots in the residuals from a single estimated cointegrating relationship. There are two types of likelihood ratio tests, either with trace or with maximum eigenvalue to test for the number of cointegrating relationships, and the results might be a little bit different. Table 2 and Table 3 separately shows results of the trace and maximum eigenvalue statistics of the cointegration test between the four model variables including the tourist arrivals from US (LUSTA), the personal disposable income of US (LUSPDI), the cost of living (LUSCL), and the substitute price (LUSSP). When the trace statistic and the maximum eigenvalue statistic are greater than Osterwald-lenum (1992) 5% critical values, the null hypothesis of \(r\) cointegrating vectors against the alternative of \(r+1\) vectors is rejected, \(r\) denoting number of cointegration equations. Regardless of the trace statistic or the maximum eigenvalue one, two hypotheses \((r = 0\) and \(1\)) were rejected at the 5% significance level, which indicated the existence of two cointegrating equations between the four model variables. Enders (2004) states that cointegrated variables share the same stochastic trends and so cannot drift too far apart. It is concluded that there is a long-run equilibrium relationship between the four model variables of the tourist arrivals from US, the personal disposable income of US, the cost of living, and the substitute price.

<table>
<thead>
<tr>
<th>Hypothesized No. of CE(s)</th>
<th>Trace Eigenvector</th>
<th>Trace Statistic</th>
<th>Critical Value</th>
<th>Prob.**</th>
</tr>
</thead>
<tbody>
<tr>
<td>None *</td>
<td>0.176401</td>
<td>49.94013</td>
<td>35.19275</td>
<td>0.0007</td>
</tr>
<tr>
<td>At most 1 *</td>
<td>0.139098</td>
<td>25.48713</td>
<td>20.26184</td>
<td>0.0087</td>
</tr>
<tr>
<td>At most 2</td>
<td>0.051150</td>
<td>6.615598</td>
<td>9.164546</td>
<td>0.1483</td>
</tr>
</tbody>
</table>

Notes: CE means cointegration equations. The optimal lags selected.
Table 3. Cointegration tests by maximum eigenvalue

<table>
<thead>
<tr>
<th>Hypothesized</th>
<th>Max-Eigen</th>
<th>Statistic</th>
<th>Critical Value</th>
<th>Prob.**</th>
</tr>
</thead>
<tbody>
<tr>
<td>None *</td>
<td>0.176401</td>
<td>24.45300</td>
<td>22.29962</td>
<td>0.0246</td>
</tr>
<tr>
<td>At most 1 *</td>
<td>0.139098</td>
<td>18.87153</td>
<td>15.89210</td>
<td>0.0165</td>
</tr>
<tr>
<td>At most 2</td>
<td>0.051150</td>
<td>6.615598</td>
<td>9.164546</td>
<td>0.1483</td>
</tr>
</tbody>
</table>

Notes: CE means cointegration equations. The optimal lags selected based on AIC. *denotes rejection of the hypothesis at the 0.05 level, **MacKinnon-Haug-Michelis (1999) p-values.

3.3 Vector error correction model

There is an error correction representation for cointegrated series. Engle & Granger (1987) reveal that, if the series are cointegrated, then the possibility of the estimated regression being spurious due to tribulations such as omitted variable bias, autocorrelation, and endogeneity is ruled out. Since the series tested above are cointegrated, a vector error correction model (VECM) can be specified. Observing the long-run and short-run properties of the series may provide very useful insights especially for policy makers. (Gune, 2007) In addition, because the cointegrating vectors bind the long run behavior of the variables, the VECM could be expected to produce results in impulse response analysis that more accurately reflect the relationship between the variables than the standard unrestricted VAR.

Due that two cointegrating vectors exist among these variables, the vector error correction model (VECM) can be written as follows:

\[
\Delta \text{LUSTA}_t = \alpha_1 + \sum \lambda_i(t) \Delta \text{LUSTA}_{t-i} + \sum \beta_i(t) \Delta \text{LUSPDI}_{t-i} + \sum \gamma_i(t) \Delta \text{LUSCL}_{t-i} \\
+ \sum \delta_i(t) \Delta \text{LUSSP}_{t-i} + \phi_1 \text{ECT}_{t-i} + \epsilon_{1t} \\
\Delta \text{LUSPDI}_t = \alpha_2 + \sum \lambda_i(t) \Delta \text{LUSTA}_{t-i} + \sum \beta_i(t) \Delta \text{LUSPDI}_{t-i} + \sum \gamma_i(t) \Delta \text{LUSCL}_{t-i} \\
+ \sum \delta_i(t) \Delta \text{LUSSP}_{t-i} + \phi_2 \text{ECT}_{t-i} + \epsilon_{2t}
\]
\[ \Delta \text{LUSCL}_t = \alpha_3 + \sum \lambda_3(i) \Delta \text{LUSTA}_{t-i} + \sum \beta_3(i) \Delta \text{LUSPDI}_{t-i} + \sum \gamma_3(i) \Delta \text{LUSCL}_{t-i} \\
+ \sum \delta_3(i) \Delta \text{LUSSP}_{t-i} + \phi_3 \text{ECT}_{t-i} + \epsilon_{t3} \quad (3) \]
\[ \Delta \text{LUSSP}_t = \alpha_4 + \sum \lambda_4(i) \Delta \text{LUSTA}_{t-i} + \sum \beta_4(i) \Delta \text{LUSPDI}_{t-i} + \sum \gamma_4(i) \Delta \text{LUSCL}_{t-i} \\
+ \sum \delta_4(i) \Delta \text{LUSSP}_{t-i} + \phi_4 \text{ECT}_{t-i} + \epsilon_{t4} \quad (4) \]

where \( \Delta \) is the first-difference operator, ECT is the error correction term coming from the long-run cointegrating relationship. The coefficients of ECT, \( \phi_1, \ldots, \phi_4 \), capture the adjustments of \( \Delta \text{LUSTA}_t, \Delta \text{LUSPDI}_t, \Delta \text{LUSCL}_t, \) and \( \Delta \text{LUSSP}_t \) towards long-run equilibrium. The coefficient vectors of the error correction terms (ECT) of the VECM results obtained from equations (1) to (4) are shown in Table 4. After the cointegration test, it is verified that there exist two cointegration vectors, so followed two coefficient vectors of error correction terms (ECT). For the first coefficient vector ECT1 of error correction terms in Table 4, the ECT1 coefficient of equations (1) and (3) are significant and have negative signs at 1% and 10% significant levels, respectively. For the second coefficient vector ECT2, the ECT2 coefficient of equation (2) is also significant at 1% level and has negative signs. These imply that the series can not sway too far and convergence is achieved in the long run. Hence, each ECT coefficient indicates that how long a deviation from the long-run equilibrium value in a given time will be corrected for depends on the size of that coefficient.

<table>
<thead>
<tr>
<th>Table 4. Results of Vector Error Correction Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent variables</td>
</tr>
<tr>
<td>Equations</td>
</tr>
<tr>
<td>Coefficient vector ECT1</td>
</tr>
<tr>
<td>Coefficient vector ECT2</td>
</tr>
</tbody>
</table>
3.4 Generalized impulse response analysis

An impulse response function measures the time profile of the effect of shocks at a given point on the expected future values of variables for a dynamic system. This study uses analysis of the generalized impulse response functions (Pesaran & Shin, 1998) to analyze the short-run dynamics of the variables. Unlike orthogonalized impulse response functions are unique solution and invariant to the ordering of the variables in VECM. The dynamic response of the tourist arrivals (tourism demand) to innovations in the macroeconomic factors can be traced out by the generalized impulse response analysis. We could see the responses of the tourist arrivals from US (LUSTA) to the personal disposable income of US (LUSPDI), the cost of living (LUSCL), and the substitute price (LUSSP) as given in Fig. 1, such that the tourism demand function takes the form

\[ \text{LUSTA}_t = f(\text{LUSPDI}_t, \text{LUSCL}_t, \text{LUSSP}_t) \]  

(5)
The top-left panel of Fig. 1 shows that a shock in the variable itself of the tourist arrivals from US will have a relatively larger impact on the current level of tourist arrivals and this impact will gradually die off and disappear after 9 periods (months). In top-right panel of Fig. 1, the response of the tourist arrivals from US to a shock in the personal disposable incomes of US is positive in the first three periods but the reaction can not be considered as significant. The shock in cost of living (LUSCL) as shown in the bottom-left has a negative impact on tourism demand for US and but the impact of the shock is rare small before dying off, while the response of tourism demand for US (LUSTA) to the shock in substitute prices (LUSSP) in the bottom-right is positive and the influence of the shock tends to last about 4 periods.
Fundamentally, the results of generalized impulse response analysis are almost consistent with the theoretical findings, if the cost of living is higher, less the tourist arrivals are. In contrary, the substitute prices and personal disposal incomes have the same tendency with the tourist arrivals (tourism demand). Overall, from Fig. 1 showing impulse response based on VECM, we see that the short-run equilibrium adjustment process is quite fast.

4 Concluding remarks

The tourism industry may be another major contributing factor to Taiwan’s economic growth. The 2002 annual statistics of Tourism (Tourism Bureau of Taiwan, 2003) reported that Taiwan’s tourism receipts accounted for 4.2 percent of the gross domestic product (GDP) in 1996. This figure exceeded the contribution of the agricultural sector to GDP, thereby making tourism as one of the major industries in Taiwan (Kim, Chen, & Jang, 2006). Besides, the Taiwan government has aggressively promoted inbound tourism over many years by a lot of policies such as “Tour Taiwan Years 2008-2009”, “The Best Trip in the World - Taiwan Explorers Wanted” contest, “The multiplying project of international tourists”, and so on. The tourism development not only increases nation income but also diversifies the range of industries, particularly, the industrial diversity can reduce the risk of export-oriented economy if economic recession occurs. Therefore, tourism has played a very important role for Taiwanese future.

Tourism demand analysis is absolutely regarded as a necessity of tourism policy makings. This empirical study is intended to understand how the important economic factors that include the personal disposable income of US, the cost of living, and the substitute price affect the tourist arrivals from an individual host country, US, by monthly data from 2001 to 2011. In the period, the tourist arrivals from US to Taiwan appeared no obvious time tendency, and verified as a stationary series by unit root tests, so it is not easy to rise the US demand up by a wide margin. Therefore, the US tourism demand must be concerned more detailed and deeply no matter for long-run or short-run
analysis. It was found that there exists a stable long-run relationship between the four model variables of the tourist arrivals from US, the personal disposable income of US, the cost of living, and the substitute prices. And for the short-term, the response of the tourist arrivals from US to a shock in the personal disposable incomes of US is positive but not significant. The shock in cost of living has a negative impact on tourism demand for US and but the impact of the shock is rare small. The response of tourism demand for US to the shock in substitute prices has a positive relation and the impact of the shock lasts about 4 periods. Overall, the short-run equilibrium adjustment process is quite fast.

This study suggests that Taiwanese government and tourism industry must pay more attention to these macroeconomic factors as making policy decisions especially for US tourists because of the long-run stable relationship, and regard Hong Kong as a main competing destination for US tourists due that the response to the substitute prices calculated by Hong Kong’s CPI is more significant. In the future, we hope to compare different important host countries or regions such as Japan, Hong Kong, Korea, and Singapore to get more detailed information for tourism industry. In addition, Taiwan government have formally opened the gates to Mainland Chinese tourists since July 2008, which has contributed to the fact that Taiwanese inbound visitors in 2010 exceed five millions, so China will also be an important research target we must focus on.

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Impulse response analysis of tourist flow
from Hong Kong to Taiwan

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Abstract. Before 1997 HK was a colony of the British Empire, a rallying point of
western and eastern cultures, business and trade prosper fast, particularly after China
resuming sovereignty. Because of vast trades, geographical relation, and a common
race, Hong Kong has been a familiar partner with Taiwan. Many tourists frequently
travel between them, resulting in HK as one of the top three source(origin) regions of
travelers to Taiwan. For tourism policy makings, it is important to realize how
economic factors affect Hong Kong travelers’ decision of choosing Taiwan as a
destination. In this paper, the vector autoregression is applied to generate a more
accurate medium and long-term tourism model. In order to understand the response of
tourist arrivals from HK to the economic factors including GDP of HK, the cost of
living, and the substitute prices, a generalized impulse response analysis is used.

Keywords: cost of living, substitute price, vector autoregression,
generalized impulse response

1 Introduction

Tourism has become one of the major players in international commerce,
and represents at the same time one of the main income sources, especially for
many developing countries (World Tourism Organization, 2006). There are
some reasons which Schubert (2010) generalized from the early literatures such
as Andriotis (2002), Croes (2006), Fagance (1999) and Lin & Liu (2000). First, tourism is an important earner of foreign exchange, allowing to pay for imported capital goods or basic inputs used in the production process. Second, tourism plays a significant role in spurring investments in new infrastructure and competition between local firms and firms in other tourist countries. Third, tourism stimulates other economic industries by direct, indirect and induced effects. Fourth, tourism contributes to generate employment even for relatively unskilled labor and simultaneously to increase national income. Fifth, tourism can cause positive exploitation of economies of scale in national firms. Finally, tourism is an important factor of diffusion of technical knowledge, stimulation of research and development, and accumulation of human capital.

For boosting tourism industries to raise economic development further, analyzing tourism demand is the foundation which all tourism-related business decision makings ultimately rely on. Song & Witt (2006) proposed the following reasons why tourism demand analysis is so important for policy makers. First, companies such as airlines, ocean liners, tour agents, hotels, casinos, other recreation facility providers, and shop owners are very interested in the demand for their products. The success of many tourism-related businesses depends largely on the state of tourism demand, and ultimate management failure is quite often due to the failure to meet market demand. It is clear that accurate analysis and forecasts of tourism demand are essential for efficient planning by tourism-related businesses, particularly given the perishable nature of the tourism product. Secondly, tourism investment requires long-run financial commitments from public finances especially for infrastructures, then, accurate analysis of the tourism demand situation will help governments and tourism-related industries to formulate and implement appropriate medium- to long-term strategies.

The focused destination country, Taiwan, is an island country located on the southeast of China, opposing each other across the Taiwan straits, furthermore the neighbor countries, Japan and Korea at Taiwanese north and Philippine at the south. In short, it is obvious that Taiwan almost locates on the center of the Asia and substantially occupies a significantly geographic and commercial
position in Asia. In obeying traditional island economic model, the last five decades have seen sharp economic growth principally based on a great deal of export in Taiwan, and the dramatic growth of Taiwanese GDP appeared over 260 times from 1961 to 2011. Within the course of economic development, the Taiwanese gross export value mainly contributed by manufacturings has the same tendency with GDP year-on-year. (The financial database of the Taiwan Economic Journal, TEJ) Recently, especially in the last decade, due to facing immense competition, principally of manufacturing industries, only manufacturing export has not been able to provide enough energy to sustain Taiwanese economic growth completely. For stimulating the impotent economy, Taiwan must aggressively make unremitting efforts to carry out an industrial transit such as raising output value of service industry, like tourism.

In order to rise up the output of the tourism industry, many actions have been done by Taiwan government in the ten years. For example, the government targets various markets by promoting packages to local travel agencies as well as to potential clients via the media, in addition to the packages, special events and activities to tourists also being boosted such as recently “Tour Taiwan Years 2008-2009: Great Quarterly Tourist Giveaway Program”, “the Key-Words marketing”, and the “The Best Trip in the World - Taiwan Explorers Wanted” contest. After these promotions taking place in 2009, the number of inbound visitors to Taiwan increased by 14.3% year-on-year, 29.47% of which came for sightseeing purposes (Taiwan Tourism Bureau). Moreover, in July 2008, a very important policy that the Taiwan government formally opened the gates to Mainland Chinese tourists was passed and implemented, which has contributed to the fact that Taiwanese inbound visitors in 2010 exceeded five millions marking a new record. Overall, the number of tourist arrivals to Taiwan increased year-by-year by about 18 times between 2010 and 1968 along tourism evolution.

In the past, the main source (origin) countries of tourist arrivals to Taiwan were almost Japan, Hong Kong, US, Singapore, South Korea, Thailand, and so on. However, till 2010 China fleetly exceeded all countries as the top one of tourist source countries, due to the open to Chinese tourists which will get
more and more important position in Taiwanese tourism. Empirical studies of
the correlation between tourism demand and economic conditions of Taiwan
have been done by some authors. For example, Kim, Chen, & Jing (2006), and
Lee & Chien (2008) both used Taiwan’s overall tourist arrivals as a proxy of
tourism growth to discuss the relationship between tourism development and
macroeconomic growth. Nevertheless, tourism arrival change from individual
source (origin) country responding to different macroeconomic condition has
hardly been discussed. In this paper, an individual source (origin) country will
be chosen to find out the relationship between its tourism demand and
economic conditions, which could be effectively in favor of more detailed
policy makings. However, which country is more interested? In the meanwhile
China must be the answer through a structure break - the open to Chinese
tourists, but lacking enough datasets to do. In addition, Hong Kong would be
another attractive research goal. Hong Kong is one of two Special
Administrative Regions (SARs) of the People's Republic of China (PRC), the
other being Macau. There are the same race and language among the three
regions: Hong Kong, Taiwan, and China. For long time, due to special
cross-strait political relationship, Hong Kong had been an important gate
between Taiwan and China. Hong Kong and Taiwan always keep the friendly
relationship no matter in economic, financial, or cultural affairs, even after
handover in 1997. In 2011, the tourist arrival from Hong Kong still got the
third position, just less than China and Japan. Therefore, this paper targets
Hong Kong as an interested source region and tried to investigate the response
of tourist arrivals to different economic factors including GDP of Hong Kong,
tourism living cost, and substitute prices. In order to verify the relationships
and impacts, the unit root test, vector autoregression (VAR), and generalized
impulse function are adopted.

The remainder of the paper is organized as follows. Section 2 reviews recent
publications about tourism economies, which will provide the rationale for
using the chosen research topic and methodology for this study. Section 3
describes the model, data, and results, while the last section summaries the
conclusions.
2 Literature reviews

The existing literature shows that there had been very few published papers in international academic journals concerning the relationship of Taiwan’s tourism demand and economic factors. The reason may be that Taiwan has not been regarded as a traditional and famous destination by international tourists. Indeed, many Americans and Europeans cannot accurately understand where Taiwan is, let alone select Taiwan as a visiting destination. Until 2006 by Kim, Chen, & Jing, a paper concerning the relationship between tourism and economy of Taiwan did not appear. The paper examined the causal relationship between tourism expansion and economic development in Taiwan with the tourist arrival and the GDP variables, and indicating a long-run equilibrium relationship and further a bi-directional causality between the two factors. However, it could be found that all these literature just concern the overall tourist arrivals but of individual source (origin) countries or regions.

Dritsakis (2004) tried to investigate changes in the long-run demand for tourism to Greece by Germany and Great Britain, which used a number of leading macroeconomic variables, including income in origin countries, tourism prices in Greece, and transportation cost and exchange rates. In the same years, Lim analyzed the seasonal patterns of tourist arrivals from South Korea to Australia, and used econometric time series modeling to quantify the factors affecting the flow of international tourists between Australia and Korea. The paper in Song & Witt (2006) used VAR to forecast tourist flows to Macau from eight major origin countries, suggesting that Macau will face increasing tourism demand by residents from mainland China. Nevertheless, the tourist arrivals to Taiwan by major source (origin) countries or regions still have not been discussed separately in academic papers. In this paper, an important source region where many tourist arrivals come from, Hong Kong, will be chosen to analyze the relationship between Taiwan’s tourist arrivals from Hong Kong and economic factors.

With regard to research about economy and tourism, it is important to verify
which economic factor should affect tourism demand closely. Lim (1997) argued that discretionary income should be used as the appropriate measure of income in the demand model. However, this is a subjective variable and the data cannot be easily obtained in practice. Therefore, alternative income measures have to be used as a proxy for tourists’ discretionary income. (Song & Witt, 2006) Among these alternatives such as GDP, GNP, PDI, and GNI, real gross domestic product (GDP) is a more suitable proxy which works in the demand models that relate to sum of visitors including holiday, visiting friends, relatives travel, and so on. So, the quarterly data of real GDP is chosen as one of the economic factors in this paper.

The own price of tourism is another variable that has been found to have an important role determining international tourism demand. Song & Witt (2006) pointed out that this variable should contain two components in theory: the cost of living at the destination and the transportation cost to the destination. However, in many studies transportation cost was omitted, by acquiring data difficultly, so transportation costs will not also be considered in this paper. The cost of living at the destination is normally measured by the destination consumer price index (CPI) relative to the origin CPI. Another important factor that affects the cost of living in the destination is the exchange rate between the origin country and destination country currencies. Qiu & Zhang (1995) and Witt & Witt (1992) used the exchange rate between the destination and origin as well as a separate CPI variable to account for the cost of tourism, while the majority of the published studies, especially the most recent ones such as Song & Witt (2006), have employed an exchange rate adjusted relative price index between the destination and origin as the own price variable. In this paper, the exchange rate adjusted relative price index is calculated for the variable of living cost.

In addition to the own price, substitute prices in competitive destinations have also proved as important determinants. There are two forms of substitute prices that have been used: one allows for the substitution between the destination and a competitive destination as Kim & Song (1998), Song et al. (2000), Song & Witt (2006), and the other calculates the cost of tourism in the
destination under consideration relative to a weighted average cost of living in various competing destinations, and this index is also adjusted by relevant exchange rates. The weight is the relative market share of each competing destination (Song & Witt, 2003). In this study, market share ratios of major competing countries are hard to obtain completely, the first form is adopted by setting a hot destination, Japan, as single competing country.

3 International tourism demand from Hong Kong to Taiwan

Hong Kong, a city-state situated on China's south coast and enclosed by the Pearl River Delta and South China Sea, is renowned for its expansive skyline and deep natural harbor. With a land mass of 1,104 km$^2$ and a population of seven million people, Hong Kong is one of the most densely populated areas in the world. In addition, Hong Kong's population is 95 percent ethnic Chinese. Because of the same race and language and region nearby with Taiwan, a large number of Hong Kong travelers choose Taiwan as a destination for sightseeing or holidays, especially attracted by Taiwanese natural scenery. Tourist arrivals from Hong Kong have become an important source of the Taiwan inbound tourist market, rising up by about 47% from 4th quarter 2001 to 4th quarter 2011. As shown in Fig. 1, the quarterly tourist arrival series exhibits a predominantly upward trend since 2001 Q1, except an abrupt shrink in 2003 caused by Severe Acute Respiratory Syndrome (SARS) epidemic. Most Hong Kong travelers regard Taiwan as a holiday destination, with the main purpose of travel being sightseeing, rather than business or trading as shown in Fig. 2. We try to analyze the seasonal patterns of tourist arrivals from Hong Kong to Taiwan based on seasonally unadjusted quarterly data for 2001 Q1 to 2011 Q4. From Fig. 1, it seems to convey a message that tourist arrivals from Hong Kong to Taiwan display strong seasonal patterns. More seriously, monthly seasonal indices for tourist arrivals are computed to prove the seasonality by using the ratio-to-moving average technique, calculated with monthly data of tourist arrivals from January 2001 to December 2011 as followed (Lim & McAleer, 2001):
\[ P_t = \frac{A_t}{MA_t} \times 100\% \]  \hspace{1cm} (1)

where \( P_t \) is the ratio-to-moving average, \( A_t \) the tourist arrivals in levels, and \( MA_t \) is the moving average. This procedure is intended to eliminate the trend and cyclical components, thereby resulting in a series that contains seasonal movements. During the period, February, March, April, July, August, and December were the high seasons for inbound tourists from Hong Kong to Taiwan, as seen in Table 1. The Lunar New Year holidays and the summer season have some influence on outbound travel from Hong Kong. Hence, the tourist arrival from Hong Kong to Taiwan has obvious seasonality.

![Fig. 1. Quarterly tourist arrivals from Hong Kong](image-url)
Fig. 2. Quarterly tourist arrivals from Hong Kong by traveling purpose

<table>
<thead>
<tr>
<th>Month</th>
<th>Seasonal indices</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>0.805</td>
</tr>
<tr>
<td>February</td>
<td>1.055</td>
</tr>
<tr>
<td>March</td>
<td>1.106</td>
</tr>
<tr>
<td>April</td>
<td>1.080</td>
</tr>
<tr>
<td>May</td>
<td>0.956</td>
</tr>
<tr>
<td>June</td>
<td>1.055</td>
</tr>
<tr>
<td>July</td>
<td>1.076</td>
</tr>
<tr>
<td>August</td>
<td>1.247</td>
</tr>
<tr>
<td>September</td>
<td>0.930</td>
</tr>
<tr>
<td>October</td>
<td>0.937</td>
</tr>
<tr>
<td>November</td>
<td>0.909</td>
</tr>
<tr>
<td>December</td>
<td>1.239</td>
</tr>
</tbody>
</table>
4 The model, dataset, and results

The vector autoregression (VAR) is estimated using quarterly data over the period of the first quarter of 2001 through the fourth quarter of 2011. The model variables are the tourist arrival from Hong Kong, the gross domestic product (GDP) of Hong Kong, the own prices, and the substitute prices. Among them, the tourist arrival is regarded as the dependent variable whose responses to the other economic factors will be understood in this study. The cost of living is deemed as the index variable of own prices in Taiwan normally measured by the Taiwanese consumer price index (CPI) divided by the CPI of Hong Kong and adjusted by the appropriate exchange rates. The substitute price is measured by the relative CPI of Japan to that of Taiwan adjusted by the appropriate exchange rate, because Japan is generally regarded as the most major opponent of Taiwan in tourism industries. The dataset of the model variables: tourist arrivals from Hong Kong gotten from Tourism Bureau, Ministry of Transportation and Communications, Republic of China (Taiwan), GDP of Hong Kong gotten from the financial database of Taiwan Economic Journal (TEJ), the cost of living and the substitute prices calculated with exchange rates and CPI of Taiwan, Hong Kong, and Japan also gotten from TEJ. Then, the four model variables were all transformed by the use of natural logarithms to ease interpretation of coefficients. Besides, there is a concern of removing important information while adjusting for seasonality, unadjusted data are used.

Before specification and estimation of vector autoregression (VAR), it is required to examine the stationarity of the four model variables. The unit roots of the variables are tested firstly to know the cointegration order of the four model variables. If the stationarity is satisfied, we applied the method of Vector Autoregression (VAR) to generate more accurate medium and long-term model. In addition, in order to understand the impacts of tourism demand from Hong Kong responding to the change of the economic factors including GDP of Hong Kong, the cost of living, and the substitute prices, the impulse response
analysis was used.

### 4.1 Unit root for the order of integration

In this paper, famous Augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) tests are made use of verifying whether the time series variable is non-stationary or stationary. All procedures allow for fitted drift in the time series model. The ADF test account for temporally dependent and heterogeneously distributed errors by including lagged innovation sequences in the fitted regression. In contrast, the Phillips and Perron procedure accounts for n.i.i.d. (non-independent and identically distributed) processes using a nonparametric adjustment to the standard Dickey-Fuller (DF) procedure. The results of testing the order of logarithm variables of tourist arrivals from Hong Kong (LHKTA), the GDP of Hong Kong (LHKGDP), the cost of living (LHKCL), and the substitute prices (LHKSP) are shown in Table 2. The results basically rejected the null hypothesis of non-stationarity for all level variables, meaning stationary. For the two level series of tourist arrivals (LHKTA) and GDP of Hong Kong (LHKGDP), rejections of the null hypotheses of having a unit root are both strongly significant at 1% level, while the substitute price (LUSSP) is significant at 5%, no matter using ADF or PP. There are two different results for testing the level variable of the cost of living (LHKCL) separately using ADF and PP. By ADF the null hypothesis of non-stationarity is rejected at 5% whereas 13.6% appears by PP. However, it is simplified in this paper that the level variable of the cost of living (LHKCL) is stationary at roughly 10%. In sum, it is concluded the level variables of the four model variables all significantly belong to the zero order of integration, $I(0)$.

When we study with nonstationary time series, the regressions usually produce significant OLS parameter estimates yet, but the residuals are ordinarily nonstationary, thus violating the standard assumption of classical econometrics. This problem is known as spurious regression. The VAR model has the same problem. In addition, Toda and Yamamoto (1995) noted that conventional asymptotic theory is, in general, not applicable to hypothesis
testing in levels VARs if the variables are integrated, I(1). However, the unit root test in this paper shows that the four model variables have the same order of integration I(0), it means unrestricted vector autoregression (VAR) is available.

### Table 2. Results of unit root tests for level variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>LHKTA</th>
<th>LHKGDP</th>
<th>LHKCL</th>
<th>LHKSP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test method</td>
<td>ADF</td>
<td>PP</td>
<td>ADP</td>
<td>PP</td>
</tr>
<tr>
<td>t-statistics</td>
<td>-4.237***</td>
<td>-5.46***</td>
<td>-5.444***</td>
<td>-4.448***</td>
</tr>
<tr>
<td>p-values</td>
<td>(0.0089)</td>
<td>(0.0003)</td>
<td>(0.0003)</td>
<td>(0.005)</td>
</tr>
<tr>
<td>Lag</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>9</td>
</tr>
</tbody>
</table>

Notes: The optimal lag length determined selected on Akaike Information Criterion (AIC). Numbers without ( ) are the t-statistics for each kind of the unit root tests. Numbers in brackets ( ) are probabilities, p-values. To reject the null hypothesis of having a unit root at different significant levels 1%, 5%, or 10%, which means that a time series is stationary. *** indicates the t-statistics is at the 1% significance level, in the same way, ** and * at the 5% and 10% significance level, respectively.

### 4.2 Vector autoregression

On the application of unit root tests in this paper, all the time series of tourist arrivals from Hong Kong (LHKTA), the GDP of Hong Kong (LHKGDP), the cost of living (LHKCL), and the substitute prices (LHKSP) are well characterized to be integrated of order zero, denoted I(0), which means stationarity that the mean and the variance of these series are constant through time and the autocovariance of the series is not time varying. Hence, the unrestricted vector autoregression (VAR) developed by Sims (1980) is suited to generate the tourism demand model of this paper.

International tourism flows are subject to disruption by a range of events that may occur in the destination itself, in competing destination, origin markets, or in areas may be remote from either. In addition, tourism demand is particularly sensitive to security and health concerns, and the industry is highly susceptible to changes in the international political situation, natural disasters, and
epidemics. (Mao, Ding, & Lee, 2010) The hallmark event considered in this paper during the period 2001-2011 is the Severe Acute Respiratory Syndrome (SARS) epidemic as an exogenous dummy variable of external shock, D_SARS. Besides, given in Sec. 2, we found the tourist arrivals from Hong Kong to Taiwan have strong seasonal patterns, seasonal dummy variables D2, D3, and D4, would be also added to the VAR model as exogenous variables. The VAR model is performed as:

\[
LHKTA_t = \alpha_1 + \sum_{i=1}^{m} \lambda_i (i) LHKTA_{t-i} + \sum_{i=1}^{m} \beta_i (i) LHKGDP_{t-i} + \sum_{i=1}^{m} \gamma_i (i) LHKCL_{t-i} + \sum_{i=1}^{m} \delta_i (i) LHKSP_{t-i} + a_1 D_{SARS} + b_1 D_2 + c_1 D_3 + d_1 D_4 + \epsilon_{1t}
\]

(2)

\[
LHKGDP_t = \alpha_2 + \sum_{i=1}^{m} \lambda_2 (i) LHKTA_{t-i} + \sum_{i=1}^{m} \beta_2 (i) LHKGDP_{t-i} + \sum_{i=1}^{m} \gamma_2 (i) LHKCL_{t-i} + \sum_{i=1}^{m} \delta_2 (i) LHKSP_{t-i} + a_2 D_{SARS} + b_2 D_2 + c_2 D_3 + d_2 D_4 + \epsilon_{2t}
\]

(3)

\[
LHKCL_t = \alpha_3 + \sum_{i=1}^{m} \lambda_3 (i) LHKTA_{t-i} + \sum_{i=1}^{m} \beta_3 (i) LHKGDP_{t-i} + \sum_{i=1}^{m} \gamma_3 (i) LHKCL_{t-i} + \sum_{i=1}^{m} \delta_3 (i) LHKSP_{t-i} + a_3 D_{SARS} + b_3 D_2 + c_3 D_3 + d_3 D_4 + \epsilon_{3t}
\]

(4)

\[
LHKSP_t = \alpha_4 + \sum_{i=1}^{m} \lambda_4 (i) LHKTA_{t-i} + \sum_{i=1}^{m} \beta_4 (i) LHKGDP_{t-i} + \sum_{i=1}^{m} \gamma_4 (i) LHKCL_{t-i} + \sum_{i=1}^{m} \delta_4 (i) LHKSP_{t-i} + a_4 D_{SARS} + b_4 D_2 + c_4 D_3 + d_4 D_4 + \epsilon_{4t}
\]

(5)

Where the model variables LHKTA, LHKGDP, LHKCL, LHKSP are tested to be stationary, \( \alpha \) is a constant, and the residual \( \epsilon \) is Gaussian white noise with zero mean and constant variance. \( \lambda, \beta, \gamma, \delta, a, b, c, d \) are coefficients. D_SARS, D2, D3, and D4 are non-economic dummy variables, where
D_SARS denotes to capture the influence of the one-off event of the SARS outbreak in April 2003. D2_t, D3_t, and D4_t represent seasonal dummy variables used to capture the influence of seasonality. The dummy variable D_SARS, D2_t, D3_t, and D4_t take the value of 1 during the corresponding quarter on the event date and 0 otherwise. The number of lags is determined by Akaike Information Crietria (AIC) and Likelihood Ratio (LR) test, the optimal lag is 3 selected with the lowest value of AIC criteria and the rejection of the null hypothesis in LR at 5% significant level.

4.3 Generalized impulse response analysis

This study uses analysis of the generalized impulse response functions (Pesaran & Shin, 1998) to analyze the medium and long-run dynamics of the variables. Unlike orthogonalized impulse response functions are unique solution and invariant to the ordering of the variables in VAR. The dynamic responses of the tourist arrivals (tourism demand) to innovations in the macroeconomic factors can be traced out by the generalized impulse response analysis. In addition, the interest point of the VAR model focuses on the one where the demand for tourism is the dependent variable. Fig. 3 plots the generalized response of the tourist arrivals (LHKTA) to a one-unit shock in the GDP (LHKGDP), the cost of living (LHKCL), and the substitute price (LHKSP), such that the tourism demand function takes the form

\[ LHKTA_t = f( LHKGDP_t, LHKCL_t, LHKSP_t) \]
Fig. 3. Generalized impulse response

The top-left panel of Fig. 3 shows that a shock in the variable itself of the tourist arrivals from Hong Kong is immediately positive with a relatively larger impact on the current level of tourist arrivals and this impact will gradually disappear after seven periods (quarters). In top-right panel of Fig. 3, the response of the tourist arrivals from Hong Kong to a shock in GDP of Hong Kong is positive in the first five periods and, in turn, accompanies some tiny oscillation then to die off, which shows the expected sign and is consistent with a basic economic theory that the tourism demand will increase if income rising up. The positive signal also implies the kind of traveling goods have positive income elasticity and are normal goods. However, the shock in cost of living
(LHKCL) as shown in the bottom-left supports a negative interaction between tourism demand and living cost and the impact of the shock lasts about seven periods (quarters), implying that tourism demand increases if living cost goes down at destination region. The phenomenon is consistent with the basic law of demand for necessities. While the response of tourism demand for HK (LHKTA) to the shock in substitute prices (LHKSP) in the bottom-right appears roughly negative, but its fluctuation trace is very close to zero. The outcome might show that the competitive scale between Taiwan and the selected single competitor Japan is not significant, but there still seems to be unobvious evidence that the tourism goods between Taiwan and Japan are complementary for Hong Kong tourists because of the negative cross elasticity.

5 Concluding remarks

The tourism industry may be another major contributing factor to Taiwan’s economic growth. The 2002 annual statistics of Tourism (Tourism Bureau of Taiwan, 2003) reported that Taiwan’s tourism receipts accounted for 4.2 percent of the gross domestic product (GDP) in 1996. This figure exceeded the contribution of the agricultural sector to GDP, thereby making tourism as one of the major industries in Taiwan (Kim, Chen, & Jang, 2006). Besides, the Taiwan government has aggressively promoted inbound tourism over many years by a lot of policies such as “Tour Taiwan Years 2008-2009”, “The Best Trip in the World - Taiwan Explorers Wanted” contest, “The multiplying project of international tourists”, and so on. The tourism development not only increases nation income but also diversifies the range of industries, particularly, the industrial diversity can reduce the risk of export-oriented economy if economic recession occurs. Therefore, tourism has played a very important role for Taiwanese future.

Tourism demand analysis is absolutely regarded as a necessity of tourism policy makings. This empirical study is intended to understand how the important economic factors that include the GDP of Hong Kong, the cost of living, and the substitute price affect the tourist arrivals from an individual
source (origin) region, Hong Kong, by quarterly data from 2001 to 2011. It was found that the four model variables are all stationary. And for the medium-term and long-term, the response of the tourist arrivals from Hong Kong to a shock in the GDP of Hong Kong is positive and, inversely, the shock in cost of living has a negative impact on tourism demand for Hong Kong, which implies the goods of Taiwan tourism are not only normal goods but necessities for HK tourists. However, the problem for the response to the substitute price seems being not significant. Next step, we must recheck which single competing destination will be more suitable than Japan, or change a different form to represent the substitute price well.

In the future, we hope to compare other important source countries or regions such as Japan, Korea, Singapore, or Thailand to get more detailed information for tourism industry and government. In addition, Taiwan government have formally opened the gates to Mainland Chinese tourists since July 2008, which has contributed to the fact that Taiwanese inbound visitors in 2010 exceed five millions, so China will also be an important research target we must focus on.

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Continuous improvement in Vietnam: what works, what does not, and what the future holds

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Abstract. This exploratory investigation of CI in Vietnam was based on questionnaires completed by 171 respondents from 139 organizations and on extensive interviews with executives, managers, and employees of twelve leading companies in that country. The paper identifies a number of uniquely Vietnamese twists and modifications to CI, due in large part to that country’s legacy of extended foreign occupation and its recent “invasion” by companies from all over the world. Vietnamese organizations operate in a deeply ingrained top-down and secretive culture that all but prevents lower-level employees from contributing to CI efforts. Furthermore, all but one of the case firms were pursuing low-cost strategies rather than improvement strategies that would enable them to compete higher up the value-added chain. Given the recent tremendous growth in business activity in Vietnam, a better understanding of the management practices of companies there is important for both scholars and practitioners.

1 Introduction

Over the last several decades continuous improvement (CI) has been a mainstay of management in North and South America, Europe, and Japan [29, 38]. Recently, CI has benefited firms in developing Asian countries including India [68, 70], and China [37, 57]. However, there is only sparse literature on how CI has to be managed differently in emerging countries in Southeast Asia. It is important to understand how organizations in those countries are doing CI, and the process and nature of the transformations that take place as they implement and sustain CI practices [16].
With an average economic growth of 7.3 percent for the last ten years [23], Vietnam is one of the fastest growing Asian nations. The country offers foreign investors low-cost production sites, a strong and young workforce, and a domestic market of 89 million consumers. Vietnam is also emerging as a global manufacturing center. Shiseido, a renowned Japanese cosmetics company, chose Vietnam as its production base for the Association of South-East Asian Nations (ASEAN) market. In 2010, Intel completed a new $1 billion facility in the country’s southern business hub that is expected to generate up to $15 billion in export revenue when it reaches full capacity.

Despite this rapid growth and the country’s emergence onto the global stage, Vietnamese organizations make relatively little use of CI, which comprises quality approaches such as ISO 9001, Total Quality Management (TQM), and Six Sigma as well as productivity improvement mechanisms such as lean production and employee idea systems. To date, the growth model of many export-oriented Vietnamese firms has been based on low costs and abundant cheap labor. Productivity and quality have hardly improved over the last ten years [23]. The experience of other emerging Asian countries suggests that the adoption and skillful management of CI by Vietnamese organizations will be a primary determinant of their future success. If Vietnamese businesses do not embrace CI techniques that work for them, they will have difficulty improving competitiveness, and eventually be sidelined as investors move onto lower cost destinations, as they inevitably will. Investigations of which CI practices work in Vietnam, which do not, and why are therefore critical to the country’s economic progress.

The studies reported on here aim to enhance understanding of the management of CI in Vietnam. They are based on questionnaires completed by 171 respondents from 139 organizations and on 80 in-depth interviews with executives, managers, and employees of 12 leading companies in that country. One of the more interesting findings, the authors believe, is that Vietnamese managers face unique cultural problems in implementing and sustaining CI practices. Vietnam’s deeply ingrained top-down and secretive culture is a serious impediment to the CI efforts of its businesses. The executives and managers interviewed for this study were generally quite frank that they did not see much potential in their employees, and so did not put much time and effort into developing them. Furthermore, leaders at most of the case companies expressed reluctance to invest in building their organizations’ future capabilities, preferring to promote their organizations as low-cost providers. Without rigorous efforts to move up the production value-chain, these enterprises will lose out to firms in
other developing nations that have even lower costs, and they will continue to fall behind those companies in competitor emerging economies that are improvement-oriented and already competing on the creativity and innovation fronts.

As part of an ongoing multiyear research project to investigate the state of Vietnamese management, the studies reported in this work aimed to answer the following question:

1. To what extent are organizations in Vietnam implementing CI practices and what are the challenges that they face when implementing and sustaining CI?

This paper begins with a synthesis of relevant research on the Vietnamese business culture and the impact of that culture on CI, and a review of the three CI practices which the authors found most common in Vietnamese organizations. It then analyzes the data gathered during the research project, and assesses the most important implications for Vietnamese managers, for foreign firms investing in Vietnam, and for academics interested in Vietnamese and Southeast Asian management practices. Understanding CI issues, commonalities, and differences in emerging countries such as Vietnam, is important to the development of CI theory in an international context. As a number of researchers have pointed out [47, 54], Asian management research can contribute to global management knowledge by generating theory that explains international issues and offers Asian perspectives on current scholarly conversations.

2 Literature Review

CI, broadly defined, is the set of principles, mechanisms, and activities aimed at raising the level of organization-wide performance through ongoing, systematic, and cumulative improvements [50]. The Japanese term kaizen, often translated as “continuous improvement,” also means “ongoing improvement involving everyone” [38]. The idea is to make continuous incremental innovation – “small step, high frequency, short cycles of change which taken alone have little impact but in cumulative form can make a significant contribution to performance” [9]. Incremental and continuous innovation can be achieved through unleashing employee experience and creativity to improve both products and processes [69], searching for problems and solving them instead of avoiding them [49], and rewarding and recognizing innovation efforts [9].

CI practices have proven fundamental to sustaining competitive advantage [30], improving product and service quality [58, 60, 72], and enhancing operational performance [5, 19, 26]. With regard to outcomes, Jorgensen, Laugen,
and Boer [43] found that CI was significantly related to increased productivity, reduced costs, improved delivery reliability, and decreased employee absence. Ittner [41] showed that the indirect productivity benefits attributable to lower scrap, rework, and inventory holding costs, provided at least two to three times the direct CI benefits. CI has also helped companies improve their green performance. By reducing environmental impacts through identifying ways to eliminate or mitigate waste and liabilities, firms can raise productivity and demonstrate their responsibility to customers and the environment [45]. For example, Subaru of Indiana has found that using CI in its green initiatives improved its profits and competitive advantage as well as its eco-friendliness [71].

In Asia, Chinese manufacturing enterprises have improved quality and increased productivity by using CI [67]. Yeung et al.’s study [81] shows that process control and improvement have a direct effect on operational performance in firms in China and Hong Kong. In Taiwan, researchers have found that TQM significantly improves quality [17], and that ISO 9000 is positively related to business performance (e.g., market share, profitability) [51]. In Singapore, TQM has led to better business performance in service firms [12], and in South Korea it has significantly improved both product quality and innovativeness in manufacturing firms [66].

2.1 Synthesis of Research Relevant to Vietnamese Continuous Improvement Culture

As these results suggest, CI practices can undoubtedly help organizations in Vietnam. However, success will depend on adapting them to Vietnamese circumstances, as the following overview of the country’s cultural challenges vis-à-vis CI illustrates.

2.1.1 Consensus-Oriented Culture

Like other Asian countries, Vietnam’s culture is rooted in Confucianism, which fosters social stability by valuing contentedness and harmony with others. Vietnamese managers therefore favor a harmonious corporate culture, emphasizing consensus and agreement at each level [83]. Often, the purpose of building consensus is to gather input, elicit advice, and gain support from colleagues and partners [62]. However, this social and work ethic also encourages individuals to behave collectively, avoid overt conflict, and believe that personal effort or initiative does not matter [27]. The Vietnamese often see individual
assertiveness as arrogance [10]. In Vietnam, the tradition of respecting elders and authority discourages young and newly hired workers from taking initiative; they tend to do as they are told and nothing more [62]. Traditional Vietnamese etiquette prevents people from questioning those who are older or higher-ranking [46], and may make it difficult to implement and sustain CI practices, whose very purpose is to question the status quo and, implicitly but unavoidably, the management decisions that created it.

2.1.2 Strict Attention Paid to Hierarchy and Seniority

According to Zhu [83], most Vietnamese employees are willing to change and adopt new ways of doing things; however, historical and ideological barriers work against active employee participation. In Vietnam, the kinship system has strong patrilineal elements, and strict attention is paid to seniority [32]. An individual is expected to defer to anyone of higher status as determined by kinship, descent, gender, and age [24]. This system spills over into the country’s business culture as senior members of a team are expected to lead a discussion, with subordinates participating only when they are called on [62].

Since the kinship system emphasizes a belief in hierarchical order, the Vietnamese strongly resist the idea of any kind of employee participation in decision-making [74]. This was seen in the Factory Improvement Programme, which was established in 2002 by the International Labour Organization to help manufacturers improve labor practices, working conditions, and competitiveness. One of its major challenges has been to maximize employee participation in the program “without putting off CEOs from signing up” [39]. Moreover, worker representation on Factory Improvement Teams is confined to the supervisor level, which is considered the frontline worker level in Vietnam [40].

A Vietnamese person’s sense of self is tied to family, friends, and society. Duties, responsibilities, and privileges in the family, the village, and the wider society underlie social dynamics and shape the work setting in Vietnam [10]. As Le et al. [47] noted of Chinese managers, some Vietnamese managers want to listen to their people but old top-down management habits die hard. Even foreign firms have to adjust their human resource programs and adopt local practices to fit into Vietnam’s unique social and cultural environment [83]. Unfortunately, experience in other countries shows that effective CI practices depend on local autonomy and empowerment that gives employees the decision-making authority to solve problems and take advantage of improvement opportunities their managers do not see [8].
2.1.3 Complicated Styles of Communication and Feedback

Like many other Asians, the Vietnamese are socialized not only to accept the principle of social hierarchy, but also to care passionately about “face”: that is, the respect they receive from others [42]. According to Ashwill [6], the Vietnamese value face highly because it helps maintain respect and harmony in interpersonal relationships. While mất mặt (“loss of face”) is severe in any society, it is unbearable in Vietnam as evidenced by the Vietnamese expression: “Better die than to lose face” [10]. Thus, for example, in the classroom any pedagogical practices that place teachers on the same level as their students violate Vietnamese tradition as they impugn the teachers’ authority and expose them to the risks of losing face [65]. Similarly, Vietnamese managers are more likely to place social above economic imperatives, accepting reduced profits or growth over the possibility of losing “corporate face” by laying off people or reducing wages [44].

To prevent loss of face, the communication style in Vietnam tends to be indirect with roundabout advice or solutions preferred over direct criticism [62]. Furthermore, Vietnamese behaviors when giving feedback depend on the relative power of the recipients [47]. As Le et al. observed, “All things being equal, it is perceived as riskier for people (e.g., a tarnished relationship, reduced benefits or lost favors) to give frank, negative, though well-intended, feedback to those with more power” [47]. This indirectness is a matter of tact rather than sincerity [10]. Nonetheless, it can impede effective CI, which is a never-ending effort to expose and solve problems, most of which could be seen as “management not having done its job.” Many world-class CI practices aim to eliminate these problems by harnessing the ideas and feedback of frontline employees [82] – a bottom-up approach that goes against the grain of traditional Vietnamese thinking.

2.2 Commonly Used Continuous Improvement Practices in Vietnam

Nguyen [63] reported that foreign firms, such as Honda, have used CI to successfully compete in Vietnam’s motorcycle industry. Nevertheless, many Vietnamese firms simply do not use CI practices, and those that try them often have difficulty implementing them, typically falling short in the areas of people management, statistical process control, and information systems [21]. CI depends upon a long-term shift in workplace culture and attitudes that Vietnam has not yet undertaken [39].
A detailed review of academic and practitioner literature on Vietnamese management plus interviews with 130 business leaders, managers, practitioners, and academics in Vietnam helped identify the three most commonly used CI practices in Vietnam. The following section presents brief summaries of these CI techniques, how they were introduced into the country, and their current state of usage and impact.

2.2.1 Suggestion Systems

The first recorded industrial suggestion system was developed by William Denny, a Scottish shipbuilder, in 1871 [77]. More than a decade later, in 1894, the National Cash Register Company instituted the first suggestion system in the U.S., followed a few years later by Kodak. After World War II, spurred by the U.S. Training Within Industry (TWI) programs, many Japanese companies started up idea systems. By the 1980s, a number of Japanese firms were exceeding 30 implemented ideas per person per year with some exceeding 200 per person. Today many companies around the world exceed 50 implemented ideas per person per year.

Organizations institute suggestion systems to help with their strategic goals, to improve organizational performance and the customer experience, to increase worker morale, to generate revenue, or to save money. In the basic suggestion box process, employees are encouraged to put their ideas in a suggestion box or submit them online. A committee or central function picks out suggestions that seem potentially worthwhile, assigns staff members to evaluate them, and the employee gets some kind of reward if the idea is accepted. High performing idea systems – which Robinson and Schroeder [69] define as those getting 12 or more implemented ideas per person per year – are more formal, structured organizational systems designed to collect, develop, and implement large numbers of small process-improvement ideas. According to Robinson and Schroeder [69], such idea systems are more effective at motivating employee idea submissions than traditional suggestion box systems because they promote involvement, hold managers accountable, and foster organizational learning.

Suggestion box systems (known as “hòm thư góp ý” in the north and “thùng thư góp ý” in the south) are common in Vietnam. It is unclear when they were first introduced into Vietnamese organizations, though the Vietnamese Army started using them in the 1950s as the “People’s Suggestion Box” system. During the Indochina War (i.e., the war with France), the Army maintained suggestion boxes in villages to encourage people to voice their complaints and to provide
information about the enemy [2]. In 1961 this system was formally established in
the Presidency and in a number of provinces, and government officials claimed
that the national and provincial programs received several thousand letters a
month, providing them with citizen feedback on their performance and leads on
subversive activities [25]. Jamieson [42] reports that, at the urging of the
Americans, a South Vietnamese official implemented a suggestion program
within his department to promote a freer flow of ideas during the time of the
Vietnamese-American War. Unfortunately, few suggestions were forthcoming, so
the official instituted quotas for suggestions, commanding his subordinates to
make a certain number each month.

Suggestion boxes are still used to get community feedback in some places,
such as public health facilities in the northern regions of Vietnam, but people
rarely use them [20]. While suggestion boxes remain in most government offices
and institutions in Vietnam, including public universities and airports, little has
been written about their use or the level of their success in the public sector. In the
business sector, the systems have proven somewhat more effective. The quantity
and quality of suggestions are one of the indicators that Nike uses to assess the
efficacy of its management training programs for Vietnamese workers [33].
Additionally, many Adidas-Salomon suppliers, including those in Vietnam,
maintain suggestion boxes at their facilities and reward employees for
implemented suggestions [34].

### 2.2.2 Quality Management Programs

Quality management has become a critical issue for Vietnam’s government
agencies due to increased global competition and international concern over the
quality of Vietnamese products and services and their effect on the environment.
For example, the Ministry of Agriculture and Rural Development has taken steps
to promote quality management programs, including ISO 9001. The Ministry of
Health required companies in the pharmaceutical and healthcare sectors to meet
Good Manufacturing Practice standards by 2010. Firms unable to meet this
requirement are allowed to produce only homeopathic medicine [75]. The June
2006 directive Decision No. 144 orders all Vietnamese government offices and
organizations to become ISO 9001 registered. Despite these government
initiatives, only 3,229 ISO 9001 certificates have been issued to organizations in
Vietnam, less than one percent of the total number of registered enterprises there
[53].
Many enterprises treat quality management certifications, such as ISO 9001, as cosmetic “things to hang on the wall,” and obtain them for marketing purposes rather than use them to improve quality and productivity [76]. As the Quality Manager of the Chien Thang Garment Company in Hanoi explained about his firm’s certification, “We just acted with the only target of achieving the certification or passing the audits, without thinking of any way to make the work better or easier” [39]. Some companies put the fact that they are certified on their products (even though this is expressly prohibited by the ISO standards). Furthermore, the Directorate for Standards and Quality, the Vietnamese government’s umbrella organization for all industrial standards, has long been issuing ISO 9001 certifications to firms, even though it is not an accredited registrar [53]. Having ISO 9001 certification, therefore, by no means guarantees that CI is practiced in the company.

2.2.3 Lean Production

The term “lean production” (also known as lean manufacturing) was coined by Womack, Jones, and Roos [78] to describe Toyota’s unique approach to manufacturing at the time, known as the Toyota Production System. Inspired by the work of W. Edwards Deming, the writings of Henry Ford, and the observations of the U.S. supermarket supply chain, post-World War II Toyota leaders developed manufacturing methods that minimized the resources needed for a product to flow through the entire production process [78]. In most industrial processes, non-value adding activities such as excessive inventory, defects, waiting, over-processing, overproduction, and unnecessary transport and movement amounts to more than 90 percent of total production activity [15]. Toyota created a management philosophy that if pursued rigorously dramatically improved performance by focusing on the systematic elimination of all non-value added activity in the production process [49].

The success of the Toyota Production System sparked the lean movement around the world. In Vietnam, lean arrived with early foreign enterprises such as Toyota, Canon, Honda, and Nike. For example, Toyota implemented a version of the Toyota Production System that was optimized for production conditions in Vietnam. Lean implementation has also benefited a number of domestic companies. For instance, Minh Hoang Garment, one of the largest private garment manufacturers, reduced defects by more than 9% with its lean program [56]. Furthermore, lean has helped Toyota Ben Thanh, a service center for Toyota Motor Vietnam, to reduce its maintenance service from 240 minutes to 50...
minutes per car by eliminating unnecessary waiting time, as well as inefficiencies in workers’ physical motions and overall process flow [36]. The impact of these global and domestic companies adopting lean practices themselves and the increasing awareness of lean manufacturing in Vietnam have triggered a wave of modern management practices (e.g., lean and Six Sigma) in the country.

3 Methodology

The challenges of doing research in Vietnam, particularly the problems of data collection and reliability, are exacerbated by the country’s lack of a research culture. Many Vietnamese executives and managers have a policy of not responding to questionnaires [48]. In addition, Vietnam’s secretive business environment makes it hard to get any information from executives and managers without the right contacts and endorsements [21]. To obviate these problems, this study adopted a field research approach using a multi-method design based on survey and interview data.

These multiple methods and data sources not only made access to reliable and valid data possible [35], they also helped generate a more accurate understanding of the underlying phenomena [11]. Each method is stronger than the other in certain aspects, but “none is so perfect even in its area of greatest strength that it cannot benefit from corroboration by other methods’ findings” [13]. The cross-method comparisons – which required multiple sets of data answering the same research questions – provided a means to triangulate the data and increase the accuracy of the findings.

The survey and interview data comprised the two studies in this research. Study 1 involved a questionnaire administered at the Hanoi School of Business (HSB) of the Vietnam National University, the Vietnam Chamber of Commerce and Industry (VCCI), and a number of Vietnam’s leading firms. Study 2 consisted of in-depth case studies of 12 leading organizations throughout Vietnam. The company setting was chosen as the level of analysis because CI practices are executed at that level and that is where the effectiveness of implementation and its ultimate sustainability are most directly determined.

3.1 Study 1: Survey Method

Study 1 used a survey of 171 respondents from 139 organizations throughout Vietnam. A convenience sample was used for two main reasons. First, since Vietnamese people are highly unlikely to answer a questionnaire unless they
know the researchers and understand how the information will be used, random sampling would severely limit the available data and might well introduce considerable bias [22, 64]. Therefore, the authors’ host institutions, HSB and VCCI, provided high-level official endorsement of the research to their customer bases and provided empowering environments that encouraged managers to participate and respond candidly. The second advantage of this particular convenience sample is that the participants were generally knowledgeable about their organization’s CI efforts, and had information and opinions on the issues directly and indirectly affecting the quality of implementation and its ultimate sustainability.

The survey instrument was grounded in the literature on quality and CI practices in emerging economies [21, 37]. To enrich the existing scales for use in Vietnam and to develop valid measures for local research, the adaptation approach described by Farh, Cannella, and Li [28] was used, in which a source language scale was tailored to the Vietnamese context by altering item wording, dropping inappropriate items, and/or adding new items. Through extensive field work, we were able to pinpoint the exact modifications needed.

The questionnaire was written in English and then translated into Vietnamese. It was then refined by a panel of ten CI experts, five from Ho Chi Minh City and five from Hanoi, who reviewed it for understandability and clarity. After changes and corrections, the Vietnamese version was translated back into English. The back-translation ensured conceptual consistency and identified any deviations [14]. The survey was administered in paper form to nine MBA classes at HSB (four full-time and five executive) as well as in seminars given at three of Vietnam’s leading firms and at VCCI in Ho Chi Minh City. A total of 240 respondents participated in the survey. Sixty-nine of the responses were not usable due to incomplete data. The final analysis for Study 1 resulted from a total of 171 respondents – 141 respondents from organizations that had CI practices in use and 30 respondents from organizations that had not implemented CI practices.

The completed surveys were analyzed with descriptive statistics. The respondents were from organizations in a wide variety of industries, including banking, healthcare, public services, telecommunication, construction, manufacturing, and software. The majority of the respondents worked in medium to large size organizations that: (1) had more than 500 employees; and (2) were located in the northern region (71.9 percent) and the southern region (21.6 percent) of Vietnam. Their organizations had varied ownership structures: 43.9 percent were state-owned, 25.7 percent were foreign-invested, and 26.9 percent were non-state owned. The majority of the respondents were middle managers.
(43.3 percent) and senior managers (30.4 percent), who were predominantly male (73.1 percent) and between the ages of 30 to 39 (57.9 percent).

### 3.2 Study 2: Interviews and Observations Method

Study 2 comprised in-depth interviews and direct observations at 12 leading companies located throughout Vietnam. Like other studies [4, 31], this sample was not random but reflected the selection of specific cases to extend theory and enhance the generalizability of the findings to a broad range of firms.

Three conditions needed to be met in selecting the case companies. First, each company had to have implemented at least one internationally-practiced CI technique and have continued to use it. Second, the collection of companies had to represent all types of ownership (i.e., state, non-state, and foreign-invested) in Vietnam and be geographically representative of the country (all were located in or near the three major industrial cities in south, north, and central Vietnam (Ho Chi Minh City, Hanoi, and Da Nang respectively); and be engaged in a diverse set of businesses. The third and final factor was our ability to access the companies and their people. By design, the research demanded admittance to production facilities and offices, and extended amounts of time with respondents involved in CI.

A list of potential case companies was compiled based on interviews with business leaders, practitioners, and academics in Vietnam, who identified leading companies that matched these criteria. We selected our case companies and worked with the leaders of these companies to ensure conditions 1 and 3 were met. In the end, the sample included three state enterprises, six non-state companies, and three foreign-invested enterprises engaged in businesses including automobiles, ceramics, food processing, footwear, garment, information systems, pharmaceutical, software, steel, and machine parts and precision castings.

Direct observations were made and in-depth interviews were conducted with 21 executives, 29 middle managers, 13 supervisors, and 17 line employees with experience of CI in these case companies. These interviews and observations were important for a number of reasons. First, they offered verification and clarification of the questionnaire results because the survey responses were “uncalibrated” in the sense that they reported the respondents’ assessments from their own points of view and states of knowledge about their organizations and CI. Secondly, the interviews and observations provided a means to directly compare each firm’s efforts in areas such as CI sustainability and effectiveness. Finally, they revealed more about how CI was embedded in the firms, especially at the operational level,
both on the factory floor and in the office setting. Table 1 provides a summary of the case companies. Toyota Motor Vietnam (TMV), Company K, was the only firm that allowed its identity to be revealed. All other firms asked for confidentiality and anonymity, and so their identities are disguised here.

<table>
<thead>
<tr>
<th>Case</th>
<th>Business ownership type</th>
<th>Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company A</td>
<td>State-owned</td>
<td>Ceramics</td>
</tr>
<tr>
<td>Company B</td>
<td>State-owned</td>
<td>Seafood processing</td>
</tr>
<tr>
<td>Company C</td>
<td>State-owned</td>
<td>Garment and apparel</td>
</tr>
<tr>
<td>Company D</td>
<td>Non-state owned</td>
<td>Footwear</td>
</tr>
<tr>
<td>Company E</td>
<td>Non-state owned</td>
<td>Pharmaceutical</td>
</tr>
<tr>
<td>Company F</td>
<td>Non-state owned</td>
<td>Steel</td>
</tr>
<tr>
<td>Company G</td>
<td>Non-state owned</td>
<td>Garment and apparel</td>
</tr>
<tr>
<td>Company H</td>
<td>Non-state owned</td>
<td>Software development</td>
</tr>
<tr>
<td>Company I</td>
<td>Non-state owned</td>
<td>Information system</td>
</tr>
<tr>
<td>Company J</td>
<td>Foreign-invested</td>
<td>Automobiles</td>
</tr>
<tr>
<td>Company K</td>
<td>Foreign-invested</td>
<td>Automobiles</td>
</tr>
<tr>
<td>Company L</td>
<td>Foreign-invested</td>
<td>Machine parts and precision castings</td>
</tr>
</tbody>
</table>

The interviews were carried out in Vietnamese or English, depending on the interviewees’ preferences. Translations, when necessary, were provided by the first author and two research assistants, all of whom were fluent in both Vietnamese and English. Many interviewees were apprehensive about being taped, so the authors were able to digitally record only a small portion of the interviews. To enhance the accuracy of the interview notes, one or both of the authors and a research assistant were present at every interview. The recorded responses were transcribed and translated into English if they were not already in that language.

These qualitative data were analyzed according to steps adapted from the literature [55]. The categories were defined with relevance to barriers to implementing and sustaining CI and factors for effective CI identified in the literature [21,37]. To achieve high reproducibility, two judges independently screened all statements using two criteria: (1) The item must have a clear meaning; and (2) The item must refer to an incident/activity or specific CI practices. Cross-classification was allowed. Only statements on which two judges agreed were kept. Then, the judges calculated the frequency with which each category appeared in interviews in each case company. Finally, the “reduced”
data were: (1) organized into compact assemblies of information; (2) used to identify relationships and patterns; and (3) compared to the findings from the survey.

4 Results

The results derive from both the analysis of the survey data and the information gathered from interviews and observations with relevance to the research question. Of the CI practices implemented, ISO 9001 was the most often cited by the survey respondents, followed by lean production, Good Manufacturing Practices (GMP), and suggestion systems. The most commonly used CI practices cited by the case companies were similar to those from the surveys except for suggestion systems. Fifty-eight percent of the case firms used suggestion systems as a CI tool compared to 17 percent cited by the survey respondents (see Table 2). These findings are consistent with the three most commonly used CI practices found in the literature review.

<table>
<thead>
<tr>
<th>Table 2. Most commonly used CI practices</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>ISO 9001</td>
</tr>
<tr>
<td>Lean Production</td>
</tr>
<tr>
<td>Good Manufacturing Practices</td>
</tr>
<tr>
<td>Suggestion Systems</td>
</tr>
</tbody>
</table>

Respondents also indicated that the top four challenges (ranked in descending order) in implementing and sustaining CI were: (1) Lack of cooperation from employees; (2) Lack of education and training of frontline employees; (3) Difficulties in establishing a vision shared by everyone across the organization; and (4) Perceived increase in workload. The qualitative results indicated that the four biggest barriers to implementing and sustaining CI practices were: (1) Employees’ lack of understanding of CI concepts and techniques; (2) Frontline employees’ lack of education and training; (3) Employees’ reluctance to participate in CI; and (4) The need to change employees’ behaviors, habits, and mindsets. The second and third of these barriers were also identified as major difficulties in the questionnaire results. What is most interesting here is all four of the barriers identified by the (managerial) respondents are employee-related. (These findings are summarized in Table 3.)
Table 3. Barriers to implementing and sustaining CI practices

<table>
<thead>
<tr>
<th>A. Top responses (ranked in descending order) from Study 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of cooperation from employees</td>
</tr>
<tr>
<td>Lack of education and training for frontline employees</td>
</tr>
<tr>
<td>Establishing a shared vision by everyone across the organization</td>
</tr>
<tr>
<td>Perceived increase in workload</td>
</tr>
<tr>
<td>Lack of training and education for management</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B. Top responses (ranked in descending order) from Study 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employees lack understanding of CI concepts and techniques</td>
</tr>
<tr>
<td>Lack of education and training for frontline employees</td>
</tr>
<tr>
<td>Getting employees to participate in CI</td>
</tr>
<tr>
<td>Changing employees’ behaviors, habits, and mindset</td>
</tr>
</tbody>
</table>

The study indicated that the most important determinant of CI effectiveness in Vietnamese organizations is the commitment and involvement of top management (see Table 4). This finding was not a surprise: many researchers have also identified the paramount importance of senior managers’ commitment to achieving high levels of CI and quality performance in firms in other Asian countries such as China [18, 79], Hong Kong [3, 81], and Taiwan [80]. Many interviewees commented that their senior managers needed to be more knowledgeable about CI, more able to communicate that knowledge, and more personally involved in rallying employee participation and driving an organization-wide culture committed to CI.

To a lesser degree, interviewees identified education and training for frontline employees and employee participation in CI as important factors in CI effectiveness. Another interesting finding is that the questionnaire responses listed an employee reward system among the top determinants of CI effectiveness. Indeed, many employees and managers who participated in the interviews identified it as the most important factor. Specifically, they felt that their firms needed to increase their budgets for CI rewards.

Table 4. Factors important in driving CI effectiveness

<table>
<thead>
<tr>
<th>A. Top responses (ranked in descending order) from Study 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top management commitment and involvement</td>
</tr>
<tr>
<td>Establishing a shared vision by everyone across the organization</td>
</tr>
</tbody>
</table>
Education and training for managers and supervisors
Education and training for frontline employees
Employee reward system

B. Top responses (ranked in descending order) from Study 2
Employee reward system
Top management commitment and involvement
Education and training for frontline employees
Participation in CI from everyone

As shown in Table 5, respondents from organizations that had not initiated any CI practices listed management’s lack of understanding of CI techniques, lack of top management commitment, and omitting CI in long-term planning as their organizations’ major barriers to CI implementation.

<table>
<thead>
<tr>
<th>Table 5. Impediments preventing CI implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top responses (ranked in descending order) from Study 1</td>
</tr>
<tr>
<td>Lack of understanding of CI techniques at the management level</td>
</tr>
<tr>
<td>Lack of top management commitment</td>
</tr>
<tr>
<td>Lack of inclusion of CI in the long-term planning</td>
</tr>
</tbody>
</table>

5 Discussion And Recommendations

The two studies identified a number of unique challenges for Vietnam and its business organizations, and offered further insights into our understanding of CI in that country. We now present these findings and discuss their managerial implications.

**Finding 1: Vietnam’s strong top-down and secretive culture is obstructing CI efforts in its organizations.** In most of the case firms (Companies A, B, C, D, E, F, G, H, and I) every plan, every action, every process improvement had to be initiated and directed by top managers and pushed down to frontline workers for implementation. Because information needs to pass through several layers, it takes longer for upper management decisions to reach line employees and this delay reduces the speed and accuracy of the communication [7]. In contrast, recent research has shown that the most effective CI is generated by frontline
employees who actually do the work and can often spot many more improvement opportunities than managers can (see, e.g., [73]).

Vietnam’s top-down model also appears to have prevented managers from seeing frontline employees as anything other than pure labor. At Companies C and H, for example, management brought supervisors for the authors to interview when the authors had asked to question frontline employees. Supervisors were, in fact, their frontline employees. Leaders and managers in all but one of the case companies generally saw no potential value in employee input, and therefore no need to solicit or enhance it. Only TMV invested significantly in employee training. Most case firms did not pay employees for time spent in CI training (if, indeed, any such training was available), or for other CI activities. At Company G, for example, CI training was used as a punishment. Employees who performed poorly were required to go to CI training every month on their own time until their work improved, while employees who performed well were exempt from the training sessions. This may potentially explain the survey and interview results showing that lack of cooperation from employees and a perceived increase in workload were major barriers to implementing and sustaining CI.

While top management support and involvement is integral to encouraging the practices and behaviors that lead to quality performance throughout organizations [29], it is paramount for CI success in Vietnam. One reason is that the country has a tradition of top-down management modeled on past Soviet influences [61]. Close supervision, limited employee authority, and power reserved at the top are common in both state-own and privately-held Vietnamese firms [74]. Typically, decisions are made at the top and carried out by lower-level employees, rather than being middle-down or middle-up. In addition, concurrency is the norm in many small and medium enterprises where the owner is also the managing director, CFO, human resource manager, technical advisor, and so forth. He or she has limited resources and time to commit to anything beyond ensuring immediate survival and profitability. To implement CI in such a company, regardless of how simple the approach, requires top management leadership and commitment. Accordingly, we offer:

**Recommendation 1:** While Vietnam’s top-down management approach obstructs CI efforts in the long run, it is critical to jump-start CI in Vietnamese organizations in the immediate future. Longer term, CI sustainability will require substantial involvement from frontline employees.
Finding 2: Vietnamese executives and managers lack understanding of continuous improvement, so they cannot successfully lead its implementation. While the majority of survey respondents indicated that their organizations used CI practices, the interview and survey results showed that Vietnamese executives and managers had a very limited knowledge and understanding of these practices. The survey found ISO 9001 cited as the practice most often used. But the CI requirements of ISO 9001 are widely regarded as weak. Companies with ISO 9001 registration do not perform better than non-certified firms [52]. Nor has ISO 9001 improved competitiveness in Vietnam [53].

Since ISO certification can be obtained in questionable ways, having it by no means guarantees CI practices are used and, if they are, that they are effective. For example, Company A, although ISO 9001 certified, had many safety violations: for example, fuel was kept in open drums next to furnaces; and barefoot workers were operating heavy equipment. At Company F, also ISO 9001 certified, cigarette butts were scattered on the factory floor near heavy cranes and machines with exposed wiring. Neither of these firms had any preventive nor corrective action systems in place (a major requirement of the standard).

Many respondents also named lean production as one of their company’s primary CI tools. Approximately one-fourth of the survey respondents said that their firms had used lean, and Companies C and G, and TMV indicated lean production was their primary CI tool. Having initiated lean only a year and a half ago, Company C’s lean activities were still in their infancy, consisting only of rudimentary waste elimination and basic training in the 5S. During the period of the study, Company C was converting its lines to lean, but its lean and non-lean lines differed only in that the lean lines were kept better supplied with product designs, raw materials, and workers, and the schedule was organized and posted. However, this was only common sense, not an application of any of the key lean principles such as kanban, pull, quick changeover (setup reduction), poka-yoke, just-in-time, heijunka, or takt time. Similarly, after four years of working with lean, Company G had invested very little in education and training. Even TMV, whose parent company is a global lean leader, was facing challenges, including a weak domestic supplier base, even though it had implemented internally a version of the Toyota Production System optimized for production conditions in Vietnam in 1996.

Approximately one-fifth of the respondents indicated that their organizations used suggestion systems. Companies A, D, F, G, H, I, and J used suggestion boxes as a primary CI tool. Although management’s expectations for the quantity and quality of employee ideas in these case companies were extremely low, their
performance was generally in line with performance of suggestion boxes in the rest of the world: an average of less than one idea suggested per person, with adoption rates of 30 percent or less [69]. Only TMV had implemented a modern, high-performing idea system. It had a department of 22 full-time employees responsible for developing and implementing improvement ideas. TMV got 24 ideas per person in 2009, with an implementation rate of just over 90 percent. This is on par with global best practice [73].

For CI to succeed in Vietnam, employers must develop Vietnamese managers who understand state-of-the-art management practices in their industries and global best-practices in general. Education and training would give Vietnamese managers the knowledge and skills to make strategic decisions that would move their firms up the production value-chain [59]. Therefore, we propose:

**Recommendation 2:** CI effectiveness can only achieve limited results without substantial investment in human capital. The effectiveness of CI in Vietnamese organizations will depend on developing managers and employees at all levels by giving them up-to-date CI education and training.

### 6 Conclusion

More than two decades into the process of market development, Vietnamese organizations have achieved substantial growth and progress. However, the questionnaire responses and the in-depth study of these 12 leading companies indicate that their CI efforts have generally had only limited success. And since the companies we looked at were identified as leaders in Vietnam, one can only conclude that the national state of CI practices will not enable the country to keep pace with the rest of the world. We believe that the Vietnamese government, still the main agent of national change, should actively promote CI as critical to the competitive strategy of Vietnamese organizations as they enter markets for more advanced technology and capital intensive products. The findings of this exploratory study suggest ways in which Vietnamese organizations can enhance their CI efforts. But further research is needed to understand the methodologies that will work best for them. As the world’s center of economic gravity is shifting towards emerging markets, especially those in Asia, it is important to understand the management practices of companies there, and in particular to discover what works, what does not, and why. Answers to these questions will help extend our ability to apply CI techniques in emerging countries in Asia and link Asian perspectives to current scholarly conversations.
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Human Resource
Cohesiveness-Performance Effects in Work Groups-Work Patterns as a Moderator

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Abstract. Past studies of cohesiveness-performance effects thrived from 1950’s were mainly experimental studies and the results of whether group cohesiveness contributed to performance were always disputable. Researchers believed that the construct of cohesiveness was multidimensional; Results varied from only task commitment contributed to performance (Mullen & Copper, 1994) to all three components bear significant influence to performance (Beal \textit{et al}., 2003). Not only was the cohesiveness-performance relation discussed, but were cohesiveness components to performance criteria and work patterns as a moderator to cohesiveness-performance relation examined in Taiwanese work groups. This study represented work groups’ cohesiveness- performance relation. Furthermore, cohesion components to performance criteria were reexamined for better understanding of which component can substantially benefit to which kind of performance. As a result, interpersonal attraction led to group members’ behaviors performance, and task commitment brought about group efficiency. Last, this study helped to realize the fact that work groups were cohesive disregarding how much interdependence the job required.

1. Introduction
Under the pressure of globalization, “cooperation” seems to be an inevitable way to pursue success. When we talk about ‘cooperation’, we mean to work together as a group or a team. Currently in organizations, tasks or work are rarely done by solely an individual, instead groups and teams exert their cohesive power to accomplish their goals. Within a group, cohesiveness is the power to bind its members together, and has significant influence upon its performance, leavings, morale. Decades ago, several studies have shown it’s relation to performance, and researchers had different points of view along with study development of group cohesion, and when the variables were mostly regarding to interpersonal-oriented or task-oriented.

Studies regarding to group cohesion started from 1950’. By the mostly cited definition from Festinger (1950), he defined cohesiveness as “the resultant of all the forces acting on the members to remain in the group”. Afterwards, by Festinger,
Schachter, & Back (1950), cohesiveness was defined to result from interpersonal attraction, liking for commitment to the group task, and group status.

This definition is also adopted by Mullen & Copper (1994), and Beal Cohen, Burke, and McLendon (2003). Group cohesiveness has once been defined as a unitary construct that means the effects of cohesiveness strength will be the same even the components of cohesion are different (Back, 1950; Schachter, 1952). Evidence is from Schachter (1951) stating that “whether cohesiveness is based on friendship, the valence of the activity mediated by the group, or group prestige, the consequences of increasing group cohesiveness are identical.”

Since this unitary tone raised controversy, another perspective was therefore derived when researchers intended to figure out multidimensional effect of individual components on cohesiveness itself and the group output. Cohesiveness is mostly interpreted into two types: socio-emotional basis, and instrumental basis by Tziner (1982), or in other words: interpersonal cohesiveness, and task-based cohesiveness, Zaccaro, and Lowe (1988), while Mullen & Copper (1994), and Beal Cohen, Burke, and McLendon (2003) defined the dimensions based on Festinger, Schachter, & Back’s (1950) three elements of cohesiveness construct; that is interpersonal attraction, task commitment, and group status or pride.

Traditionally, studies emphasized cohesiveness-performance effect by interpreting cohesiveness in terms of interpersonal cohesiveness, and the results varied from negative relation to positive relation or sometimes not specified. However, in the meta-analysis studies from Mullen & Copper (1994), and Beal Cohen, Burke, and McLendon (2003) they had each of the three components show their influence upon cohesiveness-performance effect to be positive although results of the effective components of cohesiveness were distinguishing. Mullen & Copper’s study (1994) indicated that only commitment to the task was the primary component of cohesiveness in the cohesiveness-performance effect, whereas Beal et al. (2003) testified that all three of Festinger’s (1950) original components of cohesion interpersonal attraction, task commitment, and group pride- each bear significant independent relations to performance across many criterion categories.

2. Literature Review

2.1 Group Cohesiveness

The scientific concept of group cohesiveness emerged from the booming experimental social psychological study of group process. They were Festinger, Schachter, and Back (1950) who finally formalized a theory of group cohesiveness.

They thought group cohesiveness as the central concept in explanation of group dynamics, and group process. Their classic work also had dramatic influence upon the following research of group cohesiveness. In their study, Festinger and his colleagues
set out to investigate how face-to-face, small, informal social groups exerted pressure upon their members to adhere to group standards (norms). They collected observational interview and questionnaire data from a field study of group formation and functioning in two housing projects established in 1946. The particularly appealing feature of this arrangement was that participants did not know each other and were randomly assigned to houses or apartments while they moved in simultaneously.

The significant result was that ‘friendship will be determined in large part by physical and functional distance’ (Festinger et al., 1950, p. 57). That is to say, ecological factors, especially residential nearness, were the major factors of friendship or group formation, and sociometric choices exchanges among people living with in the same court of building would be further expected in terms of these ecological considerations. From their investigation, a formal ‘theory of group structure and group standards’ was developed. Group structure was defined as ‘the pattern of connections among different parts of the group,’ (p.151) in which, ‘part’ meant people and ‘connection’ meant friendships.

2.2 Definitions of group cohesiveness

Festinger et al.’s (1950) definition of cohesiveness, which was first mentioned in their study, was ‘We shall call the total field of forces which act on members to remain in the group the “cohesiveness” of the group’ (p.164). Later, Festinger furthered the definition of cohesiveness to ‘the resultant of all the forces acting on members of a group to remain in the group. These forces may depend on the attractiveness or unattractiveness of either the prestige of the group, members in the group, or the activities in which the group engages’ (Festinger, 1950, p. 274). With a more concise group cohesiveness definition, elaborated by later researchers, ‘cohesiveness can result from interpersonal attraction, liking for or commitment to the group task and group status’ (Zaccaro & Lowe, 1988; Mullen & Copper, 1994; Beal et al. 2003). Back (1951) and Schachter et al. (1951) raised their own definition after the study. Back defined cohesiveness as ‘the attraction of membership in a group for its members.’ Schachter et al. (1951) defined ‘cohesiveness as a concept has assumed some importance for it represents an attempt to formalize or simply verbalize the key group phenomena of membership continuity- the “cement” binding together group members and maintaining their relationships to one another’ (p. 229). Some later studies once simply referred group cohesiveness as interpersonal attraction within a group; therefore, there are cohesiveness definitions, such as, ‘One such interpersonal relationship is the degree to which the members of the group are attracted to each other, or the degree to which the group cohere or “hang together.”’ This aspect of the group is usually referred to as group cohesiveness’ (Shaw, 1976).
Also in B.E. Lott’s study (1961), he defined cohesiveness as ‘that group property which is inferred from the number and strength of mutual positive attitudes among the members of a group.

2.3 Interpersonal Attraction

From the studies of group cohesiveness, interpersonal attraction was once regarded as the primary force of group cohesion, because researchers tried to defined group cohesiveness as the social attraction among group members within a group, and they thought interpersonal attraction was main force to remain those members in a group. And the reason for this was because normally people join a group may try to seek for social affiliation within a group. Except for affiliation need, attitude similarity also exerted tremendous influence on interpersonal attraction (Byrne, 1961).

In the study also mentioned that the expression of dissimilarity attitude by an individual may incur punishment and threatening while having interaction with one another. This kind of notion can also be referred to earlier study of Dollard & Miller. (1950). They pointed out that people received a great deal of social training which made them learn to know logic and make correct report of the environment. The primary criterion to judge whether we were logical or correct in interpreting the world was by the consensus of others. That’s why we normally constantly check if our perception or conception is acceptable by other or go against. Also in Heider’s (1958) study, he proposed that a state of harmony or balance existed if entities which belonged together were all positive or if they were all negative.

In Graham’s study (1971) to figure out the major concerning while one choosing his work companion or social companion, the result showed that ‘desirability as a work companion correlates very well with ideas, people orientation, contribution to goal, and desirability as a social companion’.

In addition, the study of Cavior et al. (1975) supported that physical attractiveness, perceived attitude similarity, and attitude similarity, contributed to interpersonal attraction. In Byrne’s earlier study (1961), his investigation indicated attitude similarity was major factor contributing to interpersonal attraction; however, in Cavior et al.’s study (1975) they tried to demonstrate that they were physical attraction and perceived attitude similarity which contributed more to the variance in interpersonal attraction than did actual attitude and length of acquaintance. And this hypothesis did go with the result of the study, and physical attraction and perceived attitude similarity prevailing against actual attitude length of acquaintance implicated that people who usually desired to be liked by an attractive other might say or do things to reduce actual attitude dissimilarity and increase perceived attitude similarity.

Stimuli which elicited interpersonal attraction were also introduced in Byrne and Griffitt’s study (1973) on interpersonal attraction. In the study, they figured out not just attitudinal similarity elicited interpersonal attraction, there were other factors,
such as, physical attraction, racial and belief similarity, gazing (eye-contact) while
having interview, superiority and prestige, scholastic and intellectual competence, and
anticipation of future contact of the target. All the above may have contribution in the
attraction between individuals. Furthermore, they introduced the consequences of
interpersonal attraction that led to individual’s behaviors. Consequences of attraction
were various like, individuals’ approach to the person they like or avoidance against
to the person they dislike, having positive evaluation to the liked person than the
disliked one, conformity to group opinions and judgment, incurring modeling
phenomenon to the liked person, showing more cooperation when a group member
was liked than disliked and better learning and performance exhibited by liked ones.
In sum, from the consequences of interpersonal attraction, we learned that it may
affect either the behavior of individual himself or an individual’s behavior within a
group.

Jehn and Shah’s (1997) study on interpersonal relationships and task
performance gave evidence showing that interpersonal relationship may affect
positive task performance. The result of the study indicated that ‘several process
differences in friendship and acquaintance groups account for the performance
superiority of friendship groups on both cognitive and motor tasks.’ This result was
not concordant to prior researches which suggested that friendship among members
may harm the performance because of group’s focus on social interaction instead of
the task improvement. However, their explanation to the positive result of friendship
to task performance was that friendship groups work more voluntarily, mutually, and
communally. Their commitment was positively related to task performance, and
friendship members were more willing to provide or even share voluntarily
improvement for task in their communication. Although researches of whether
interpersonal attraction benefited to performance always varied according to different
variables adopted in the researches, in the present study it will be reexamined its
influence upon group performance in Taiwanese work groups.

Hypothesis 1-1a: Interpersonal attraction and performance are positively correlated.
Hypothesis 1-1b: Interpersonal attraction has influence upon performance.

2.4 Task (Goal) Commitment

Traditionally, investigators of group cohesion restrained their cohesion study
from social cohesion, in which group members were more emotionally attached to
each other, and group cohesion was normally generated by their friendship and
membership. However, Schachter et al. (1951) first demonstrated that this attraction
within group members was not necessarily directly related to the level of group
productivity (performance). They concluded that ‘direction’ was the main criterion to
high productivity in high cohesive groups. That is to say, high cohesive groups were influenced either to positive direction for high productivity or to negative direction for low productivity than those directions manipulated in low cohesive groups. This result drew the attention for later researchers like Berkowitz (1954) to do study on group standard, cohesiveness, and productivity; in the study “‘group standard’… by which we mean the expressed and shared attitudes of the group members toward their task. And a standard of high production… refers to attitudinal consensus favorable to the designated group task’ (p. 510). He gave the conclusion that high cohesive group members had the social pressure and tended to learn the attitude of their co-workers and conformed, so that the group standard that led to high productivity can therefore become persistent. His result echoed the conclusion of Schachter et al’s study that other factors must intervene to provide a goal for the group to their high or low production, and cohesiveness then exerted its influence by making for greater acceptance of this goal. All in all, both studies suggested group standard or direction exerted influence on productivity (performance); furthermore, researchers started to pay attention to task commitment and its effect to productivity.

According to Locke, Shaw, Saari, and Latham (1981), task (goal) commitment referred to the determination to try for a goal and the persistence in pursuing it over time. Such a goal commitment was defined by Campion and Lord (1982) as the extension of effort, over time, toward the accomplishment of an original goal and emphasized an unwillingness to abandon or to lower the original goal. In Porter and Lilly’s study (1996), they adopted the conceptual definition of task commitment as the group’s determination to perform to a degree that was superior to acceptable standards of performance.

In Hollenbeck and Klein’s study (1987), they asserted that ‘goal commitment was one of the first potential moderating variables recognized by Locke, who stated that people who “stop trying when confronted by hard task (i.e., those uncommitted to a goal) are people who have decided that the goal is impossible to reach and who no longer are tying for that goal” (Locke, 1968) This notion stated that goal commitment was an essential condition for group members’ acceptance to the difficult goal and the goal difficulty-performance relation, and it was central to the early goal setting theory. In addition, in Hollenbeck et al.’s study, they also suggested that ‘expectancy theory (Vroom, 1964) may be a useful approach for increasing the understanding of the determinants of commitment to difficult goals’.

Consequently, they used the previous empirical studies and expectancy theory to develop a model of the antecedents and consequences of commitment to difficult goal for our better understanding to the relation.

As for the relationship among group goal, group task commitment, cohesion, and performance, we learned the evidences not only in the antecedent studies from
Schachter et al., (1951) and Berkowitz (1954), but also supported by Shaw (1981) whose study concluded that the effects of cohesion on performance were mediated by motivational factors, group goals and commitment, providing the generative mechanism through which cohesion influenced group performance. Moreover, except for the result of Mullen & Copper’s meta-analysis study (1994) on cohesiveness-performance relation indicating that only commitment to the task was the primary component of cohesiveness in the cohesiveness-performance effects, in Klein’s later study (1995) a significant relationship among these variables were revealed, and suggested that ‘goals are the more immediate determinants of performance, mediating the effects of cohesion on performance’ (p. 44). And more recent study of Beal et al.’s (2003) meta-analysis study, they suggested that task commitment had the most significant independent relation to performance across many criterion categories. From the evidences revealed, we are persuaded that task commitment indeed is influential to performance and its relation to cohesiveness and performance will be reexamined in the present study.

Hypothesis 1-2a: Task commitment and performance are positively correlated.
Hypothesis 1-2b: Task commitment has influence upon performance.

2.5 Group Pride

The theory of group cohesiveness formalized in the 1950s was rapidly concerned and simplified as the theory of interpersonal relations to members within a group. However, after all interpersonal attraction arises from peoples’ mutual satisfaction of interdependent goals which bind them as a group. Therefore, it is inevitable that the attraction of a group itself, and how an individual conceptualize oneself in a group should be concerned in the concept of cohesiveness. It is doubtless that social identity theory and self-categorization theory can give the better explanation to this phenomenon.

First, it’s likely to define ‘pride,’ an artificial emotion derived from society. It was Rousseau who first defined ‘Pride is only a relative, artificial sentiment born in society, a sentiment which prompts each individual to attach more importance to himself than other anyone else’. His class work of ‘A Discourse on Inequality’ suggested that why human societies resulted in so much inequality.

Rousseau examined the emotional inequalities and believed that pride was an emotion that stimulated by social comparison. With pride, self feeling occurred and self-evaluations made people accustomed to ‘make comparison’.

Such self-esteem may lead to positive performance because one may want to be superior to others. Knowing the notion of how pride, an emotional feeling, derived, we have to address that this notion is used on a group-based when we talk about group
pride. That is, an individual has the feeling of pride from his group by comparing to outgroup, and the self-esteem is a collective self-esteem.

Aside from the notion of how pride generated, social identity theory and self-categorization theory are also essential theories which can explain how individual’s perception to group solidarity comes from. Social identity theory was brought out by Henri Tajfel in late 1950s, but it was formalized by him and through collaboration with students and colleagues in late 1979 for Tajfel and Turner’s discussion of intergroup relations, and in 1982 for Turner’s cognitive redefinition of group membership. In addition, self-categorization theory was developed by Turner and his colleagues (Turner, 1985; Turner et al., 1987).

Social identity (by American terminology as collective identity) theory was defined by Tajfel as ‘that part of an individual’s self-conception which derives from his knowledge of his membership in a social group (or groups) together with the value and emotional significance attached to that membership’ and based upon a fundamental distinction between interpersonal and group process. Social identity was the notion different from personal identity (one’s conception of self as unique and distinct from all other humans, and/or in terms of unique interpersonal relationship); social identity was that one’s conception of self in terms of the defining features of a self-inclusive social category that rendered self stereotypically ‘interchangeable’ with other in-group members and stereotypically distinct from out-group members. In the social identity process, an individual entirely depersonalized himself that was identical to other ingroup members and different from out group members (Hogg, 1992). And this group behavior had distinguishing characteristics from interpersonal behavior like ethnocentrism, in-group bias, intergroup competition and discrimination, stereotyping, prejudice, uniformity, in-group cohesion, conformity, and so forth (cf. Brewer and Campbell, 1976).

Social identity provided an individual a relatively consensually recognized sense of who we are and helped to locate us in the complex network of social relationships existing in a community.

Self-categorization theory was a development of social identity theory but different from it by emphasizing much on the content and focusing more on intragroup processes than on macro-social intergroup relations. The cognitive process of categorization was the basic mechanism for self-categorization theory. In the process an individual perceptually accentuated both similarities among stimuli belonging to the same category, and differences among stimuli belonging to different category. This process eventually gave the function explain the world in a subjectively meaningful way. Moreover, categorization clarified intergroup boundaries and fostered group prototypicality, stereotypicality or normativeness which made an individual define himself in a social category. Figure2-3-2 clearly depicted how
self-categorization exerted its influence to an individual to behave in a group. In the figure we learn that, first people categorized and defined themselves as members of a distinct social category or assigned themselves a social identity; secondly, they formed or learned the stereotypic norms of that category; and third, they assigned these norms to themselves; and last their behavior became more normative as their category membership became more salient (Hogg, 1992).

From Tuner’s (1985) illumination – ‘the depersonalization of self-perception is the basic process underlying group phenomena (social stereotyping, group cohesion and ethnocentrism, cooperation and altruism, emotional contagion and empathy, collective behavior, shared norms and mutual influence process, etc)’, this self-categorization theory was considered to better interpret one’s cognitive process within a group and that explained one of the components, group pride, of group cohesiveness.

According to Hogg (1992), ‘From a social identity perspective, group processes can operate only with reference to an internalized group norm or goal, so productivity or success can be affected by cohesiveness only if they are the relevant norms.’ And he suggested that this theory gave the performance management implication by encouraging group members to ‘construct and internalize a group norm of high productivity and performance excellence’. Therefore, we are persuaded that the relation between group pride and group cohesiveness-performance effects did exist in certain degree even thought it was not much addressed and presented in past literature. However, in recent studies of group cohesiveness-performance effect although in Mullen & Copper’s study (1994) it showed no significant correlation to the effect; nevertheless, it was still influential and even as important as other components showing in the result of Beal et al.’s study (2003).

Hypothesis 1-3a: Group pride and performance are positively correlated.
Hypothesis 1-3b: Group pride has influence upon performance.

2.6 The Nature of Work - Work Patterns

And while Beal et al.’s study (2003) mentioned ‘workflow matters when researches are related to group level in history’. Consequently, while they were doing their meta-analysis on how group cohesiveness exerted it influence upon performance that aroused their curiosity and attention to figure out how workflow moderated cohesion-performance relations at the group level. Accordingly, the result was shown as what they had hypothesized that the higher of interdependent degree in the workflow a group attends the stronger relations its cohesiveness to the performance. However, in their conclusion, they mentioned ‘this dearth of research contributed
to our inability to examine the relations between performance criteria and group pride, as well as the relations between any components and patterns of teamwork’.

While we are looking at the nature of work, especially workflow, we must refer to task typology which consists of a set of categories or classes in which tasks can be sorted. The simplest way is to classify it into two categories like simple and complex, or easy and difficult. More complex task typology can be formulated by more specific classification of tasks in different ways. Tasks were usually classified into categories by considering the following task characteristics: difficulty, solution multiplicity, intrinsic interest, cooperation requirements, intellectual-manipulative requirements, and population familiarity (Shaw, 1981). The earliest task typology was done by Carter, Haythorn, and Howell (1950). They classified the task into 6 categories: reasoning tasks, intellectual construction tasks, clerical tasks, discussion tasks, motor coordination tasks, and mechanical assembly tasks. Hackman (1968) classified tasks into three types: production tasks, discussion tasks, and problem-solving tasks. Alexander et al. (1977) in a study of family process, and husbands and wives were observed doing their house affairs by categorized their house tasks by three types: discussion tasks, decision tasks, and performance tasks.

Afterwards, Steiner’s (1972) ‘partial typology of tasks’ introduced that tasks maybe either divisible or unitary, maximizing or optimizing, and may involve permitted process or prescribed process. On this basis, he later classified tasks into disjunctive, conjunctive, additive, or discretionary. A disjunctive task requires a choice among alternatives. On this kind of task, of one person in a group can complete the work, then the group can finish it, and the performance depends on the person who did the work. A conjunctive task is one that requires all group members to participate the task and each one normally has the same share of the work. An additive tasks is the task that allow to combine the contribution of each individual group member. The task performance is the summation of each group member’s outcome. Last, discretionary tasks means the tasks that group members can decide to make it a disjunctive one, conjunctive ones, or additive ones.

According to Beal et al.’s meta-analysis on cohesiveness-performance effect in which they tried to figure the relation of any components and patterns of teamwork but failed to do so, they tried to adopt the work patterns suggested by Tesluk et al. (1997). In Tesluk et al.’s study of task issues in the analysis and assessment of team performance, there were four types of work patterns introduced - pooled/additive interdependence, sequential interdependence, reciprocal interdependence, and intensive. A pooled task means each individual of the group members contributes to the task completion, the team performance is the aggregation of each individual’s contribution; a sequential task is that the work flows from one member to another one
step by step. The performance is not only the summation of totally group members, but also how fluent the process goes until the last group member finishes the task. A reciprocal task is similar to sequential task in workflow but it is not from one to another step by step, members work in a reciprocal task by bidirectional cooperation that means member can exchange work with one another several times. The work flows back and forth and the interaction with group members is more dynamic. Also, the team performance is done until the last group member accomplishes the last piece of work. Finally, an intensive task is a task in which all team members work together closely at the same time to diagnose, brain storm, and solve problems in performing the task. This kind of task also requires high level of interdependence, synchronization, communication, and coordination between team members. Therefore, aside from individual factors, environmental factors, group process accounts most for the group performance.

And aside from Mullen & Copper’s study (1994) dealing with moderators of cohesion-performance, such as, group size, group reality, level of analysis, and group interdependence, and the result showed no moderating effect of group interdependence. Therefore, the present study would like to find out again the moderating possibility; that is work patterns (work interdependence). Also with the reason that Beal et al. failed to figure out the relation of each of these four types of task to cohesiveness-performance effect, this present study will also adopt these four workflows (pooled task, sequential task, reciprocal task, intensive task) to reexamine the relation empirically for the existing phenomenon within groups in Taiwanese companies.

Hypothesis 2: Work patterns contribute differently to cohesiveness.
Hypothesis 3: Work patterns moderate cohesiveness-performance effects.

3. Methodology
3.1 Research Framework

This model is designed based on the hypotheses after the literature review. In the model, cohesiveness is a construct built by interpersonal attraction, task commitment, and group pride, and they are also the independent variables in the study. Group performance is the dependent variable, and four types of work patterns are the moderators of cohesiveness-performance effects.
Figure: Framework of the present study

References


INTELLECTUAL DIVERSIFICATION AND COMPETITIVE ADVANTAGE

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Abstract. This paper attempts to integrate current theories on human intelligence and organizational development in order to draw conclusions on how to increase firm value. Many studies have argued in favor of the value of emotional intelligence in leadership. Few have attempted to adapt multiple intelligence theory to the firm. The uniqueness of this research lies in its interdisciplinary approach: clarifying theories of intelligence and integrating them with competitive firm theories in order to reach conclusions supporting the role of capabilities in firm strategy. The results of this study will have practical and universal implications for firm strategy.

1 Introduction

The concept of superior intelligence is an interesting one. It is a divine bestowment that can be attributed to success in the genetic lottery. And then, some of us hit the mega lottery of genetic mutations, becoming a member of the rare and unique breed of geniuses. Carl Von Clausewitz spoke highly of the genius in his unfinished treatise on military strategy, “On War.” In observing military genius Napoleon Bonaparte, he noted that it is difficult to understand the actions of the genius; but being able to observe one is absolutely fascinating. It requires intelligence to understand intelligence.

This paper will argue that differences in intellectual profiles can be internalized to augment the problem solving capabilities of the firm. First, theories on multiple and emotional intelligence are introduced. Second, contingency theory and the resource-based view are summarized in its relation to the argument. It will be argued that teams that operate within the firm require intelligent problem-solving capabilities to resolve issues that arise from environmental changes. Finally, this paper will argue that problem solving capabilities are enhanced through increased intellectual diversification and
emotional intelligence. This research is original in its interdisciplinary value and its deductive approach to modeling intellectual capacities in organizational development theory.

2 Intelligence Defined

The Oxford Dictionary defines intelligence as the ability to acquire and apply knowledge and skills. From an evolutionary perspective, “the core of intelligence is the ability to anticipate and predict variation and novelty and to devise strategies to cope with this novelty” [Geary 2009, 22]. In experimental psychology’s infancy, Charles Spearman paved the way for psychometric studies when he administered tasks to 123 local children and adults and found correlations to support a “General Sensory Discrimination,” or “General Intelligence” [Spearman 1904]. Psychologists expanded on this notion of a general intelligence and labeled it $g$. The measurable factor of intelligence $g$ is the basis for IQ and psychometric testing. The empirical support for $g$ is plentiful. In neurological studies, IQ has shown correlations to overall brain volume, brain neural markers, and the coherence of white matter fibers [Lee 2009, 60]. Psychometric advocates have conducted many tests that have linked IQ with later successes in life.

Given the hereditary nature of psychometric theory, it can be assumed that general intelligence does not significantly change in one’s lifetime. In 1988, Michael Anderson collected evidence to support that intelligence can be ascertained even among infants. Arguing against psychometrics, Gardner wrote that although IQ is an indication of one’s ability to grasp academic concepts, it does not correlate well with success in life [Gardner 1983]. Researchers are beginning to argue that intelligence is an interaction between certain potentials such as $g$, and opportunities as characterized by an individual’s environment and cultural setting. This allowed Gardner and others like Robert Steinberg to expand the theory of intelligence outside of general intelligence. Intelligence can be viewed from many perspectives: traditional, sociological, neurological, etc [Gardner 2002]. This certainly further complicates the definition of intelligence.

This study recognizes that there exists a general intelligence $g$ as well as the existence of other specialized intelligences. Assuming a normal distribution for general intelligence among people, most people will fall within a similar IQ range. This does not mean they have similar abilities in acquiring and applying knowledge. Combining a dictionary and evolutionary definition, intelligence is defined as the ability to acquire knowledge and apply this knowledge to anticipate
and adapt to changing environmental pressures. This definition allows for differences in learning and reasoning abilities despite an identical psychometric IQ score.

### 2.1 Theory of Multiple Intelligences (MI)

The theory of multiple intelligences was not completely novel when it was introduced by Howard Gardner in 1983. If Gardner coined his discovered intellectual traits as talents rather than intelligences, his book might not have sold as many copies. The idea that there is more than one form of intelligence appealed to many people and educators. Gardner criticized Piagetian IQ testing as being blindly empirical and fails to come to grips with higher levels of roles in society [Gardner 1983]. The idea that IQ does not fully explain higher level cognitive processes is supported by studies on top level executives [Cherniss & Goleman 2001; Goleman, et al 2002; Hughes & Terrell 2007]. Goleman concludes that differences in the success of executives can be more greatly attributed to other intellectual factors than general intelligence. IQ fails to explain differences in success among executives because they are already selected with certain IQ standards based on education and prior work experience [Goleman 1995].

To uncover new sets of human intelligences, Gardner developed a set of criteria based on: psychology, observations of prodigal beings, anthropology, cultural studies, and biological sciences [Gardner 1998/2004]. For a trait to be considered a new intelligence in Gardner’s theory, the trait must consist of a unique cognitive process used for problem solving that is useful in one or more cultural settings. Summarized in Figure 1, Gardner originally proposed seven intelligences [Gardner 1983]. In 1994, Gardner took a sabbatical from Harvard and proposed two more intelligences [Gardner 1999]. Gardner continues to consider other intelligences including: spiritual, sexual, attention, and pedagogical [Gardner 1983/2011]. Neurobiological studies continue to be shape Gardner’s paradigm. Each of the intelligences Gardner identified can be biologically linked to a cognitive process. For example, spatial intelligence can be linked to the parietal and occipital lobes whereas linguistic intelligence is attributed to the temporal and frontal lobes [Noruzi 2010]. MI theory will continue to evolve with the field of human neurobiology.
Table 1.

<table>
<thead>
<tr>
<th>Author</th>
<th>Intelligence</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gardner 1983</td>
<td>Linguistic</td>
<td>Effective usage of words in writing or speech.</td>
</tr>
<tr>
<td>--</td>
<td>Logical-Mathematical</td>
<td>Understanding of numbers, patterns, relationships</td>
</tr>
<tr>
<td>--</td>
<td>Spatial</td>
<td>Perception and accurate visualization of the world</td>
</tr>
<tr>
<td>--</td>
<td>Bodily-kinesthetic</td>
<td>Physical expression of ideas and feelings</td>
</tr>
<tr>
<td>--</td>
<td>Musical</td>
<td>Perceive, transform, and express music</td>
</tr>
<tr>
<td>--</td>
<td>Interpersonal</td>
<td>Capacity to understand emotions of others</td>
</tr>
<tr>
<td>--</td>
<td>Intrapersonal</td>
<td>Awareness of oneself</td>
</tr>
<tr>
<td>Gardner 1999</td>
<td>Naturalist</td>
<td>Discriminate living things and natural world</td>
</tr>
<tr>
<td>--</td>
<td>Existential</td>
<td>Comprehend deep questions about human existence</td>
</tr>
<tr>
<td>--</td>
<td>Pedagogical</td>
<td>Effectiveness of teaching others</td>
</tr>
<tr>
<td>Pink 2005</td>
<td>Design</td>
<td>Structural creativity</td>
</tr>
<tr>
<td>--</td>
<td>Story</td>
<td>Ability to tell a story</td>
</tr>
<tr>
<td>--</td>
<td>Empathy</td>
<td>Understanding emotions of others</td>
</tr>
<tr>
<td>--</td>
<td>Symphony</td>
<td>See the big picture and compose components</td>
</tr>
<tr>
<td>--</td>
<td>Play</td>
<td>Ability to have fun</td>
</tr>
<tr>
<td>--</td>
<td>Meaning</td>
<td>Finding and giving purpose</td>
</tr>
</tbody>
</table>

The existence of \( g \) does not prohibit the existence of other intelligences. Traditional psychometric researchers and modern psychologists have argued ad nauseum on the classification of multiple intelligences and the viability of IQ tests. A wealth of empirical studies validate psychometric testing, supporting the \( g \) argument. Multiple intelligences theory is supported by neurological developments in brain modularity, such as works by Jerry Fodor at MIT. Tooby and Cosmides support claims for brain modularity – “intelligence is a constellation of distinct capacities with separable mechanistic and evolutionary bases, each designed by natural selection in response to a particular adaptive problem faced recurrently in the history of the species” [Lee 2009]. Since data is processed in different parts of the brain depending on the nature of the specified information, the existence of other intelligences can exist. Brain modularity is further supported in brain studies where some of the subject’s cognitive abilities are drastically affected whereas their general intelligence is unaffected (e.g. HM, KC and WM).

Many people have gone against traditional psychometric measures of general intelligence to support Gardner’s notion of multiple intelligences. Steinberg argues that intelligence must be taken in context of the culture. According to his triarchic theory, “intelligence can be understood only in relation to three aspects in interaction: the internal world of the individual, the individual’s experience, and the external world of the individual. [Sternberg 1999, 148]” This defines intelligence as a factor underlying internal processes, experiences, and the
environment [Sternberg 1999]. Dan Pink described the importance of right-brain logic given his hypothesized future demand for intellectual firm needs; emphasizing a paradigm shift in brain-lateralization [2005].

By definition, MI theory is adaptable to cultures and environments. It can also be adapted to cognitive processes that will be valuable to a specific industry. Figure 1 summarizes and categorizes proposed intelligences, but there exists more cognitive processes that may be critical to a specific setting or industry. Critics of MI theory argue that many of these intelligences are mislabeled and should be classified as traits or skills [Gardner 1983/2011]. This argument can be emphasized when considering extending MI principles reductio ad absurdum to include such talents as face recognition, catching a ball, or whistling. Therefore, it should be kept in mind that MI theory is based on problem-solving abilities, prodigal capabilities, and modular cognitive processes – key elements of Gardner’s research.

2.2 Theory of Emotional Intelligence (EI)

Emotional intelligence is a relatively new concept hypothesized from the field of “positive psychology,” a study that leads to a sense of well-being rather than the study of treating illnesses1 [Bar-On 2010]. The concept of EI can be popularized with Gardner’s MI theories of intrapersonal and interpersonal intelligences, a similar approximation to EI [Gardner 2002]. Interpersonal intelligence is described as the capacity and ability to distinguish between emotions and feelings. Intrapersonal personal intelligence is an extension of these abilities to others – “in particular, among their moods, temperaments, motivations, and intentions” [Gardner 1983, 239]. Gardner found unique characteristics in the neurological representations of intrapersonal and interpersonal intelligence, although both MI forms develop together.

EI brings together Gardner’s dual theory of personal intelligences, but psychologists still disagree on a precise definition. It wasn’t until 1990 that EI was coined as “an accurate appraisal and expression of emotions in oneself and others” [Mayer, DiPaolo, Salovey 1990, 772]. Mayer, Salovey, and Caruso went on to advocate a four-branch model of EI ability: perceive emotions, use emotions to facilitate thinking, understand emotions and symbols, and manage emotions to attain a goal [Caruso, Mayer, Salovey 2008]. This group of leading psychologists

1 By extension, this also classifies MI theory into the realm of positivist psychology
also developed the MSCEIT\(^2\), an empirically tested and highly recommended measure of EI [Caruso, Mayer, Salovey 2000; Salovey & Grewal 2005; Seal, et al 2009]. The EI construct was popularized by Daniel Goleman, who made claims of EI’s importance over IQ in his 1995 best-selling book, “Emotional Intelligence.” Goleman expanded the definition of EI to the leadership qualities of influencing others, management styles, and temperament [Goleman et al 2002]. Since Goleman, many academic researchers and private consultants conducted studies to better understand EI. The goal was an overwhelming evidence of the importance of EI in the workplace [Cherniss & Goleman 2001; Hughes & Terrell 2007; Polychroniou 2009].

The effectiveness of EI is still disputed because EI is so loosely defined. EI can be found defined by non-psychological qualities such as reality testing, assertiveness, self-regard, trustworthiness, innovation, adaptability, etc. This opens EI to criticism as a bucket theory of everything but IQ: emotions, personalities, and social intelligence\(^3\) [Caruso Mayer Salovey 2008]. Empirical evidence has shown that while “managing emotions and understanding emotions did show singular relevant relationships worthy of consideration, the relationships appear to be influenced by other variables, submissive to other variables, or inadequate to suggest a meaningful relationships worthy of consideration, the relationships in the business setting” [Davis 2011, 45]. This study recognizes two arguments presented as fact. First, it is proven that there exists some relationship between emotions management and organizational effective. This relationship has to do with leadership, employee retention, employee happiness and customer service, and workforce morale [Cherniss & Goleman 2001; Goleman, et al 2002]. Second, there exist cognitive processes that aid in emotional management: interpersonal and intrapersonal intelligence. This is further supported by empirical data that shows significant EI differences in the ability to discern emotion and the capability to apply emotions [Seal, et al 2009].

In the context of this paper, EI will be defined by the most consistent definition with the previously proposed view on intelligence – the ability to perceive emotions in the self and in others, and the ability to predict emotional states. This definition ignores personality and social aspects that is so often attributed to EI, and is consistent with the evolutionary definition of intelligence: to anticipate and adapt to environmental pressures.

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\(^2\) Mayer-Salovey-Caruso Emotional Intelligence Test

\(^3\) Social intelligence is a much older theory than EI, coined by Thorndike in 1920.
3 Organizational Development and Effectiveness

Over the last forty years, researchers and business thinkers have attempted to derive a model of the firm to maximize organizational effectiveness by identifying an ideal structure. It is axiomatic that the objective of the firm is to increase profits in light of competitive pressures. The underlying premise of contingency theory is that there is no one solution to the most profitable organization structure [Ginsberg & Venkatraman 1985; Pennings 1987; Fredericks 2005]. Rather, the structure is dependent on a number of contingencies. Established in 1977, a general contingent theory of management described performance as a function of environmental, resource, and management variables: \( P = f(ERM) \), [Luthans & Stewart 1977, 188].

Researchers continued to debate over which variables should be included in a contingency theory of the firm [Ginsberg & Venkatraman 1985]. Seemingly circular, it appears that contingent variables in contingency theory are also contingent on the environment itself. As researchers began to argue against the practicality of contingent theory, multivariate analysis proved that dual contingency models are able to hold under empirical scrutiny [Pennings 1987]. As businesses globalize, technology advances more rapidly, and firms begin implementing riskier strategies; the uncertainty in business strategy began to increase. Because of exogenous pressures, the contingency model is a more suitable model of profitability given environmental dynamics (Fredericks 2005). More recently, abilities and knowledge have become proposed as contingent variables in adapting to environmental pressures [Conner & Prahalad 1996; Birkinshaw, Nobel, Ridderstråle 2002, Spender 2003, Nobre & Walker 2011].

A relatively newer analytical framework for firm strategy to increase economic profits is the resource-based view (RBV) on management strategy. RBV has been developed and refined over time by many researchers. This theory assumes resource scarcity, heterogeneous resource endowments, a diversification of resource leverage, and costs to changing resource endowments [Wernerfelt 1995]. RBV provided a strategic framework for focusing on resources rather than products. By holding valuable resources, firms create a barrier to entry allowing them to reap sustainable profits [Wernerfelt 1984]. Resources that provide a sustainable competitive advantage are defined by four characteristics: valuable, rare, imperfectly imitable, non-substitutable [Barney 1991]. By attributing firm competitive advantages to valuable resources, RBV became a logical model for analyzing firm strategies.
3.1 Group Capabilities and Organizational Development

The knowledge-based theory of the firm is a corollary to RBV. It recognizes the importance of structure in developing, storing, and passing on knowledge and abilities in the firm [Birkinshaw, Nobel, Ridderstråle 2002]. These abilities and knowledge are shaped by management, the collective abilities of the employees, and the procedures and systems derived through trial and error over the history of the firm. Barney acknowledged that business routines “become part of the path-dependent process through which a firm develops its resources and capabilities” [Barney, et al 2004, 36]. These business routines are shaped over time by key business resources.

The managers and leaders represent the potential of the firm to continue to strategize, problem-solve, and direct the firm’s resources. When faced with uncertainty, the firm’s management has a large impact on the management of knowledge-based resources and development of goals and systems [Carillo & Gaimon 2004]. The management of the firm is argued to represent the knowledge endowments and intellectual capacity of the firm to adapt to changing environmental pressures. The capabilities of the groups and subgroups in a firm can be classified as a resource of any competitive firm, especially the executive team and their role in shaping the overall strategy.

Linking RBV to contingency theory, the knowledge and abilities enable firms to capitalize on opportunities that arise from the environment [Conner & Prahalad 1996]. Returning to Luthans and Stewart’s proposal [1977]: P = f(ERM), we can substitute team capabilities (C) and knowledge (K) in for management; arriving at P = f(ERCK). This simply states that the performance of the firm is a factor of the environment, resources, knowledge, and the team capabilities of the firm. Since variables in contingency theory interact with each other [Ginsberg & Venkatraman 1985; Pennings 1987] and environment is an exogenous variable, the resources and knowledge capabilities of the firm must react to the environment. This is the main argument in contingency theory – firms must be able to react to environmental changes to maintain profits in the long run. These environmental dynamics represent a contingency that threatens the future profitability of the firm. This contingency is mitigated by improving on the flexibility of the firm’s resources and capabilities.

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4 Knowledge and abilities being shared in a firm depends on the mobility of the knowledge and the structure of the firm (Birkinshaw, Nobel, Ridderstråle 2002).
Proposition 1. The firm’s value, as defined by its competitive advantages over the long run, is improved if the firm can improve its contingencies to a changing business environment and increase its resources, knowledge, and capabilities.

The intellectual resources of the firm cannot be viewed by the standpoint of the individual, but by the collective ability of the group and routines already in place. The canonical attributes of resources being rare and non-substitutable and the fact that there will always be some employee turnover presents an issue to the team’s intellectual structure. A team member’s ability to exit the firm at any time creates a major contingency on the sustainability of the team’s effectiveness. Reconciling this issue, the human capital resource must be considered in light of the knowledge and capabilities of the group, not the individuals. Individuals within the group may leave and be replaced, changing the dynamic of the group. However, the competitive strength of the group can remain in place. Restating the argument, the individuals within a group can be substituted, but the group itself cannot.

The collective cognition in the organization and its relationship in reducing environmental uncertainty is a key aspect of the ability-based view of the firm [Nobre & Walker, 2011]. This view supports the relationship between firm capabilities and sustaining profits facing uncertainty. Based on the contingency theory of organizational effectiveness and the risk-based view on competitive advantage, it is proposed that improving the capabilities of the group increase the performance and profitability of the firm in the long run.

Proposition 2. Increasing the capabilities of groups and subgroups in the firm will decrease the firm’s contingencies to a dynamic business environment and increase the quality of human capital.

By a stated assumption of RBV, competitive resources are sticky and not meant to be mobile, making reacting to the environment slow and unwieldy. However, the firm’s problem solving abilities of an intelligent group of management does not have to be rigid and can be equipped with adaptation abilities. The flexibility of the firm is then mostly a function of the current group’s capabilities in seeking out the most profitable solution to environmental changes, since other competitive resources are slowly changing by nature. To deal with a dynamic business environment, the firm must seek to improve the problem-solving capabilities of the groups in the firm. By definition, increasing
the capabilities of the groups in a firm is also improving on the quality of the firm’s human capital.

3.2 Effects of MI on the Group

There is very little literature on the intelligence of the group versus the intelligence of the individual. Logic dictates that certain individuals within the group will have a larger effect on the group’s intellectual abilities and problem-solving capabilities, and that the intelligence of the group is not simply a sum of its parts. The actual capability of the group depends on the group’s social construct, personality of the individuals, and intellectual profiles of the individuals at the critical time the group’s concerted effort is required. The number of variables and number of members further increases the complexity of the group. Instead of proposing any exact relationships, this paper will simply propose a much more basic tenant about the pre-facto capabilities of the group in its relationship to MI theory:

Proposition 3. There is a complex relationship between the intelligence profiles of the individuals of a team and the team itself which is not a mere summation of the parts.

Team AA:
Let’s assume a team of two: Anne whose skill sets and knowledge base is defined as A, Andy whose skill sets and knowledge base is defined as $A_1$. Further assume that Anne’s intelligence capabilities include all of Andy’s capabilities with the addition of uncommon variables (U). The intelligence capability of the team ($T_{AA}$) is simply Anne’s skill sets and knowledge base.

$$T_{AA} = A = A_1 + U$$

From an intellectual perspective of problem solving capabilities, this team is no better off with the inclusion of Andy. Because intelligence is a product of one’s MI profile, environment, and personality; Andy will always have some knowledge or experience to bring to the team. However, Andy is limited in his capability to think outside Anne’s proverbial box. The purpose of this example is to illustrate a case of intellectual redundancy.

Team AB:
Let’s take another example on a team of two: Anne whose skill sets and knowledge base is defined as A, Ben whose skill sets and knowledge base is
defined as B. In this scenario, let’s assume that Anne and Ben have different multiple intelligences (uncommon knowledge base U) and also share a common knowledge base (C). It can further be assumed that intellectual synergies (S) can be found between Anne and Ben when solving a problem. The intelligence capability of this team \( T_{AB} \) is improved because Anne and Ben both contribute to the problem-solving perspective of the team.

\[
T_{AB} = A + B - C + S; \quad T_{AB} = C - U(A, B) + S
\]

This overly simplistic example of the team structure emphasizes the point that, ceteris paribus, the team’s capabilities are benefited by the addition of an individual with different experiences and MI profile. Figure two illustrates these differences. Note Team AB covers a larger, better-rounded area.

**Proposition 4.** The more dissimilar is the individual’s MI profile to be added to the group, the more the group’s intellectual capabilities will benefit.

This proposal implies that the group will have a greater chance of improving its goals by adding an individual with a unique MI profile. This ignores the presence of the differences in general intelligence \( g \), which enables each group member to be able to carry out ordinary individual tasks effectively. Thus, this proposition assumes a minimal level of \( g \) as defined by the needs of the group.
3.3 Effect of EI on the Group

Emotions are contagious. A single individual with a powerful emotion, whether it is disheartening or inspiring, can change the emotional profile of the entire group. Hillary Anger Elfenbein found that groups with higher EI scores “reported that they felt greater psychological safety with each other, had lower levels of conflict, made decisions more collaboratively together…” [Elfenbein 2006 pg 172, through Hughes & Terrell 2007]. But emotions are difficult to control in the organization, “the same conditions that make emotional intelligence so vital for organizational effectiveness also make EI difficult to nurture in organizations” [Cherniss & Goleman 2001]. Cherniss argues that the turbulent U.S. market creates emotional turmoil that can be a real issue if unabated. This dilemma becomes more difficult considering Barsade’s argument that contagious emotions have a negative preference; “unpleasant emotions are more likely to lead to mood contagion than are pleasant emotions” (2002). There are many more cases for disgruntled employees wishing to quit than there are for motivated employees rising above and beyond. Emotional contagion is the firm’s concealed virus.

It is a truism that transformational leadership, highly motivated workers, and effulgenty gleaming customer service is beneficial for a business; but the relationship from such idealistic states to emotional intelligence is not clear [Caruso, Mayer, Salovey 2000]. It is clear that emotionally intense events dramatically constrain the organization’s rationality, and that emotions cannot be ignored when analyzing the knowledge-based structure of the firm [Spender 2003]. By developing a high EI and being able to understand emotions in others, leaders and followers can control their emotional subterfuge of non-productivity. By being able to identify and understand negative emotional states, leaders can prevent productivity hindrances like emotional contagion. These productivity hindrances act as friction in the firm’s acceleration efforts:

**Proposition 5.** Increasing the emotional intelligence (EI) of each team member will reduce the emotional friction (EF) of the team.

Emotional friction is not the only source of friction in team productivity. For example, teams can also suffer from structural friction. A team of 150 people will work inefficiently if every member must participate because the structure will drastically slow down any decision-making process. Emotional friction is a subset of productivity friction. Emotional friction is used to describe the loss of
productivity due to emotions not being at a normal state. Emotional friction will always exist.

**Team AB (revised):**
Revisiting the example that Anne and Ben’s team capabilities is a function of their common knowledge (C), uncommon knowledge (U), and any synergies that may exist in their knowledge bases. It can now be added that their intellectual capabilities will also be reduced by their emotional friction, a function of their emotional capabilities.

\[ T_{AB} = A + B - C + S - EF; \]
\[ T_{AB} = C - U(A, B) + S - EF; \]
\[ EF = f(EI, \text{environment}) \]

This argument ignores the existence of possible emotional states that increase productivity, such as transformational leadership. Empirical data has shown a correlation between EI and transformational leadership, but the causal relationship is unclear [Polychroniou 2009]. Such surreptitious incidences of highly charged emotional states of productivity are generally unsustainable and difficult to attribute to one factor. Returning to Luthans and Stewart’s general contingency model (1977), the revised contingency theory for intellectual variables is: \( P = f(FERCK) \); performance is a function of friction (namely emotional friction), the environment, resources, capabilities, and knowledge.\(^5\)

### 3.4 Effect of MI and EI on Group Capabilities

From the previous propositions, the following can be deduced:

**Proposition 6.** *The organization as a whole and subgroups within the organization constitute a team whose capabilities can be defined by its emotional and intellectual fluidity.*

Fluidity is used here as a double entendre because it can mean the water-like efficiency of the group or the fluid intelligence of the group. Fluid intelligence, as opposed to crystallized intelligence, is pure intellectual abilities independent of experiences [Geary 2009]. Emotional fluidity is used here to mean the lack of emotional friction and the natural ability of the members to understand emotions.

\(^5\) Capabilities and knowledge are a special subset of resources, and friction can be a function of the environment.
The groups and subgroups within the organization constitute a team and at the same time, they constitute many teams. The word team here is used to describe the possible sets of teams that can work together in a firm. Some firms have specialized teams that always work together, but most firms have team members that interchange with other groups. For example, the CIO would work with his IT group and the executive team, and also be a member on a new product release team.

3.5 Intellectual Diversity, Emotional Intelligence and Organizational Development

From the preceding proposals, the following can also be deduced:

**Proposition 7.** It follows from the preceding premises that intellectual diversity and increased individual emotional intelligence will increase the value of the firm.

Intellectual diversity increases firm value by increasing the capabilities of teams within the firm. Intellectual diversity also allows the firm to adjust better to changes in the business environment by being capable of offering a wider combination of modular thinking and solutions. Increased emotional intelligence, a subset of MI and intellectual diversity, will increase the value of the firm directly by decreasing emotional friction. The effectiveness of teams and employees will be increased by the reduction of emotional vices that reduce productivity.

4 Managerial Implications

This paper suggests that intellectual diversification and increased emotional intelligence improves the effectiveness of the firm. It allows the firm to be more flexible to environmental changes, and represents in itself an improvement of human capital capabilities in terms of creativity, problem-solving, and teamwork. The implications are universal and can apply to any culture.

The needs of the organization's intellectual and emotional needs should first be evaluated based on the proposed model. An organization with a high amount of emotional friction needs to increase the emotional intelligence of the organization either through hiring more empathetic individuals or terminating individuals that are workplace stressors. The intellectual profile of the firm can also be evaluated with Gardner's MI model. An organization in financial services
specifically requires intrapersonal intelligences and logical-mathematical abilities whereas a recording company might require spatial and musical talents. Each organization may be different. This does not mean that an organization in defense research won’t benefit from artistic or spatial intelligence, as this type of intelligence can boost the creative prowess of the team.

The firm should create a strategy to hire an intellectually diverse management team. This does not mean that every executive board should have a world-class sculpture. It means that when choosing between two candidates of similar intelligence, it would be more profitable to the firm to choose the person whose intellectual profile is different than that of the group. If the candidate is well qualified and has an artistic mind, this candidate will be more beneficial to the intellectual capabilities of a group that doesn’t already have such a person. It should be taken into consideration, that at higher levels of thought, the differences in IQ become less important. This is due to a selective bias [Goleman, et al 2002] and the complexity of higher level thinking 6 [Gardner 1983/2011]. By considering the intellectual diversity of the team, the firm ensures that the team is capable of using more combinations of neurological modules in solving problems.

Third, the emotional intelligence of leaders in high profile positions should be evaluated based on their emotional effect on those around them. Because such individuals are highly visible, their emotional effects on others are greater, thus increasing the emotional friction of the entire firm. Remember that emotions are contagious, and that these individuals can affect other leaders as well as any staff member with whom they interact. There are many tests such as the Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT) that can aid the firm in determining a leader’s emotional intelligence. Also, by taking EI into consideration, the firm is also strategically making a statement that emotional qualities like empathy and considerateness are of importance.

Firms should seek to solve issues that arise from negative emotions as quickly as possible. Management should consider the emotions of their employees in making and carrying out decisions. Not all decisions have to be liked by the members of the organization, but management should attempt to minimize productivity losses in organizational changes. Following the EI construct, managers must be able to identify emotional friction before being able to resolve the issue.

The final suggestion is to expose the team to different intelligences, or different types of thinking. Introducing and integrating other styles of thinking

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6 Gardner defines as originality, common sense, metaphorical – largely ignored by psychometrics
into the workflow will be even more effective. By promoting a variety of intellectual thinking, the entire firm can support different views on cognition. Firms that want to think outside the box must first step outside of it. This is a method of internalizing MI theory into the structure of the firm. It is not enough to just have thinkers capable of different brain modularity functions, the environment must also be conducive to bringing out higher level thinking.

5 Suggestions for future research

We hope that the logical construct provided in this paper can be used for future empirical studies on the effect of MI and EI differences in individuals on organizational effectiveness. To our knowledge, there is currently no published study that shows the relationship between MI and firm performance. There is a plethora of studies that show a correlation between EI and such performance standards as turnover and profits, but no studies show the effects of an effort to improve EI in the workplace. This has made it difficult for firms to internalize EI theory. We suggest a controlled study on the effect on performance when team members are filtered through EI tests such as the MSCEIT.

MI and EI theory can also be used to further studies in human resources development (HRD) such as hiring and training practices. By providing the foundation for an analytical framework relating human resource capabilities to the value of the firm, we hope this research can be used in future empirical studies and theoretical treatises on team intelligences in the business setting. More research is required on how individuals affect the intellectual capacity and emotional friction of the group. More research is also required on the sources of friction in a group. We also hope that this research can somehow be used to better define emotional intelligence as a source of intelligence used in social situations, rather than a umbrella definition of social talents, personalities, and proclivities.

6 Conclusion

6.1 Research Limitations and Directions for Future Research

Although much research is being put into the modularity of the brain, much more work would be needed to fully understand the extents of Gardner's theory on multiple intelligences. There is also no research that has been done on the effects multiple intelligence on groups. As the foundations of teamwork are becoming
increasingly important to organizational development, research should be done correlating a diversely intelligent team to various tasks. If Team IQ is a group of similar intelligence profiles and Team MI is a group of intellectually diverse individuals, then research can be carried out measuring the output of Team IQ against Team MI.

There is not enough peer-reviewed and academic studies and papers on the effects of EI on the group or team. Most studies are cited in this paper, but it is still unclear if adding an individual with high EI can improve the EI of the entire group. More research also needs to be carried out on the effects of emotional stressors on the group. What emotional friction can be controlled by management and does emotional friction affect high EI individuals less than low EI individuals.

6.2 Concluding Remarks

This paper has applied the positivist psychological theories on multiple intelligences and emotional intelligence to the contemporary organizational theories of contingency and the resource-based view of competiveness. Intelligence is still as difficult to define today as it was 100 years ago, but with developments in psychology, anthropology, and neurology; we have a much greater understanding of the human intellect. MI and EI have provided breakthroughs in expanding the paradigm. The firm can apply MI and EI to the firm through hiring practices and training to increase workforce capabilities and stabilize emotions. The contingency theory construct shows how such efforts will be effective in allowing the firm to better adjust to environmental contingencies. The resource-based view shows how such human capital improvements can equate to firm competencies and profits. This paper especially emphasizes how important and profitable it is to focus on well-rounded experiences in addition to traditional academic intelligences.

References

Information Technology 1
SATISFACTION OF INTERNET BANKING IN BANGKOK AND METROPOLITAN AREAS

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Abstract Nowadays the competition in the business world has been extremely high especially in service provider businesses such as banking, communications, hotels and restaurants, etc. Banking sector has been one of the business sectors that particularly changes by the uses of ICT to serve all needs of customers faster such as e-commerce and internet banking. In addition the convergence of technology now changes the scheme of transactions dramatically from walk-in windows to ATM and finally to “anytime anywhere any device”. The internet banking has then been the significant tool to serve this requirement. However to promote the use of internet banking several factors regarding to the quality of service are focused. This study has been focused on a satisfaction of customers’ transaction. The results provide some significant concerns that can be used to improve or fine-tune the service in achieving the customer relationship management goals.

Keywords: Internet banking; SERVQUAL; satisfaction.

1. Introduction

It can be seen that the growth of computers, internet uses and computer skills of consumers now significantly increase [20]. The computer and internet can be used to facilitate people in many aspects such as reducing working process, accessing the information and providing many services, etc. Noting that with these benefits a lot of (public and private) organizations have been changed or adjusted their business models by utilizing information and communication technology (ICT) capabilities to their processes. One of the organizations that use ICT to maximize their services and profits is commercial banks.

The main business transactions of commercial banks are usually done at the
front desks or windows of the banks which are limited due to the space of the bank office but these transactions can be trusted because the customers begin and finish their transactions at the windows. However with the use of internet, the transactions can be done remotely. Customers can process their transactions distantly via internet with any communication devices such as notebook, mobile phone, desktop computers or even tablets. The main problem is how customers can trust the transactions provided by internet banking.

Internet banking has been positioned as a new kind of service that provides an alternative method in doing the financial transactions. The characteristics of internet banking is an virtual financial transaction service which customers can do from anywhere anytime outside banking offices including of checking balance, transferring, payment, etc. that the commercial banks guarantee [4]. Now the internet banking has been dramatically grown indicated by the growth rate of number of customers [14]. It can be shown that this service helps customers save time and provide them the convenience; therefore, it impacts directly to the satisfaction of using internet banking. Moreover, since the factors toward using internet banking are convenient, security and ease of use, many banks offer different platforms of service to serve their customers and lots of them were unsatisfied causing the highly increasing churn rate [18].

In this manuscript the satisfaction toward using internet banking had been investigated. The results provide some significant factors and needs that can be used to improve the internet banking service.

2. Literature review

2.1 Internet banking service

Internet Banking is the financial transaction on a computer via internet. The customers can do the transaction anytime and anywhere if they can connect their computer to the internet [21]. There are six important services of internet banking i.e., account information, transferring, cheque, personal credit service, payment and funding [4], [22].

2.2 Customer satisfaction

Satisfaction is the level of personal emotion of any person or consumers causing by the comparison between Product’s Received Performance and Person’s Expectation [10]. If the consumers get a lower level of service than their expectation, they feel unsatisfied or they get satisfied and continue use the service in another way round. Moreover, the human motivation is categorized consecutively by the needs called Hierarchy of Needs [16] i.e., 1) Bodily Needs or
Physiological Needs, 2) Safety Needs, 3) Love and Belonging Needs, 4) Self – Esteem Needs, and 5) Self – Actualization, which the second needs (safety needs) is the key consideration of internet banking.

2.3 Service quality

The quality of service concept has been broadly investigated. One of the well-known models is so called SERVQUAL [17] describes that the perceived service quality came from the comparison the expected service to the perceived service. The result provided ten significant factors. However, in 1993 the service quality model had been constructed by [19] namely SERVQUAL which modifies the previous ten significant factors to five factors by using co-relational analysis and testing the reliability and validity of the model. The five factors include Reliability, Responsiveness, Assurance, Empathy and Tangibles.

3. Research Methodology

The SERVQUAL model has been used in this study. This model considers relationships among satisfaction and 5 factors of SERVQUAL in Internet Banking. Therefore the paper has focused on 5 factors affect to satisfaction. The research framework of this study can then be shown in Figure 1.

Fig. 1. Proposed research framework
H1. Reliability affects satisfaction of Internet banking.

H2. Responsiveness affects satisfaction of Internet banking.

H3. Assurance affects satisfaction of Internet banking.

H4. Empathy affects satisfaction of Internet banking.

H5. Tangibles affect satisfaction of Internet banking.

4. Data sampling and model testing

4.1 Data collection

The Quota sampling technique was used to collect the data. From the survey, 400 Internet Banking users who live in Thailand are our respondent. The respondents consisted of 57.2% male and 42.8% female, respectively. The participants range in age between twenty three and forty. The majority were in age 23-30 and 31-40. Around sixty percent had completed Bachelor degree while 37.5% had completed postgraduate degrees. A high percent of occupation (89%) were mostly officer, while others were 0.8-4.2%. The result described in Table 1 – 5.

Table 1. Sample statistics (Gender)

<table>
<thead>
<tr>
<th>Sample</th>
<th>Gender</th>
<th>Among</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Male</td>
<td>229</td>
<td>57.2</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>171</td>
<td>42.8</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>400</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 2. Sample statistics (Age)

<table>
<thead>
<tr>
<th>Age</th>
<th>Among</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 23</td>
<td>15</td>
<td>3.8</td>
</tr>
<tr>
<td>23-30</td>
<td>234</td>
<td>58.5</td>
</tr>
<tr>
<td>31-40</td>
<td>138</td>
<td>34.5</td>
</tr>
<tr>
<td>&gt;40</td>
<td>13</td>
<td>3.2</td>
</tr>
<tr>
<td>Total</td>
<td>400</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 3. Sample statistics (Education)

<table>
<thead>
<tr>
<th>Education</th>
<th>Among</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>High School</td>
<td>3</td>
<td>0.8</td>
</tr>
<tr>
<td>Diploma</td>
<td>6</td>
<td>1.5</td>
</tr>
<tr>
<td>Bachelor</td>
<td>241</td>
<td>60.2</td>
</tr>
<tr>
<td>Postgraduate</td>
<td>150</td>
<td>37.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>400</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Table 4. Sample statistics (Occupation)

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Among</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student</td>
<td>12</td>
<td>3.0</td>
</tr>
<tr>
<td>Officer</td>
<td>356</td>
<td>89.0</td>
</tr>
<tr>
<td>Government</td>
<td>12</td>
<td>3.0</td>
</tr>
<tr>
<td>Own business</td>
<td>17</td>
<td>4.2</td>
</tr>
<tr>
<td>Unemployed</td>
<td>3</td>
<td>0.8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>400</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Table 5. Sample statistics (Income per month)

<table>
<thead>
<tr>
<th>Income per month (Baht)</th>
<th>Among</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 10,000</td>
<td>35</td>
<td>8.8</td>
</tr>
<tr>
<td>10,001-20,000</td>
<td>54</td>
<td>13.5</td>
</tr>
<tr>
<td>20,001-30,000</td>
<td>128</td>
<td>32.0</td>
</tr>
<tr>
<td>30,001-40,000</td>
<td>97</td>
<td>24.2</td>
</tr>
<tr>
<td>&gt;40,000</td>
<td>86</td>
<td>21.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>400</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

The survey has 3 parts: population, service quality (SERVQUAL), and user’s satisfaction, respectively. For each question, respondents were asked to choose the response which best described their level of agreement with the statement. All items were measured using a 5 Likert scale, where 1 was strongly disagreed and 5 was strongly agreed. Of the 550 surveys, 416 responses were returned and thus the response rate was 75.64%. However, only 400 returns were useful and thus the response rate was 72.3%.

4.2 Questionnaire development

Measurements for SERVQUAL were adapted to Internet Banking services
context from [17]. The questions for measuring SERVQUAL were adopted from [12] and can be shown in Table 6.

<table>
<thead>
<tr>
<th>Construct Name</th>
<th>Number of Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliability (Rel)</td>
<td>5</td>
</tr>
<tr>
<td>Responsiveness (Res)</td>
<td>4</td>
</tr>
<tr>
<td>Assurance (Ass)</td>
<td>4</td>
</tr>
<tr>
<td>Empathy (Emp)</td>
<td>4</td>
</tr>
<tr>
<td>Tangible (Tan)</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 6. Summarize of model constructs

4.3 Refinement of SERVQUAL

From the 5 factors of Hypothesis namely, reliability, responsiveness, assurance, empathy, and tangibles, the testing of reliability and validity were performed. The Cronbach's alpha should exceed 0.7, which is acceptable (reliability = 0.877, responsiveness = 0.784, assurance = 0.896, empathy = 0.835, tangibles = 0.777 and overall = 0.936) [16]. These suggested a good reliability and convergent validity. The result is shown in Table 7.

<table>
<thead>
<tr>
<th>Construct Name</th>
<th>Cronbach’s Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliability (Rel)</td>
<td>0.877</td>
</tr>
<tr>
<td>Responsiveness (Res)</td>
<td>0.748</td>
</tr>
<tr>
<td>Assurance (Ass)</td>
<td>0.896</td>
</tr>
<tr>
<td>Empathy (Emp)</td>
<td>0.835</td>
</tr>
<tr>
<td>Tangible (Tan)</td>
<td>0.777</td>
</tr>
<tr>
<td>Overall</td>
<td>0.936</td>
</tr>
</tbody>
</table>

Table 7. Reliability statistics

To test hypotheses, SPSS for window is used to analyze the data. For testing relationship stated in the conceptual framework model in fig. 1, multiple linear regressions method is used with the level of significance 0.05.

From the hypothesis multiple regression analysis method had been used to inform the relationship between independent variance and dependent variance with Stepwise method. The result provided the effect of qualities to the satisfaction of Internet Banking. It can be found that Reliability, Assurance, and Tangibles affect the satisfaction of Internet Banking [3], [11]. Moreover, there are interaction between Reliability and Tangibles. As shown in Table 8, the results of factors affecting on SERVQUAL at p<0.05 with $R^2 = 0.528$ and $F = 112.403$, imply that those variables are significantly to increase or decrease the use of
Internet banking. Thus, the developing of Internet Banking should consider the use of all three variables which is consistent to the previous results on Assessment of employee' perceptions of service quality and satisfaction with e-business [12].

Table 8. Multiple regression analysis for SERVQUAL

<table>
<thead>
<tr>
<th>Factor</th>
<th>Adjust R²</th>
<th>Coefficient</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satisfaction</td>
<td>0.528</td>
<td>0.202</td>
<td>0.223</td>
</tr>
<tr>
<td>Reliability</td>
<td></td>
<td>0.225*</td>
<td>0.957</td>
</tr>
<tr>
<td>Assurance</td>
<td></td>
<td>0.570*</td>
<td>12.736</td>
</tr>
<tr>
<td>Tangible</td>
<td></td>
<td>0.250*</td>
<td>1.075</td>
</tr>
<tr>
<td>Reliability x Tangible</td>
<td></td>
<td>-0.031*</td>
<td>-0.529</td>
</tr>
</tbody>
</table>

*p<0.05

Noting that the variance of satisfaction of Internet Banking in this manuscript is only 52.8% indicating that there are other factors at 48.2% impacting on satisfaction of Internet Banking such as the ability to use technology and computers of customers [8], the capability of operator in the internet [2], factors of professional users and the selection of technological services [13], etc. Those can also reflect on the number of respondents, mainly office workers which is the majority of the respondents.

5. Discussion

In this study it can be found that assurance reliability and tangibles have positively impact with satisfaction of internet banking which agreed with [1], [7], [23]. Also there are significant relationships between reliability and tangibles factor. Therefore to achieve the satisfaction of using Internet Banking the organization should take an account for both Reliability and Tangibles together in consideration. The results of this study can be shown in fig. 2.

![Fig. 2. The adjusted research framework](image-url)
6. Conclusion

It is hard to tell the difference of Internet Banking features between each bank and this service is also non-face to face. However, by applying SERVQUAL for analyzing the satisfaction toward using Internet Banking, the results provide that Reliability, Assurance and Tangibles are the significant concerns to Internet Banking user. It is important that Internet Banking providers should serve basic requirement that users concern, consider new development and improve their service to achieve customer's goal the most.

It is recommended to retest the model since there might be other constructs affecting users' satisfaction. It will be valuable to explore those factors that affect the users’ satisfaction on Internet Banking. In addition the retest should focus on each factor for adopted with satisfaction in other business.

7. References

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How to utilize the new 4 P’s with e-marketing strategies

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Abstract. A lack of a comprehensive and integrated framework for managing customer’s experience, it remains challenging for e-marketers to effectively employ e-marketing tools. This paper proposes a formal approach to managing customer experience in electronic markets. We propose to expand the conventional 4Ps marketing mix model (price, place, product, and promotion) by incorporating four additional e-Ps including Push-pull-participative communication, Personalization, Promptness, and Privacy. We have further discussed how our framework can help e-marketers identify their customer experience strategies and e-commerce tools to implement e-customer experience management.

1 Introduction

The purpose of this paper is to examine existing marketing frameworks and propose a framework for customer experience management based on e-marketing concepts and related technologies. The paper is organized as follows: First, we present the foundation of e-marketing by briefly discussing the 4Ps model and its extensions. Next, we propose an electronic customer experience framework or e-CEM, and we discuss how to implement the framework.

Our motivation to develop the new 4 P’s model is driven by the rapid development of technologies. Internet commerce has become of age with smart technologies ranging from context-aware URL that seems to know who we are and from where we access the website to mobile apps on smart phone that can provide us helpful recommendation using location-aware technologies. As customers we expect “instant gratification” and enhanced personal experience, nearly 90 percent of companies surveyed by Forrester in 2011 say customer experience are their strategic priority and 76% seek to differentiate on customer experience.

Effective marketing is the management of individual customer’s experience. Each offer must be uniquely tailored for individual customer. Put it differently, instead of buying or receiving a product or service from a company, customers co-create the value according to their personalized needs and wants during the
life cycle of transaction from searching to after-sale feedback. The offer usually composes of products, services, and personalized experience from interactions with marketers at different touch points. The question is “how to better manage electronic customer experience?”

2 Foundation of e-marketing

Traditionally, marketers embrace the framework of marketing mix or 4Ps model to guide them in marketing planning. The model was championed by McCarthy (1978) who simplified a theory put forward initially by Borden (1964). The model postulates that a product or service is best marketed when marketer employ the right mix of product attributes, pricing, availability (place) and promotion, to the targeted market segment. The marketing paradigm of the time was that of “facilitating exchange” where transaction is the end goal.

The 4Ps was formulated in the mass marketing era to guide marketers in allocating marketing resources. It is product-oriented and relies heavily on the push method of mass media. Today’s customer expects a one-on-one relationship with service/product provider. To succeed marketers cannot rely solely on the marketing framework of the past era; they have to understand the interactive nature of electronic commerce. Evidences show that companies who know how to use the tools on the Internet to enable long term customer relationship will likely get more satisfaction, trust and repeated patronage from their customers. Responding to the new realities of electronic markets, the 4Ps framework has received several face-lifts. Notably, Kotler and his colleagues (1999) redefined the 4Ps into 4Cs as previously suggested by Lauterborn (1990): customer needs and wants replace product, costs to customer replace price, convenience replaces place, and communication replaces promotion (Figure 1). The discussion of the 4Ps and 4Cs frameworks is beyond the scope of this paper and such discussion exists elsewhere (e.g., Constantinides, 2006). However, it is worth noting that while the 4Ps framework is product-oriented the 4Cs framework is customer-oriented because it is formulated during the mass customization era of the Internet and it belongs to the customer relationship marketing paradigm. It incorporates the “pull” marketing communication methods of the Internet. The products and services are mass customized to fit the needs and wants of smaller segments of customers. It is a useful framework for e-marketing practitioners, but it also has some shortfalls that we will discuss later.

Besides 4Cs framework, several studies have attempted to address the lack of e-marketing framework (e.g., Kalyanam and McIntyre, 2002, Constantinides, 2002). Klyanam and McIntyre (2002) proposed an extension of 4Ps with 4Ps + P²C²S³ by adding (to the 4Ps) personalization, privacy, customer service, community, site, security, and sales promotions. Citing the diminishing role of
4Ps model and the lack of strategic element in 4Ps, Constantinides (2002) proposed the 4S web marketing model. While Klyanam and McIntyre's model is a good contribution to the 4Ps paradigm, it is very complicate and lack the strategy and metrics for practical implementation. The 4Ss model on the other hand is a good framework for managing web-enable business not particularly about e-marketing. Both models don't take into account the interactions among the components of the e-marketing mix, although Klyanam and McIntyre (2002) admitted that all of the new online components (P²C²S³) of their model are overlapping functions.

Existing frameworks of e-marketing that base on the 4Ps model do not adequately address the experience aspect of online customer. Furthermore, they have several operational shortfalls: (1) they share the lack of flexibility of the 4Ps framework in the sense that each of the components of the mix is presumed to be distinct, well-defined, and independent management process, there is no interaction among them; (2) they lack the interactivity aspects of today one-to-one online marketing; (3) they lack the consideration on privacy issues of online customers (except for Klyanam and McIntyre, 2002); (4) they treat customer experience secondary, because there is no time sensitive element in the model; and (5) they don’t discuss the strategic, controlling, practical, and technical aspects of implementing the framework in today online environment.

Thus, we propose a new framework to help online marketers to effectively execute their marketing strategies in the new reality of customer experience marketing paradigm, the 4e-Ps of electronic customer experience management (e-CEM) framework (Figure 1). We contend that, to deliver meaningful experience to today’s online customers, e-marketers should communicate with them using the combination of push-pull-participative methods to get to know each customer on a one-to-one basis. Therefore, the offers can be personalized according to the needs and goals of each individual customer and at the same time online marketers need to ensure that customers feel being promptly dealt with and yet they are in control of their privacy.

The contributions of our framework are: (1) it provides a simple communication tool depicting customer experience as the primary focus of e-marketing; (2) it bases on a unified marketing paradigm of our time and doesn't attempt to force fit the components into the old 4Ps paradigm; (3) it incorporates the time sensitive component of promptness and its interactions with other components; and (4) it provides practical guidelines for the strategy, for successfully implementing the framework.

3 e-CEM framework

Today’s market space of customers that expect “instant gratification” and “real time” services (McKenna, 1999) operates according to four important
principles of marketing: the exchange principle, the retention principle, the network effect principle, and the trust principle (Figure 1). The four principles are the pillars of today’s Internet marketing. First, the exchange principle dated back to era of mass marketing and early economic transaction theory suggests that entity engaged in a transaction for the meaningful exchange of value and the function of marketing is to facilitate the exchange. When applying to online environment in its optimal state, this principle stipulates that due the transparency of information made possible by the Internet and communication technologies, today marketers are able to match the customer needs and wants with an offer in every transaction. It results in an efficient and personalized match of the products and services at the perfect moment. Second, the retention principle, rooted in the relationship marketing paradigm suggests that retaining current customer is more cost efficient and profitable than recruiting a new one. For instance, according to McKinsey, a ten percent increase in repeat customers would mean a 9.5 percent increase in the corporate coffers (Mowrey, 2007). Thus, the aim is repeat business with cross-selling and up-selling of related products and services. To achieve this end, marketers must understand customers’ behavior online at the moment of transaction. Third, the network effect principle derived from Metcalf's law, stipulates that the value of a network is the function of the square of the number of individuals participated in the network. Coupled with the view that customers exist in a social context, this principle is very appropriate in today's cyberspace that is dominated by social networking technologies. Finally, the trust principle states that, customers only do business with online marketers that they trust. Due to the faceless nature of online commerce customers don’t always feel that they are dealing with a real brand and real people (Cyr, Hassanein, Head, and Ivanov, 2007). The four principles of online marketing constitute the driving forces behind the proposed e-CEM framework. Therefore, we depict them in a big arrow pointing to the framework.

![Figure 1: e-CEM Framework](image_url)

Despite the growth of online advertising, marketers did not fully harvest the potential of online marketing for three reasons. First, there is still a huge
disparity between the budget spending for online advertising and the percentage of actual time spent by customers online. Advertisers spend 6.9% of their advertising budgets on online media (MarketingProfs.com, 2011), even though online consumers spend 23% of their media time on the Internet (excluding the access via smart devices) according to a recently released analysis by eMarketer. This is what we mean by communication gap. Second, most personalized offers are considered irrelevant for customers. According to a study by IBM Coremetrics (2011) consumer attention continue to decline in terms of number of pages viewed per visit and time on site, suggesting that personalization gap is a major problem for e-tailers. Finally, although the customer satisfaction with e-commerce sites are in general high (around 80 percent between 2005 and 2006), the conversion rate is flat (between 2.4 percent in 2005 and 2.8 in 2007 according to Forrester, 2008). Conversion rate is the ratio between the number of actual orders and the number of site visits (Cutler and Sterne, 2000). This observation pertains to conversion inefficiency depicted in figure 1. To improve the communication gap, the conversion inefficiency, and the personalization gap; we propose the e-CEM framework that composes of four e-Ps (Bui, 2000).

(1) Use the combination of Push-pull-participative approaches to communicate with customers to get to know them in a one-to-one basis and to identify opportunities for designing new customer experience. The right combination of the three approaches of communication can bridge the communication gap and may lead to improvement in personalization.

(2) Personalization of products and services to minimize customer search effort and to optimize customer experience and improve the conversion rate.

(3) Ensure Promptness in web site responsiveness, delivering of products/services, returning the products, replying customer inquiries, service failure recovery. The key is to manage customer expectation toward the timeliness of services, one important ingredient of good customer experience.

(4) Appeal to customers’ fear of the lost of Privacy with policies, practices, controls and technologies to ensure that customer personal information is secured. Managing customer privacy properly can improve customer disclosure of confidential information and lead to better personalization (Hui, Teo, and Lee, 2007).

3.1 Push-pull-participative communication
The starting point and the cornerstone of the online experience management framework is how customers’ preference and needs is collected by using the balanced approach of three different methods.

The **Push** method involves preparing and sending personalized messages and offers to customers using e-mail marketing, banner ad, and other push technologies. For instance, Amazon.com sends personalized information to previous customers about special offer on Memorial Day, suggesting the title of books that are on discount and might be of interest to the customers. Note that, online customers' willingness to receive email offer has been declining. According to a survey by Forrester Research in 2000, only 44% of North American online customers thought that they received too many e-mail offers. In 2006 the rate rose up to 77%. However, 73% of customers still want to receive notifications of sales and promotions via email from their favorite retailer at least bimonthly (Forrester survey, 2005). Thus, there are still opportunities for online companies to communicate effectively with their customers using push method if they formulate their tactics appropriately. The content (can be dynamic) of the message and the media that company chooses to send the message to the customers are important. However, timing the message at the right moment is even more important in today’s e-mail spamming culture; to achieve this company need to take into account three-way interaction among Personalization, Promptness, and Push communication.

The **Pull** method of communication means information is stored in company’s database and customers initiate the communication process through one or many customer touch points to fetch information. The Pull method also involves the presentation of related information on the sideline while customers visiting a website. For example, YouTube displays related video links around the active one. Some call the sideline presentation of information as passive communication. The third method of communication is **participative** communication. Marketers participate in online forum and social media sites to have dialogue with customers. These are the emerging channels of communication resulting from the increasing popularity of social networking, blogs, and e-word-of-mouth media. According to Nielsen Netview Report, in 2010 Americans spend nearly one third of their time online on social media and blogs up from only 15.8 percent in 2009. Given the limits of push method of communication mentioning earlier and the ever-increasing population of social media users, marketer should pay special attention to participative communication, especially for young audience. Younger social media generation customers are more inclined to be conversationalists by posting updates on social network sites, tweeting, and participating in online forum to provide feedback on their online experience, according to a survey by Forrester in 2010.
3.2 Personalization

At its basic level, online personalization is tailoring a Web page design according to customer's behavioral needs. It is different from customization because, with customization customers pick and choose the features/components of products and services that they like while in personalization, companies use recommendation engines to design plausible configurations of products and services to their customers based on customer profiles or online behaviors. Personalization also includes methods of communication, pricing, and timing of an offer.

In the literature of recommendation systems, there are at least five different methods for personalization of recommendation (Kazienko and Kolodziejski, 2006). They are: demographic filtering, collaborative filtering, context-based recommendation, content-based recommendation, and simplified statistics approaches. Demographic filtering personalizes the recommendation based on customers’ profiles that either were provided by them or collected from other sources. Collaborative filtering uses recommendation engines to extract trends from the behavior of other site visitors and use that information to present suggestions to current customer based on behavioral similarities. For example, Amazon.com uses collaborative filtering to recommend books on the basis of purchases by other people who bought or rated similar items in the past. Some called this method “affinity selling”6. This method is good for customers who don’t have sufficient product knowledge. Context-based recommendation focuses on the similarity between the content currently viewed and the context of viewing. The recommendation engine generates the list of related items based on the viewing patterns and association rules between items. It is a good method for first-time buyers and for gift buying. Content-based recommendation focuses on the product attributes, textual descriptions, hyperlinks, related ratings. Items that are closest to the currently viewed items are recommended on an item-to-item correlation basis. This method is good for new products. Simplified statistics approach recommends products based on some statistical aspects usually popularity of the item (most popular) and average customer rating (top rated). This method is good for new user or for user that doesn’t have sufficient product knowledge.

Conversion rate of personalized product offers are low, according to a study by Forrester Research, more than 90 percent of consumers who were recommended the products or services on personalized sites turned down the offers (Forrester, 2003). Another study by IBM Coremetrics in 2011 showed that general conversion rate remains flat with only 5.2% for general population, 3.9% for mobile users, and 10.7% for social media users. Thus, there is room for improvement regarding personalization for conversion. There is no single personalization method works for every circumstance, studies showed that the personalization strategies that work are those that incorporate multiple methods.
for different customers and web visiting scenarios (Kazienko and Kolodziejski, 2006). Furthermore, the adoption of event-driven technologies and constant analysis of customer behavior are keys to success in personalization (Kalyanam and Zweben, 2005). The IBM data also underscore the important of personalization to mobile users.

3.3 Promptness

Promptness in delivering of products and services, reimbursing, replying customer inquiries, recovering from service failure are crucial for online marketers. According to a study by Oracle ATG in 2011, consumers are using multiple channels to research and purchase and 22% of customers don’t buy online because of the time constraints. Online customer expects minimal waiting times and ease of site navigation. Studies show that online customers don’t like to wait online for the Web page to load. They can tolerate around 10 seconds of delay according to Nielson (Nielson, 2007) while another study (Selvidge, Chaparro, and Bender, 2000) showed increased customers’ frustration with delay of 30 seconds. In terms of product delivery online customers have moderate expectation on the speed of the delivery of online retailers. In a study by Forrester Research, when asking: “for a typical online purchase with standard delivery, within how many days would you normally expect a package to arrive?” 59 percent of online shoppers expected three to five days delivery, while 32 percent expected six to ten-day delivery (Forrester, 2006).

Promptness is about managing customer’s expectation of how they will experience the delivering of products and services. Today’s customers expect website that they visit to be very responsive, easy to navigate, and clearly display the right information at the right places. Providing clear policies in shipping and handling, returning of products, answering inquiries are good practices for online businesses.

Because error is inevitable in the operations of online business, well-planned recovery tactics in place is very crucial. Promptness in service failure recovery is a key to customer retention. It can change customer outrage into customer delight by leaving the customer experience better off than before the error. It is five to seven times more expensive to recruit a new customer than to retain an existing one, according to U.S. Consumer Affairs. Customers need alternative ways to communicate with the company, providing toll free number, instant messaging, online chat room, and interfacing on smart handheld devices are some of the ways to provide the sense of presence while dealing with frustrated customers and regular customers alike.

3.4 Privacy
Customers used to be very generous in giving out personal information. However, today’s customers need justification in the form of receiving meaningful value in return or to be compensated for giving out such information. Companies have good reasons to collect customer information. It enables them to serve customer better by offering personalized products and services. (Hagel III and Rayport, 1997). However, personalization comes at a price, the potential lost of customer privacy (Awad and Krishnan, 2006). This has been one of the major problems that turns many online customers away from personalization and online shopping. For example, giving out financial information online was the number one reason not to shop online for North American customers surveyed by Forrester in 2005 (62 percent in general and 72 percent among senior shoppers).

Trust is critical in online privacy. Internet privacy practices, thus, are important to gain customer trust and they are also required by law. For example, in United States online companies must comply with the Fair Information Practices and other internet privacy requirements. The encouraging news is; customers are willing to give up some privacy if it can be made sure that the personal information improves their shopping experience (Hui, Tan, and Goh, 2006). What they want are controls over the giving and distribution of such information. Customers don’t want companies to sell personal data to marketers due to the fear of “spamming” and ID theft.

Among the four e-Ps of e-CEM, privacy is both insider-oriented and outsider-oriented; because, the policies, controls, practices, and technology infrastructure to achieve customer privacy must be clearly communicated in the company before dealing with customers. Privacy practices must be properly planned and managed because success depends upon the understanding and participation at every level of corporate governance. To protect customer privacy customer information must be secured from both outside intruders and employees. Security breach can do a lot of damage to a company’s brand. The privacy issue becomes even more important in the location-based services environment where customers’ every move is shared with service providers (Xu, Teo, Tan, and Argawal, 2009) as highlighted in the recent court cases against Apple and Google.

4 New 4P’s and Strategies

The e-CEM framework implementation should focus on four organizational levels reflecting different aspects of online business. In this paper, we discuss mainly on strategies, because they are marketers can take actions to fix the e-marketing issues.

Strategy involves defining and setting the corporate customer experience strategic goals around the four components of e-CEM framework and in alignment with overall corporate strategy. The four principles that we
mentioned earlier are the basic building blocks for the e-CEM strategy. For instance, exchange and retention principles guide the strategy to achieve the right mix of communication. This means company should not focus on push communication alone (to acquire customer or to increase sales). Retention principle focuses on personalized message to individual customer at different stages of customer’s life cycle (which bases more on participative communication). One-to-one dialogue is personal and addresses the specific needs of customers; it reduces the waste of time and frustration from the part of the customers. Thus, customer appreciation and trust is achieved. Embedding business rules/best practices into personalization strategy by using state-aware personalization engines (e.g. those who purchase more than 4 times are loyal customers) is the desired strategy (Kalyanam and Zweben, 2005). Based on retention principle, state-aware engines allow marketers to treat customers in different stages of their life cycles differently with different channels of communication and messages (Kalyanam and Zweben, 2005). Based on network effect principle, a company should use participative communication with customers who are mass connectors or mass mavens. Recent Airbnb fiasco illustrates this principle. By ignoring the complaints of a customer who is a blogger Airbnb, a vacation rental match-making service provider is forced to do damage control when the case spread from the blogger's posts to the mainstream media. Promptness strategy involves the resource-based management of customers’ expectation of promptness to delight customers. Privacy strategy defines the high-level privacy and security policies and generates the privacy and security practices for the enterprise. The goal is making customer privacy an enterprise-wise commitment.

5 Conclusion
We content that to better manage online customer experience we need a framework that take customer experience front and center. We proposed an electronic customer experience framework or e-CEM that composes of 4e-Ps: Push-pull-participative communication, Personalization, Promptness, and Privacy. We have further discussed how our framework can help e-marketers identify their customer experience strategies and technical tools to implement the framework. We also offered some examples of how to monitor and evaluate the effectiveness of e-marketing with tangible e-metrics.

References
How do Web events impede E-service use

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Abstract. One stream of IS research has focused on the effects of online incidents, including online waiting interruptions and service failures, on consumer behaviors. Many research has explore how web event such as long waiting time influences the use experiences. Yet, other web events have been identified with e-services users. In this study, we recruited 132 college students to report their experiences with negative web events. Content analysis was performed and the results show that long waiting time, server problems, web errors, network problems, and hacking were on the top of list where e-service users report their use experiences will be impeded. Practical implications are also suggested.

Keywords: Web event, waiting time, e-service, service failure, use experiences

1 Introduction

E-service or online service has enjoyed a broad adoption by online users because it is efficient to use and allows customers to use services (traditionally only available in physical stores) from the comfort of their home. For e-service providers, retaining customers with a customer-centric strategy is important. The intensified competition of online service providers and the decrease in exit barriers for customers to switch loyalty is only a mouse click away. With the recent popularity of online social-oriented systems, including blogs, social networking, and consumer review forums, as media for online customers to spread word-of-mouth and complaints, a better understanding of other post-adoption behaviors, such as word-of-mouth and complaint behaviors and their determinants is needed because findings can help practitioners engineer better online services.

One research stream in information systems (IS) is focused on the effects of
interruption and online waiting on consumer behavior (Nah 2004, Ryan and Valverde 2005, 2006). This research stream has substantially contributed to an understanding of online customer behaviors. Some web incidents delay, interrupt, or prohibit a smooth online experience. For instance, longer-than-necessary loading time, fail-to-load pages, and pop-ups are viewed as inhibitors to a satisfied online experience (Weinberg 2000, Ryan and Valverde 2006, Smith and Bolton 2002). These incidents are not expected by web users and they induce negative emotional reactions, which will lead a negative use experiences.

2 Literature review and research question
2.1 Web events and use experiences

Many research has been discuss how these web events have negative impact to successful web use experiences. For instance, a study on long waiting time of web use explores how long the waiting time is tolerable to users (Nah, 2004). A study explores the effect of waiting times on consumers' retrospective evaluations of Internet web sites in four computer-based experiments. Results show that waiting can, but not always, negatively affect evaluations of web sites (Dellaert and Kahn, 1999). It is desirable to provide a positive use experiences because that create a positive word-of-mouth (WOM) (Chea and Luo, 2008).

2.2 Online incidents: some examples

Waiting time, service failure, and recovery efforts have been prevalent in traditional service setting due to the nature of encounter in service consumption. Likewise, current literature also suggested that incidents also happen in the online environment; however, previous studies don’t always make clear distinction between these incidents that can be categorized into three types; online waiting, online interruption, and online service failure, based on the level of negative effects that users have experienced. First, online waiting is operationalized as download time. The foci include ‘how tolerable is the customer to the delay due to download time?’ (Dellaert and Kahn, 1999; Nah,
2004; Galletta et al., 2004); ‘how download delay affect the behavior of online customers?’ (Rose and Straub, 2001; Ryan and Valverde, 2006); and ‘how to manage user perception of online waiting?’ (Weinberg, 2000). Secondly, online interruptions refer to predatory pop-up offering, online customer survey, plug-in installation, and other undesirable unexpected events associated with the use of e-service (Ryan and Valverde, 2005). Finally, service failure refers to a more serious group of incidents which might include a situation where customer is totally denied from using a service, website don’t fulfill a transaction, or customer lose opportunity to do business. These have been happening in the financial e-service where time is critical, for instance, an online brokerage site fails to fulfill the transaction.

These incidents can stem from human errors (customer and service provider) or security breach on the site. E-consumer.gov compiled the complaint data from e-consumer from member countries found that top online violations includes merchandise or service never received 20%, other misrepresentation of product or service 17% and cannot contact merchant 10%. The impact of these incidents to the totally quality of the e-service is tremendous, it might influence customers’ level of satisfaction to the e-service, as if employees impact greatly by the work events. One thing worthy of noting here is that sometime customers do not attribute the causes of these incidents totally to the e-service providers simply because the e-services rely the Internet as the major delivering channel; these incidents may be external to the e-service providers. Thus, it is necessary to take into account of the customers cognitive responses while studying the affect that customers experienced with the e-services. Ironically, World Wide Web is often referred as ‘world wide wait’ (Weinberg, 2000) or ‘web rage’ (Eisenberg, 2002). Actually, not all waiting and interruptions are bad. While a form that pop up out of context might induce negative emotional experience, a pop-up asking for help by a live representative when customer seems to get lost have been identified as a preferable interruptive event. In some cases, delays are just random events that occur to everyone on the web. Customers do not atributable them to the
websites. For example, the Internet seems to be slow to a crawling pace at a certain time of the day. As long as users perceive that the incidents are not in the realm of control of the e-service providers, customer might be able to put up with them.

Yet, the incidents and web events have been fully investigated. We believe that there is great value for understanding these incidents and events for e-service providers to fix them, regardless internal or external, and provide remedies and solutions, and ultimately, to provide a positive use experience. This study attempts to investigate the web events that keep users from having a positive use experience. Our research question is:

What are the web events that e-service users perceive as a hurdle of their use experiences?

3 Method

Focus group method was performed. Participants were recruited and given instruction to report their experiences with e-service use. These e-services rang from banking, airline ticketing (travelocity.com), social networking websites, online media, to intelligent interactivity in post-sales product support. Participants were students who enrolled in a 300 level IT course at a major Taiwan university. A total 132 responses were collected. They were asked to discuss their web use experiences and noted down the web events that they have encountered on a form. They self-reported the web events and noted down whether these events were internal/external locus, controllable/uncontrollable causes, and stable/unstable.

4 Data analysis and results

We performed content analysis and generated top 12 web events that impede e-service use. Participants mainly report web events that keep their use experience less successful. Table 1 shows these web events:

Table 1. Web Events List
<table>
<thead>
<tr>
<th>Ranking</th>
<th>Online Events</th>
<th>Counts</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Waiting</td>
<td>80</td>
<td>62.50%</td>
</tr>
<tr>
<td>2.</td>
<td>Server Problems</td>
<td>78</td>
<td>60.94%</td>
</tr>
<tr>
<td>3.</td>
<td>Web Error</td>
<td>66</td>
<td>51.56%</td>
</tr>
<tr>
<td>4.</td>
<td>Network Problems</td>
<td>65</td>
<td>50.78%</td>
</tr>
<tr>
<td>5.</td>
<td>Hacking</td>
<td>64</td>
<td>50.00%</td>
</tr>
<tr>
<td>6.</td>
<td>Exploring Interface</td>
<td>61</td>
<td>47.66%</td>
</tr>
<tr>
<td>7.</td>
<td>Application Errors</td>
<td>58</td>
<td>45.31%</td>
</tr>
<tr>
<td>8.</td>
<td>Advertising Flood</td>
<td>57</td>
<td>44.53%</td>
</tr>
<tr>
<td>9.</td>
<td>Information Errors</td>
<td>53</td>
<td>41.41%</td>
</tr>
<tr>
<td>10.</td>
<td>Login Problem</td>
<td>42</td>
<td>32.81%</td>
</tr>
<tr>
<td>11.</td>
<td>Virus Infection</td>
<td>36</td>
<td>28.13%</td>
</tr>
<tr>
<td>12.</td>
<td>Missing Letters</td>
<td>12</td>
<td>9.38%</td>
</tr>
</tbody>
</table>

Results of content analysis show that long waiting time (62.50%), server problems (60.94%), web errors (51.56%), network problems (50.78%), and hacking (50.00%) were on the top of list where e-service users report their use experience will be impacted. In the following paragraphs, we describe each type of web events in greater details.

1. **Waiting Time**

“Waiting Time” category includes three event types: 1) waiting for web pages to open; 2) waiting for the response of online customer service; and 3) waiting for the updating web contents. “Waiting for web pages to open” is
the web event that reported by most of respondents, and the rest two are “waiting for the response of online customer service” and “waiting for the updating web contents”.

“Waiting for web pages to open” refers to the time that Internet user have to spend on opening a web page; “waiting for the response of online customer service” refers to the waiting time that starts from sending requests for help to service providers to a satisfactory solution for their problem was received. “Waiting for the updating web contents” only occurs for blogs or some website with the functionalities of providing information for Internet users. Users’ purpose of visiting these websites is to get the information, so they will take into account the website’s speed of updating information.

2. Server Problems

There are three web events included in the category of “Server Problem”: 1) server down; 2) web maintenance; and 3) data processing error. Majority of respondents found “server down” and “web maintenance” having great impact to them whereas few of them chose “data processing error” were the web events that bothers them.

Both of “Server down” and “web maintenance” refer that Internet users cannot connect web pages because the servers have been closed. The difference between these two events is whether the users are informed or not, if yes, most of them are in the category of “web maintenance”; if not, these events are “server down”. The causes of “server down” are mainly because of overload of the network traffic.

“Data processing error” only occurs for online game players, most of them have many kinds of these experiences. When this event happened at the server-side, players may face some loss on their properties of their online game characters.

3. Web Errors
“Web Errors” category has two event types: 1) address error and 2) browsing error. These two events occur because of similar reasons. “Address error” refers web pages cannot be opened successfully and results a message or a blank web page to Internet users. In contrast, “browsing error” refers to the situation that the web page can be opened but it cannot work smoothly. For example, certain functions of web pages cannot work or garbled pages appear.

4. Network Problem

Under “Network Problem” category, all the events related to the disconnection of internet service, most of respondents indicate that the problem may come from ASP service providers.

5. Hacking

“Hacking” includes three event types: 1) disclosure of personal information, 2) malware, and 3) account theft. These two events occur because of similar reasons. “Disclosure of personal information” refers to Internet users’ personal information is given by the website or is revealed because of hacking attacks. “Malware” refers that some web pages will force the installation of malware to Internet users, and that damages users’ computers. The problem of “account theft” often happens in the portal website (such as yahoo) and online games.

6. Exploring interface

Under “Exploring Interface” category includes two event types 1) unfamiliar with the interface and 2) unsatisfied with the interface. These two events occur because of similar reasons. Both of “unfamiliar with the interface” and “unsatisfied with the interface” refer that the functions that online service provides cannot be operated smoothly by users. This may due to the lack of experience with the websites or the design of the website is too complicated to use; this kind of events are called “unfamiliar with the interface”. On the other hand, when only little functionality are provided by
online services where not all the requirements from Internet users are supported, users are not satisfied with the online service. These kinds of events are called “unsatisfied with the interface”.

7. Application Errors

“Application Error” includes all the events related to the abnormal browser problems which are caused by application programs. This may happen from both the server-side and the user-side. For example, the server-side may force Internet users to install specific software so that they can browse web pages or run the online service correctly.

8. Advertising Flood

“Advertising Flood” category includes all the events related to online ads, such as fake website, spam, or pop-up windows. Those ads always make Internet users uncomfortable.

9. Information Errors

There are two types of web events under “Information Errors”: 1) fake information and 2) information asymmetry. “Fake information” refers to web pages or online service providing wrong information or incomplete information to Internet users. “Information asymmetry” refers to the information that web pages or online service are not enough to make all the Internet users understand the information at the same level, this kind of event occurs mostly in auction websites.

10. Login Problem

“Login Problem” refers to all the events related to unacceptable service request caused by login process. For example, Internet users may forget their accounts or passwords so that they cannot login successfully. Or, their accounts may be pended or removed by the websites because the accounts have not been accessed for a long time. Few respondents reported that they are not
happy with websites services that to pay for memberships.

11. **Virus Infection**

“Virus Infection” includes all the events related to the web pages that maliciously distribute virus to Internet users’ computers.

12. **Lost Emails**

“Lost Emails” includes all the events that the mail servers fail to deliver emails to users’ accounts. A common situation is that some emails are not spam (such as registered emails) but the mail servers regard it as spam, and that causes the event of lost emails happen.

5 **Discussion**

In this study, we identified 12 major web events that impede the success of web services. Waiting time is the most serious problem with online service provision. Further research addressing the affective or cognitive process behind consumers’ evaluations of and expectations for web events such as waiting times would also be valuable. Our study indicates that if managers can effectively communicate that waiting times or other web events well, users’ negative feedbacks will be reduced in future services, users generally will be able to account for this change in their decision calculus and their expected utility for the internet service would not be biased by previous experienced waiting periods or negative web experiences. Further research would help to indicate which communication strategies would be most effective for such a purpose. Specifically, we found that waiting or other web events need not have a negative effect on consumers’ retrospective evaluations of internet web sites if these problems are well managed. We conclude that if uncertainty about the waiting experience or other web events is reduced and countdown and/or duration time information is provided, consumers can retrospectively evaluate the web material independently from their frustration with the waiting time or other web events. In addition, if waiting times are
other web events are significantly shorter than expected and well-managed, and if the waiting occurs in expected positions, the negative carryover effects of waiting experiences on subsequent internet web sites are minimal. E-service providers therefore will be able to provide better web experiences to users.

References
Information Technology 2
Problems with inter-organisational Information systems: a case study from a United Kingdom training organisation

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Abstract: The movement of organisations away from standalone activities to one of being embedded within a network of organizations has received a lot of attention from a range of fields of endeavour. Areas of increasing interest for information systems have been how to develop and maintain the inter-organizational information systems (IOIS) needed to support the inter-organizational processes which run across networks. This paper uses a case study involving three organizations to explore the issues associated with IOIS.

1. Introduction

For the past three decades there has been a growing body of literature focussing on the movement toward networked organizations from a variety of perspectives. For instance, in marketing, (Lusch, and Vargo, 2011), sociology (Burt, 1992 and Granovetter, 1985), strategic management (Dyer and Singh, 1998 and Gulati, Lavie and Singh, 2009) supply chain management, (Choi and Wu, 2009) and information systems (Golden and Powell, 2010). Despite various researchers approaching the topic of networks from different perspectives, all seem to agree on the important role played by collaboration among the various actors. The most common reason being that collaboration in inter-organizational networks is foundational to the ability of organizations to achieve their goals in complex and uncertain environments. To achieve these goals, organisations have to increasingly depend on their networks of
relations with other organizations, rather than on their capacity to act independently and rely solely on their internal resources (Hult, Ketchen and Arrfelti, 2007; Lavie, 2006; Wagner, 2006). The actions which sustain collaboration include sharing information, synchronizing decisions, aligning performance goals and measurement, and integrating innovations (Simatupang and Sridharan, 2005).

Most modern organizations have invested heavily in information technology in order to better retrieve and share information in a timely manner. The supply chain literature in particular has stressed the importance of having in place systems that can share information across organizational boundaries in a timely manner. The tacit assumption appears to be that although these systems were developed in separate organizations, it is relatively unproblematic for them to come together and share their information in a meaningful way to the entire network (Johnston and Vitale 1988; Dyer and Singh 1998; Kaushik 2009).

Despite this impression often given that these inter-organizational information systems (IOIS) are unproblematic, information exchange between organizations is often times not that simple with technical problems such as integration and common standards and social problems such as communication and governance issues prompting the comments that IOIS are “still far from effective” (Ravarini, Pigni and Buonanno 2005, p1) and “prone to abandonment and low levels of adoption” (Rodon, Sese and Christianse 2011 p 223). However IOIS have also been used to improve business outcomes and perhaps the most famous is the American Airlines SABRE reservation system (Norby 1961), which is now used by a large number of travel agencies and airlines worldwide.

Williamson (2007) suggests that success is, in part, dependent on the level of information systems maturity between organizations and she provides categories of maturity ranging from elementary to intermediate and advanced (Williamson 2007). Organisational factors such as barriers from business partners, costs, lack of standards and managerial commitment also play a role in the success or failure of the IOIS (Williamson 2007).

Emberson and Story (2008, p2) suggested that a “multi-level analysis in furthering understanding of the complex relationships between processes of network and individual learning” was important and that exploring (in their case) “buyer-supplier relationship structures” was vital in order to understand how as they coined it “network learning difficulties” occurred (Emberson and
Story 2008, p2). It is this social dimension within the context of an elementary inter-organisational information systems environment that we focus this research on.

2. The Case Studies

This paper looks at the relationships that exist between three organisations associated with training in the United Kingdom (UK) and how the use of information systems at an inter-organisational level has caused concern and misunderstandings between individuals across all three organisations.

The paper uses a case study approach to identify problems that have occurred in a UK training facility through misunderstandings and confusion through the use of non-aligned, incompatible information systems. This misalignment may be consistent with the organisational factors associated with technical maturity and managerial commitment as outlined by Williamson (2007), but we also consider that relationship structures as outlined by (Emberson and Story 2008) could also be an important factor.

The training organization (referred to as DOT in this paper to preserve anonymity) is a university based training centre supplying post graduate training and degrees in conjunction with a large UK department (DEPT). DOT will be the focal organization. The second organization (SERVICE) has a service role for the DOT and provides the basic computer infrastructure for some of DOT’s operations as well as faculties such as offices and catering. The third stakeholder in this inter-organizational study is the DEPT who owns the buildings and land and has a long term contract with SERVICE. SERVICE is accountable to DEPT, but not directly with DOT and this is a source of tension that plays a part in the communication problems we will outline further in this paper.

3. Method

This research will use an interpretative case study approach (Klein and Myers 1999, Walsham, 1993) to provide insights into the social interactions that have occurred with respect to inter-organizational information systems (IOIS) in the three organizations described in the following paragraph. The case study approach (Stake 1995; Yin 1994) was selected and qualitative methods were used as the investigation centered on exploring initial reactions
to the use of IOIS and to investigate how stakeholders in one of the organizations perceived the use and effectiveness of these systems. As we were concerned with social and organizational rather than technical issues, the case method (Stake 1995; Yin 1994) was considered highly appropriate for our purposes.

This study is conducted from DOT’s perspective and all interviews were done through DOT staff, therefore the unit of analysis for DOT is lecturers and managerial staff providing direct support to the primary DOT function of education and training. Semi structured, face to face interviews were conducted with key staff and their thoughts on the usefulness of the IOIS were sort. All interviews were guided by a protocol, involving ethics approval and a sheet of “starter” questions. The average length of time for each interview varied from 23 minutes to approximately one hour.

Thematic analysis was conducted using the software package Leximancer (Leximancer manual 2005) and major themes were extracted and these are shown below in the results section. The “starter” questions asked were as below;

1. Right now in your present position, can you comment on the inter-organizational information systems used at DOT?
   a. Is there anything wrong with them?
   b. Can you think of ways to improve them?
2. What is your experience with TimeO? (a time management recording system)
3. The finance system?
4. Other systems?
5. Do you think the three organizations work well together?

4. Results

Thematic analysis of the interviews revealed that there was a degree of concern and discontent with much of the interaction within and between IOIS. Thematic analysis identified several themes, including a lack of feedback for financial systems, a lack of feedback for health and safety issue, a lack of education and training in the need for and use of existing systems and a lack of integration in timetabling. These results tend to confirm the overarching
question with respect to IOIS at DOT; namely “Who owns the system and who do we report to about problems with the system”?

4.1 Lack of Feedback – Financial systems

Interviews were conducted with the Deputy Director of DOT and four lecturers who provided educational content. Excerpts for the interview with the Deputy Director are shown below.

When asked a follow up question - We have a minimum of three organisations trying to work together. Do you think their information technology systems integrate that well? The deputy director of DOT had concerns about the financial system and how the lack of feedback was particularly problematic for him.

Financial systems are an example where the financial information is entered and stored and managed by a separate finance department for which we don’t have access to that information so our relationship with that department is that we will give them information totally unformatted or random format there are no forms that we tend to fill in they will then translate that into their spreadsheet store them. Then [they] give us a printout which is designed to suit their purposes and not necessarily designed to suit our purposes in managing the team here [in my position at DOT] We are going through a process whereby we are going through the budget for the next year which starts in August 2012.The finance department have produced an outline spreadsheet which is very coarse in the way that the data is presented so we have short courses that we budget so much – then they ask us “does that look OK?” and we don’t know what assumption underpin that particular number what courses are included [and] what the associated risk of these courses. Does it include courses that are 100% certain to run or does it include aspirations and to what level so our interpretation of that can be difficult – it could also mean that other department’s interpretations can be different to ours which means that they’re not getting a good picture of what our financial situation is and as a result we are not getting the right
information in which to manage our activities to best effect to deliver the financial performance targets of [DOT]. [Deputy Director of DOT]

This is an example of the frustration expressed about systems lacking in feedback capability. When asked for a solution, the Director’s answer (shown below) was to make the assumptions about the management systems more clear, yet this apparently simple solution is extremely difficult to implement because there are no clear owners of the system or complaint mechanisms back to SERVICE. Again the deputy director of DOT offered this simple yet elegant solution to the problem. However the solution is not easy to implement because of the main question with respect to IOIS, namely “Who owns the system”? And “Who do we report to with respect to improvements in the system”?

Question - **So what could be a solution to that do you think?**

A solution is making sure we capture the assumptions anything when it comes to risk, performance management, planning scheduling estimating is to capture your assumption. So I suppose we should have access to a common form we can add stuff to that they can add stuff to it and we both have visibility and for comment on those assumptions and that can then be used to manage the risk. We haven’t got those processes in place at all at present. [Deputy Director of DOT]

When further pressed with regard the implications of this solution not being incorporated into the IOIS, the deputy director’s response to the following question is as below.

Question - **Could that be a precursor for you developing systems outside their system?**

Well what are doing at the moment is we sort of reverse engineer their spread sheet and tend to second guess them so we capture our own assumptions and create our own spread sheet – when they send us their outputs we compare one with the other, identify deltas between the two and then have to somehow identify why there are deltas. What are the differences in the underpinning assumptions? This is very wasteful because we are duplicating work which we shouldn’t do if we had the right
processes to capture the right sort of information in the first place [Deputy Director of DOT]

4.2 Lack of Feedback – Health and safety issues

The lack of feedback with the financial system was not the only problem with a similar situation occurring with repairs provided by SERVICE with respect to health and safety issues. For example the deputy director of DOT outlined the process for getting repairs done.

Yes and an example of that we have a focus now on health and safety so there is a push at the moment to improve health and safety performance but that is dependent on us working closely with the DEPT and in particular SERVICE the facilities manager for example if we identify a safety issues here we have to get SERVICE to rectify that but we haven’t got a commercial relationship with them. There are processes in place but we haven’t got any commercial levers to enhance or improve their performance. In terms of systems and processes we are trying to up skill our processes so if we identify a particular safety issue here we can raise a safety report which goes from here to our safety manager who then passes it to SERVICE. [Deputy Director DOT]

However the Deputy Director indicated that there was no feedback loop to indicate if the repairs were completed. The IOIS apparently failed to provide the vital information required.

One would hope that SERVICE will at some time come down to rectify that particular issue. What we have discovered I, we don’t know whether it is working and one reason is we don’t get feedback. So effectively it is a black hole. We produce a safety report (a stair tread needs fixing – for example) Then it starts working its way down the workflow and we lose track of it. So we don’t know one week later has it gone missing, has it been done yet or is it 5 days overdue and should have been done 5 days earlier? So we have got open loop systems at present and we have to move from that to a closed loop system so when you put stuff in we are getting feedback on when it is done. Particularly with safety (it is always important anyway) but now
there are legal aspects attached to that Duty of Care – if we are in a building and identify a problem we have to make sure that issue is raised and we have to make sure (even if it is not our direct responsibility) to rectify that issue. We have to make sure that action is being taken if you don’t get the feedback then you don’t know if the action has been taken so that is one of the issues I see between us and SERVICE.

4.3 Lack of Education and training – The time recording system (TimeO)

A time recording system called TimeO (not its real name) was mandated by the DOT and each individual academic was required to enter time data, although little was known as to why this was required and how the data was to be entered and what it was to be used for. This immediately evoked a degree of suspicion as to the true motivation of its output by DOT headquarters. The official definition of TimeO was “A system used by the University to manage staff time recording and procurement activities”. However it is treated with a degree of suspicion and caution as one lecturer said when asked about TimeO replied.

Firstly that information that went into what went into the construction of the cost is not disseminated effectively. So if I am doing a course no one tells me how many days or hours I have allocated to [cover] my contribution so I don’t know how to fill in the form as a result of this everyone does this bit in a different way [Lecturer one DOT]

The Deputy Director appeared to be clear about the purpose of the TimeO system;

One area that is critical is the [TimeO] time recording because as time goes on and things develop. We are very much dependent on that for the transfer of money from the different cost centres for what we do for other departments and for what other departments do for us. When a new bit of work comes in and a contract is placed with us it is given a job code and various elements of work will included in that based on the way the cost was structured in the first place (x days design, y days delivery) and things like that.[Deputy Director of DOT]
However he was very cognizant of the shortcomings of the system and also admitted that;

*it [TimeO] is a clunky system and difficult (unless you are an expert) to access it to get the information off.*[Deputy Director of DOT]

Confusion was also expressed as to the reason for the system and the apparent lack of clear guidelines from another lecturer.

*And so many people have got different answers then other people find different ways of using or abusing the system or apparently complying so I don’t know – you can literally copy last week’s figures down for this week. I know of other people who just delegate that job to a secretary – I personally use an Excel spreadsheet because I have 77 different codes. I put it into a spreadsheet which allows me to keep the record because the centralised system won’t let me get the record or not at least without a lot of fuss and then I transcribe it from one record on to [TimeO] which still takes long enough there are all sorts of issues about that, but the confusion about what’s required*[Lecturer two DOT]

This is another example of a lack of understanding of the need for the system or of its usefulness for that matter. For example lecturer two also indicated that (with respect to TimeO);

*Is it there to accurately cost activities? They claim it is but if the information is not accurate? You are not accurately costing anything so it is a waste of time and sometimes you say sod it I will just put down what I think because there is no respect for the system – there is no appreciation of what it is or could do and they just improved it and it is even worse than ever now.*[Lecturer two DOT]

Another Lecturer also expressed dismay and could not understand the reason for the TimeO system;

*When I arrived here there were 3 time recording systems on was called track another called [TimeO] and a third one, but we had to record our time; time spent teaching, time spent doing research, time spent doing other things and it was an open ended sewer as we put all this data in but nothing ever came out*
to say what the answer is. No explanation – the reason we are taking this data is for your benefit or not. But even now (I have been here 6 years) I still have no idea who uses the data and for what purpose [Lecturer Three DOT]

The same lecturer described how he simply “gave up” and put his times into an Excel spreadsheet and presumably re-enters it when asked to by management.

Why did they have those three systems in place when no one is going to use them? I have no idea I gave up – if you stop using it then someone should come around and tell you why it is important – the purpose of it was for some external body – fine what do they do with it? Answer “not sure” how does it affect me? – “not sure” so I stopped doing it. I put my time stuff into an Excel spread sheet. [Lecturer Three DOT]

4.4 Lack of integration in timetabling

Lecturer four at the DOT described a situation that emphasises the lack of integration of resources by three bodies (customers) within DOT.

in theory there is only one customer but for me there has been 3 customers really all of whom think that their courses have priority and that is the person over in [name withheld for anonymity], the other person from [name withheld for anonymity] and then there is the staff college and I suppose that is a person as well and for me it has frustrated me immensely. I have to struggle to be in three places at once and it is because they all manage their programs independently. [It is] one of us and 3 of them and each one thinks they should be able to structure their program to suit their requirements. They would plan their courses and simply send me the program and I said hang on a minute, I haven’t even been consulted. I checked with them and asked on what basis they plan their program and there answer was room availability. I replied, you may have the right room but if there is no one to run the course, you may as well not bother.[Lecturer four DOT]
A well-integrated IOIS here would have provided a timetable that reflected staff availability as well as room availability and this was all that the lecturer wanted. Timetabling software can be easily used and the IOIS did have a site licence for the timetabling software package CELCAT (CELCAT 2012). This, according to their website, is “a leading timetabling product for Universities and Colleges throughout the world”.

Perhaps the lecturer and the three other customers did not know of the existence of CELCAT or maybe it wasn’t used to its full potential. This problem was revealed to the researchers through the interview with lecturer Two (DOT).

We have a timetabling system called CELCAT but I only look at CELCAT when I am doing a course that is on the academically provided contract which seems to be the only stuff that ends up on CELCAT.

It could very well be that a lack of communication has resulted in a perfectly good software package that could have provided a useful solution was overlooked. This could not have been a limitation of the software as its basic product (Timetabler) can “be used across any sized institution - from a single college department to multi-site universities” (CELCAT 2012).

5. Discussion

Hult et al (2007) suggested that for IOIS to be effective, organizations need to depend on each other rather than rely on their own resources. This research has highlighted a problem with DOT and their interactions with SERVICE in so much as both parties appear place more reliance on their own systems than attempting to negotiate with each other in a networked way. The actions that form effective networks such as collaboration with respect to sharing information, synchronizing decisions and aligning performance goals as outlined by (Simatupang and Sridharan 2005), do not appear to be happening judging by the results of this study.

The main problem at this stage of development of all three organizations appears to be a lack of communication or even a desire to communicate and perhaps this is a reflection of the chain of command in which SERVICE is accountable to DEPT while DOT can only make improvements through discussions with DEPT which are then feed down to SERVICE. In reality, many of the problems with the IOIS described in this study could be easily
solved within a single organisation, for example the problems with the financial spreadsheet which led the deputy director of DOT having to “reverse engineer” in order to “second guess” what was required. The “reverse engineering” approach is particularly problematic for multitude of reasons including the dangers of second guessing requirements and losing vital context. This problem is perhaps indicative of a lack of integration of IT between different organisations and a function of the technical immaturity of the present systems in the DOT/SERVICE/DEPT inter-organizational environment. It may well be that this IOIS is at what Williamson (2007) terms the elementary stage of development. However given the modest demands of such a system, we suggest that the problems could be more social in nature with relationship structures as described by Emberson and Story (2008) being at a level whereby the connections between the processes of the IOIS and an individual’s learning about the system has not advanced sufficiently. This is exemplified by the examples of a lack of feedback from both the financial system and the health and safety duty of care requirements.

The central problem within this IOIS appears to stem from the confusion over ownership of the system and the pathways available for constructive feedback of system performance and even data feedback within the system itself. These appear to be more of a social problem through a lack of communication between SERVICE, DOT and DEPT about the assumptions that inform their systems and a lack of ability for DOT to complain directly to the service provider. The technical issues with the systems in use should be relatively simple to overcome once all three parties are able to communicate effectively as the demands from the various stakeholders are modest. For example Lecturer four just wanted a timetabling system that would allow for all three customers to be aware of his time constraints, not just the room constraints for each customer and as it turns out a suitable product (CELCAT) was available, however it was only used for “academically provided contract” courses. Discussions could have been initiated between relevant stakeholders to enable them to use CELCAT had they known of the existence of the software.
6. Limitations of this study

This study has limitations in that it was small scale and not generalizable. The interviews were only conducted with staff from DOT and interviews with staff from the other two organizations will need to be conducted before specific solutions can be canvased.

7. Conclusion

The requirements of the IOIS at DOT appear to be relatively straightforward in that they do not require the introduction of and complex systems. As existing systems are fit for purpose, the problems appear to stem more from a lack of communication between each organisation. This poor communication pattern results in inefficient systems that force people to “second guess” what is required or attempt to work in situations whereby the intent and even the operational aspects of standard data entry within the system is unclear. It is suggested the research be conducted into inter-organisational communication strategies using the multi-layered analysis approach advocated by Emberson and Story (2008) to ensure a smoother running of this relatively simple IOIS.

References

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Uncertainty and online information seeking

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Abstract. Kuhlthau’s Information Search Process stage (ISP) model was developed in the context of information retrieval with library users. In this model information searchers experience different stages and ultimately complete their information retrieval with end results. This study intends to understand whether Kuhlthau’s ISP model can be applied in Internet search. There are two phases of collection. In phase one, data collected from 30 searchers suggested that the ISP model was applicable in studying searchers’ information retrieval behavior in simple tasks. However, searchers’ emotional responses differed from those of the ISP model for a complex task. In phase two, bilingual users will be recruited and survey method will be performed with appraisals, behavior, and outcome measures. In phase one, we found that search engines have multi-language search functions can provide an advantage for bilingual searchers in the Internet’s multilingual environment. Results of phase two data collection will be presented at conference.

1 Introduction

As business becomes more international and global, a large percentage of software developed in a country is exported to other countries. Internet applications produced by U.S. companies are sold overseas and there is a need to develop Internet applications for international users. Web technology enables language identification and machine translation by leading search engines. Search engines are international information retrieval tools. There has been little research on what searchers in the large Internet population are experiencing in the Web’s multi-language environment.

In this study, we examine Internet searcher’s information retrieval behaviors by applying Carol Kuhlthau’s information search process (ISP) model that was developed and tested with library research tasks. We intended to determine whether this model could be applied to better understand the Internet search process. In the ISP model, affect and uncertainty play significant roles in the search process. We discuss the presence of these emotional states in the six ISP. By testing searchers using English or another language in conjunction with English to construct searches we aim to gain insight into multiple language searching. In computer-mediated communication (CMC)
environment, bilingual searchers need to take into account many factors and most researcher believed that uncertainty play a crucial role of information search, we therefore would like to investigate how uncertainty has impact toward three aspects of information seeking. Three specific research questions of interest are as follows:

Q1: To what extent can the ISP model be applied to Internet search?

Q2: What affective experiences do searchers have in Internet search during complex and simple tasks, and when using English only or Combined-language strategies?

Q3: How uncertainty has impact to appraisals, behavior, and outcomes of bilinguals’ online information search?

We intended to see how Kuhlthau’s model can be applied in bilingual searchers’ task success and how uncertainty play role in the process. Three major concepts of concern are: appraisals, behavior, and outcomes. The idea follows Ramirez et al.’s (2002) study on information-seeking strategies in the CMC environment. Our attempt of understanding bilingual searchers’ experiences can go further step to advance uncertainty literature.

2 Literature review

2.1 Model of the information search process

Carol Kuhlthau (1993) proposed a six-stage model of the information search process (ISP). The model has been widely applied and tested in information retrieval especially in the field of library and information science (Wilson, 1999) and Internet information retrieval (Shamo, 2001). The most notable aspect of the ISP model is that Kuhlthau included the feelings, thoughts and behaviors of student researchers. Ideally, we begin to search for information because we want to know more about something that is necessary, interesting or troubling. As a result, the motivation to seek information arises naturally out of a person’s own experience.

The information search process model incorporates three human realms common to each research stage: the affective (feelings), the cognitive (thoughts), and the physical (actions). The six stages are Initiation, Selection, Exploration, Formulation, Collection, and Presentation. Each stage presents a task that a researcher conducts. In several longitudinal and large-scale studies, it was found that searchers go through a number of different feelings as they proceed through the stages including uncertainty, optimism, confusion, frustration, doubt, clarity, sense of direction, confidence, relief, and satisfaction or dissatisfaction. Searchers’ thoughts change from ambiguity to specificity
and their interests increase. Their actions move from seeking relevant information to seeking pertinent information. Figure 1 shows the connection between the stages of the information search process and library researchers’ feelings, thoughts, and actions (Kuhlthau, 1993).

Kuhlthau’s ISP model is recognized as one of the most frequently studied and cited models of information-seeking behavior in the field of library and information science. She is a pioneer known for recognizing that affect cognition (C), and actions (S, sensorimotor behaviors) are integrated in problem-solving activities. Kuhlthau’s information behavior research approach examines affective, cognitive and sensorimotor information behaviors holistically and longitudinally, showing the relationship between thinking and feeling within problem solving stages (Kuhlthau, 2004). The ISP model was based on a longitudinal study of high school seniors conducting research for a term paper. Despite this limited context Kuhlthau’s theoretical contribution remains significant due to empirical evidence of the fundamental role of emotion in information problem solving, thus retaining relevance throughout the continuous development of information technologies and diverse research contexts. In the 1980’s utility and usability were often addressed but emotions were rarely taken into account (Norman, 1988)

2.2 Affect and information search

Affect is a fundamental aspect of human beings, including mood and emotion, which have an impact on perception, cognition, social judgment, and behavior (Russell, 2003). Affect is not as well-understood as cognition, so several researchers regard affect as a neutral term commonly understood to represent mood, emotion, and feelings in general (Brave and Nass, 2003). Empirical studies have found that affect influences task performance therefore it is important to information retrieval and information communication technologies (ICTs) use (Kuhlthau, 1993). Donald Norman, following cognitive neuroscience, describes affect and cognition as separate and interacting internal information-processing systems. Affect and cognition interact as some emotions and affective states are driven by cognition, while affect often impacts cognition (Norman, 2004, p.11). An empirical study of Web searching examined users’ affective, cognitive, and physical behaviors collectively (Wang, Hawk, and Tenopir, 2000). Using the same approach, Web searchers were found to apply “user coping skills” to counteract and reduce the negative effects of uncertainty, irritation anxiety, frustration, and rage during search tasks (Nahl, 2004). As a result of studies identifying the influential nature of affect in task completion and success, the concept “affective load” was proposed and tested ((Nahl, 2005), and its relationship to
both simple and complex information tasks was identified (Nahl, 2004). These and other studies shed light on how affect influences ICT use and information behavior.

2.3 Uncertainty: a basic principle

Uncertainty is a basic principle in information seeking that serves to integrate cognition and affect (Kuhlthau, 1993). Prior research on the ISP model showed that though searchers often start a project with enthusiasm and initial success, they often become confused and uncertain as they progress. A substantial number of people give up after their initial search for information regardless working on a class research project or simply using the library (Kuhlthau, 1993). Research has shown that uncertainty and other positive-negative feelings are correlated in the information seeking process (Wilson et al., 2005). The most highly inter-correlated variable is the scale disappointed-pleased at the Problem Precognitive Stage. At the Problem Definition stage, uncertainty is correlated with confused-clarity, and doubtful-confident, while at the Problem Resolution Stage uncertainty is correlated with pessimism-optimism and doubtful-confident (Wilson et al., 2005). Building research upon the much-tested ISP model provides a solid theoretical background for this ongoing cross-language research. Further analysis and theoretical development will be presented at the conference.

2.4 Appraisals, behavior, and outcomes of information search

Ramirez et al.’s (2002) noted that in CMC environment, there are three concepts related to information search: appraisals, behavior, and outcomes. “Appraisals” refers to technology-related, information related, goals-related, situation/context-related, and communicator-related factors. “Behavior” refers to selection of information seeking strategy including type of strategy and individual or multiple strategies. “Outcomes” refers to feedback, experiences, and assessment. Since uncertainty is the basic principle of information search, we would like to understand how uncertainty has impact toward these three aspects.

2.5 Information-seeking activities and problems

Information seeking and retrieval activities and problem cause uncertainty (Chowdhury and Gibb, 2009). These activities and problems have been identified in academic environment and their relationships with uncertainty were found to be positive. We adopted the list of activities and problems with bilingual users where single language search and combined-language strategies
were compared in an information-seeking context. This is an area has yet explored by researchers; however, it is worth to pursue given the Internet is a multi-lingual environment where the use behaviors of users can be complex and diverse. Specifically, we compare the different level of uncertainty while search online with single language search and combined-language strategies.

3 Method

In phase one, 30 participants who were students of a major US university were recruited. We designed a quasi-field experiment because we intended to simulate the natural situations that searchers experienced. In this study the independent variables are the two common search tasks, and the language used, i.e., either English only or combined English and Native language searching. In phase two, 120 participants will be recruited for an online survey, the survey intends to how uncertainty plays a role in activities of information retrieval behaviors and information retrieval activities. The data collection is in process and we will report the results at conference presentation. The survey website shows in Appendix C.

3.1 Procedures

In phase one, participants used the Google search engine to finish the same assigned search tasks. Both groups used Internet Explore browser 6.0 or 5.0. To simulate a realistic experience, subjects were asked either to use their own laptops or to search in a computer lab where multiple language input functions were available. A path analysis was used to track subjects in order to understand the searchers’ experiences. Participants were asked to think-aloud while searching. Immediately after finishing each task, participants reported on their search experiences in a questionnaire that measured their perceptions of the information they retrieved, and the positive and negative feelings they experienced.

In phase two, we recruit MBA students who enrolled in English based programs in a major Taiwan university. The participants will be instructed to fill out an online survey based on their experiences of using Google search engine. Given that the MBA program is in English, the survey questionnaire is in English language. The results will be obtained in June, 2012 and be analyzed and presented in the conference presentation.

3.2 Measures
While participants thought aloud, all of their search actions, search results, and emotional responses were recorded on the researcher’s observation form using the six-stages of the ISP model, including the searchers’ emotional responses and actions (Kuhlthau, 1993) (see Appendix A). When participants raised their voices the words were recorded with exclamation marks. In addition, participants reported their perceived emotional responses immediately after finishing each task by filling out a post-search questionnaire to allow the subjects to report perceptions of their task completion, overall emotional response, and their priority in choosing certain links. After finishing the search tasks, we looked at the History function in Internet Explorer to record the pages visited and to record the keywords that the subjects entered in the Google search engine.

Since Kuhlthau’s model was not originally developed for the information retrieval on the Internet, we attempted to determine the searcher’s ISP stages by their think-aloud spontaneous statements and actions presented in Appendix A. We adopted Kuhlthau’s definitions of six ISP stages with slight refinement:

1. **Initiation**: just recognized a need for information and thinking how to start and what keyword to use.
2. **Selection**: having different ideas and trying to select or decide on which idea or selection to search for information.
3. **Exploration**: searching for information in order to find a focus and understanding about a general topic that later will help gather more relevant information.
4. **Formulation**: trying to find a focus or understanding about the topic from information has found.
5. **Collection**: searching collecting information extensively.
6. **Presentation**: having enough information and thinking about stopping the search for information and using the findings.

Chowdhury and Gibb (2009) have developed the lists of information search problems and activities and figure out the relationships between these problems/activities and uncertainty. The measurements adopted in phase two are based on these problems and activities. Respondents are asked to rate their level of uncertainty with these problems and activities with likert-type scales ranging from 1 to 7.

<table>
<thead>
<tr>
<th>Information Retrieval Activities</th>
<th>Adopted from Chowdhury and Gibb, 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formulating a search expression</td>
<td></td>
</tr>
<tr>
<td>Taking an action following a search when a set of results appear on screen</td>
<td></td>
</tr>
<tr>
<td>Deciding when to stop a search and then use the retrieved items</td>
<td></td>
</tr>
</tbody>
</table>
Making use of the retrieved items to perform the actual task
Deciding how many of the retrieved items should be viewed when many items are retrieved
Deciding what to download or print
Ensuring that all the information required for a given task has been obtained

Information Retrieval Problems
Too much information or information overload
Search output is not exhaustive
Search results are not up-to-date
Time-consuming
Search results can be unreliable
Not enough relevant materials
Too many different passwords needed to search
Hard to read or view on the screen
Poor quality of display of text or graphics
Slow downloading pages
Lack of search skills
Unfamiliar with Google
Poor quality of information
Too many irrelevant results

4 Data analysis and results

4.1 Phase one results

Table 1 shows the results for the searcher’s task performance. Given that the Internet is a multi-language environment, searchers were instructed to use either English only (single-language, SL) or both English and their native languages (combined-language, CL). Descriptive statistics provide information on search actions taken, perceived performance (likert-type scale ranging 1-5, 1=strongly disagree, 5=strongly agree), perceived and actual number of task completions, and level of positive feelings reported.

Table 1. Quantitative results: study 1 and 2 (Means)

<table>
<thead>
<tr>
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<tr>
<td></td>
<td>CL N=5</td>
<td>SL N=5</td>
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<tr>
<td>Pages visited</td>
<td>33.2</td>
<td>25.4</td>
</tr>
<tr>
<td>No. of times menu</td>
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<td>15.2</td>
</tr>
<tr>
<td>and back button used</td>
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<td></td>
</tr>
<tr>
<td>Task completed</td>
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</tr>
<tr>
<td>Perceived task completed</td>
<td>2.0</td>
<td>1.6</td>
</tr>
<tr>
<td>Time to complete tasks</td>
<td>24.5</td>
<td>22.8</td>
</tr>
<tr>
<td>(min.)</td>
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<td></td>
</tr>
<tr>
<td>Positive Feelings</td>
<td>3.2</td>
<td>4.8</td>
</tr>
</tbody>
</table>
Table 2 presents the level of searchers’ positive feelings during tasks on a seven-point bi-polar scale used by Wilson et al. (2005). The scales in Table 2 were employed as compound measures of uncertainty, including clarity, optimism, relief, satisfaction and confidence.

<table>
<thead>
<tr>
<th></th>
<th>Study 1</th>
<th>Study 2</th>
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<tbody>
<tr>
<td><strong>Phase one</strong></td>
<td></td>
<td></td>
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<tr>
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<td>SL N=5</td>
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<td>5</td>
</tr>
<tr>
<td>Relieved</td>
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<td>5</td>
</tr>
<tr>
<td>Confident</td>
<td>5.4</td>
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<tr>
<td>Satisfied</td>
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<td>5</td>
</tr>
<tr>
<td>Pleased</td>
<td>5.2</td>
<td>5</td>
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</tbody>
</table>

Findings suggest that searcher’s level of uncertainty varies with task complexity. Participants in study 2 were less satisfied, confident, relieved and clear than those in study 1 with simpler tasks. Table 3 shows the global level of uncertainty searchers experienced. The level of uncertainty was a self-report measure on a 1-to-7 bi-polar scale of an adjective pair: uncertain-certain. The lower the rating, the more uncertainty participants reported. Participants in both studies reported greater uncertainty with complex tasks, and participants in the combined-language condition felt more uncertainty.

<table>
<thead>
<tr>
<th></th>
<th>Study 1</th>
<th>Study 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Phase one</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N=10</td>
<td>CL N=5</td>
<td>SL N=5</td>
</tr>
<tr>
<td>Task 1</td>
<td>6</td>
<td>5.8</td>
</tr>
<tr>
<td>Task 2</td>
<td>4.6</td>
<td>4</td>
</tr>
</tbody>
</table>

These descriptive statistics are supporting but not sufficient evidence for statistical inference. Further studies are needed with bilinguals and multilinguals, using random selection and random assignment to test the variables identified in this research.

**On task completion.** The qualitative analysis from observations showed that one searcher did not finish the task because he used a second language instead of a native language for searching. Word processing in the second language took longer and prevented him from finishing the more complex task (task 2). He expressed frustration during the search process with words and gestures. This is supported by earlier findings that “processing first-language messages may be less effortful than processing second-language messages…” (Nahl, 2001, p. 576). Because first-language conceptual links are stronger,
therefore it demands less cognitive resources. Another searcher who did not finish the task, claimed that the results were not what he expected, so he decided to quit (See Appendix A, Case 1). Probing searcher expectations will be added to the methodology in subsequent studies.

**User frustration.** User frustration was one of the reasons that searchers could not complete tasks. Qualitative analysis suggested that one searcher did not complete a task because the online ticketing services kept requesting personal information. He could not find a Web page to compare airfares without inputting his personal information. This made him very frustrated so he decided to quit. User frustration also resulted from the insufficient information provided in Google searches. A searcher read an excerpt, which suggested that the page had information on a trip from Hawaii to Las Vegas; however, when the searcher linked to the page, he did not see anything about the trip. His level of frustration was spiking at that time, as he frowned and shook his head. Frustration appears in the ISP model in Stage 3 Pre-focus Exploration, considered the most difficult stage and characterized by uncertainty, confusion, and doubt as students try to determine a focus within a much larger topic domain (Kuhlthau, 2004, p. 45, p. 82; Appendix A, Cases 2, 3, 4).

User frustration led searchers to fail to complete the tasks. Qualitative analysis from observations suggested that one searcher did not complete a task because he could not find information in what he considered an acceptable amount of time. As time passed without success, searchers changed keywords and linked to many Web pages, if the information still was not found, a searcher would quit. User frustration not only led some searchers to quit searching on the Internet, but also led them to search using other resources. Three participants who did not finish their tasks reported that they wanted to go to the library next or ask a friend for information.

**Uncertainty and task complexity.** Searchers’ uncertainty varied with task difficulty. Searchers had a high level of uncertainty with a more complex task (task 2). In study 1, we found that searchers shifted from the Initial stage to the Collection stage, and then to skipped ahead to the Presentation stage (Kuhlthau, 1993) in the simple task 1. Task 2 searchers went through all of the six-stages, and they reported high levels of uncertainty during complex task 2.

**On six-stage of ISP model.** We were interested in how Internet searchers’ feelings, thoughts, and actions might differ from the linear ISP model. Participants’ feelings appeared to be more complex than what has been described in ISP model. For instance, conversation analysis showed that
searchers in different stages experienced similar and different emotional responses from that of ISP stages. A searcher in the Initial stage (stage 1) was optimistic because he said he felt excited at the prospect of finding the information about airfares to Britain; however, he eventually did not finish his task because he felt the ticket was too expensive. He said that he wanted to try to search another day and maybe he would have better luck (See Appendix A, Case 1). This is different from ISP model where students exhibited uncertainty in the Initial stage of a research paper. Likewise, ISP model notes that in the Collection stage (stage 5), researchers may gain a sense of direction. Rather, our conversation analysis found that a searcher who went to seven different online booking Websites did not find an air ticket with a reasonable price and this caused him to quit. In addition, the searcher had complex feelings within the same stage. For example, in the Collection stage the searcher reported both positive and negative feelings. The searcher’s level of frustration was high after visiting seven Websites without satisfaction (See Appendix A, Case 1). User frustration appears in Stage 3 Pre-focus Exploration of the ISP model.

Searchers who applied varied search strategies showed feelings that were more complicated and different from the ISP model. A single-language searcher who did not finish his task showed that he was clear in the Selection stage (stage 2) but in the Collection stage (stage 5), he felt uncertain because he was not sure which museum was the one with the best impressionist painting (See Appendix A, Case 3). Kuhlthau’s model suggests that in the Collection stage (stage 5), the researcher should get a sense of direction and confidence. Instead, Web searchers expressed confusion and frustration. A searcher in the combined-language group exhibited uncertainty in the Selection stage (stage 2) because she had problems selecting the best art museum in Rome with impressionist paintings. She felt pessimistic in the Exploration stage (stage 3) similar to the emotional response Kuhlthau defined in the Exploration stage. However, when she was in the Formulation stage (stage 4), she had doubts and she said that the Paris might have the best impressionist paintings instead of Rome (See Appendix A, Case 4). In contrast, the ISP model describes a feeling of clarity in stage 4.

As in ISP model, Internet searchers showed a tendency to move from ambiguity to specificity. In this respect our findings are consistent the ISP model. For instance, in more complex tasks Internet searchers made plans in the Initial stage (stage 1), and adjusted their goals during the Formulation and Collection stages (stage 4 and 5). This is evidence of developing their thoughts from vague to something more specific, because they were forming search strategy along with the search. When searchers found that the air ticket prices were higher than expectation, they would either increase the money they
wanted to pay, or decide to take a plane during a different season, or cancel their travel plan. One searcher decided to quit when he did not find a reasonable price. Another searcher wanted to find the best impressionist art museum in Rome but could not find the result, then the person raised the question “What is impressionist painting?” Then, the intervening search sub-goal became finding general information about impressionist paintings and artists to make sure that the museum carried impressionist paintings. This is again the evidence of the searcher moving from looking for something general to something specific to achieve the information goal.

In actions, the ISP model notes that researchers will seek relevant information and gradually seek pertinent information. A searcher in the combined-language group found that the place he wanted to go did not have an airport; he started to think about the possible nearest airport. Then he searched in the Website he found and eventually found the results. He was disappointed in the Collection stage, but when the search results appeared, he felt satisfied (See Appendix A, Case 2).

The result of phase one is encouraging. In phase two we will have an in-depth understanding on how uncertainty plays a role in bilingual’s information search.

5 Discussion

The results suggested that Kuhlthau’s ISP model is applicable to Internet searchers in the broadest sense as participants began with a general approach and focused to specifics to find information to complete tasks. While searcher thoughts and actions were similar to what have been described in the ISP model, they occurred within different stages. Conversation analysis showed that while searchers’ emotional responses corresponded to those in Kuhlthau’s model, some variations were found. For instance, one searcher in the combined-language group felt confused in the Selection stage while in Kuhlthau’s model that stage is characterized by optimism. The possible reason is that the magnitude of retrievals provided by Web searches may overwhelm searchers with results that engender more complex feelings in the Selection stage. In any case, the ISP model may be used as a baseline for examining Internet searcher’s affective experiences.

The results of the phase on studies suggested that the actions of the combined-language group and the single-language group varied. Both studies showed that the combined-language group used the Back buttons and menus less frequently, spent longer searching, and reported that they could finish tasks
effectively. They also reported more positive feelings and less uncertainty. By using the results of both studies to depict users’ experience, we found that the combined-language group finished more tasks and had more positive feelings in searching. Although task complexity varied, results were consistent.

This study contributes the understanding of information behaviors by applying Kuhlthau’s ISP model to online context where the user’s behaviors may different from an off-line setting. This study also contributes to the information retrieval on how bilingual searchers responses to information-seeking activities and problems and discovers how uncertainty plays a role in the search process. Triangulation method is adopted in this study as such we collect rich data to explain online user’s information behaviors; to our knowledge, this is the first attempt with users from both the US and Taiwan, from a perspective of bilingual search.

6 Conclusion

To understand information search experience on the Internet, 30 participants who were students in a major U.S. university were recruited for a quasi-field experiment. Participants were instructed to perform two search tasks with the Google search engine and to think aloud as their emotional responses, verbal conversations, and actions were recorded on an observation form. In addition to this qualitative data, participants self-reported their emotional responses and perceptions of performances of the search tasks on likert-type and a bi-polar scales. Findings suggest that the searcher’s feelings differed from the emotional responses in Kuhlthau’s ISP model (Kuhlthau, 1993) due to task complexity. Our attempt of understanding uncertainty is actualized by using Ramirez et al.’s (2002) conceptual model for social information seeking via CMC. With the conceptual framework in mind we adopted the lists developed by Chowdhury and Gibb (2009). We are conducting the data collection with participants from a Taiwan’s major university and intend to uncover how uncertainty plays a role in CMC environment. The results will be reported in the conference presentation.

References
Figure 1. Model of the information search process

<table>
<thead>
<tr>
<th>Stages</th>
<th>Task</th>
<th>Topic</th>
<th>Prefocus</th>
<th>Focus</th>
<th>Information Collection</th>
<th>Search Closure</th>
<th>Starting Writing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initiation (1)</td>
<td></td>
<td>uncertainty</td>
<td>optimism</td>
<td>confusion, frustration, doubt</td>
<td>clarity</td>
<td>sense of direction/ confidence</td>
<td>relief</td>
</tr>
<tr>
<td>Selection (2)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Exploration (3)</td>
<td></td>
<td>ambiguity</td>
<td></td>
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<tr>
<td>Formulation (4)</td>
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<tr>
<td>Collection (5)</td>
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<tr>
<td>Closure (6)</td>
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<tr>
<td>Writing (7)</td>
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</tbody>
</table>

Thoughts
- ambiguity
- increase interest

Appendix A: Conversations with searchers
Case one: Searcher from the single-language condition, who did not complete the search tasks

<table>
<thead>
<tr>
<th>ISP</th>
<th>Dialog</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Initiation</td>
<td>Searcher: Hey, I am a bit excited! Can I use bookmark?</td>
<td>Wrote down the ticket price that he was willing to pay. Clicked “advanced search” function.</td>
</tr>
<tr>
<td></td>
<td>Researcher: Nope! You have to use Google.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Searcher: Oh! Okay!</td>
<td></td>
</tr>
<tr>
<td>2. Selection</td>
<td>Searcher: Fine! This is fine!</td>
<td>Underlined the term in the questionnaire to make sure exactly what he had to find in the task.</td>
</tr>
<tr>
<td>3. Exploration</td>
<td>Searcher: A problem!</td>
<td>Typed in keywords: Britain + air + ticket</td>
</tr>
<tr>
<td></td>
<td>Researcher: What is wrong?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Searcher: Oh! Well, no, that is okay</td>
<td></td>
</tr>
<tr>
<td>4. Formulation</td>
<td>Searcher: Silent for awhile</td>
<td>Scrolled down the page, and carefully looked over the pages.</td>
</tr>
<tr>
<td></td>
<td>Researcher: How do you feel now?</td>
<td></td>
</tr>
<tr>
<td>5. Collection</td>
<td>Searcher: Boy! This does not look good! I do not think I can find something I want. This is not what I want.</td>
<td>Went to “Travelocity” Wrote down all the prices that he found.</td>
</tr>
<tr>
<td></td>
<td>Searcher: Quick! There you go! I found it! It is hard.</td>
<td>Went to “orbitz” by linking the side-bar ads, not the ranking results.</td>
</tr>
<tr>
<td></td>
<td>Searcher: Ha! Ha! Stupid website! The pop out window do not have London, UK. But they have it here!</td>
<td>Wents to “hotwire” Browsing the pop out window to choose the destination. However, there was a place called London, Canada, but not London, UK.</td>
</tr>
<tr>
<td></td>
<td>Searcher: I am not happy with the bargain, not the search results. Silence.</td>
<td>Went to “Airfare Planet” Went to “Air Gorilla” Went to Travel Air”</td>
</tr>
<tr>
<td>6. Presentation</td>
<td>Searcher: I am not sure what I am doing is right. The pop out windows are annoying.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Searcher: I probably cannot find the best one, because of the high season. Silence.</td>
<td></td>
</tr>
</tbody>
</table>

Case two: Searcher in the combined-language condition who completed the search tasks

<table>
<thead>
<tr>
<th>ISP</th>
<th>Dialog</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Initiation</td>
<td>Searcher: What should I do? (Feels frustrated because he cannot go the pages that he already knows for this task.)</td>
<td>Typed in keywords: Cheap ticket Honolulu Grenoble</td>
</tr>
<tr>
<td>2. Selection</td>
<td>Searcher: It is confusing!</td>
<td>Scrolled down the page to see if it was necessary to change keywords. Link that appeared are neither English nor French</td>
</tr>
<tr>
<td>3. Exploration</td>
<td>Searcher: I am not sure what I am doing is right. The pop out windows are annoying.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Searcher: I am not happy with these.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Searcher: This is a good one.</td>
<td></td>
</tr>
<tr>
<td>4. Formulation</td>
<td>Searcher: Stupid!</td>
<td>Searched in the Website that he found.</td>
</tr>
<tr>
<td>5. Collection</td>
<td>Searcher: Cannot find. No airport in the city I want to go. (Disappointed)</td>
<td>Typed in keywords: Air ticket Honolulu Grenoble Tried to think of the nearest airport close to the place he wanted to go.</td>
</tr>
<tr>
<td>ISP</td>
<td>Dialog</td>
<td>Actions</td>
</tr>
<tr>
<td>-----</td>
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</tr>
</tbody>
</table>
| 6. Presentation | Searcher: **Super good**! (Satisfied)  
I search in English, but the results are in French. English is better in searching. | Searches within the online booking website he found. |
|  |  | Found the Webpage that he could compare the prices of the ticket. |

**Case three: Search in the single-language condition who did not finish the search tasks**

<table>
<thead>
<tr>
<th>ISP</th>
<th>Dialog</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  Initiation Searcher:</td>
<td>I am thinking about what key word to use.</td>
<td>Typed in “Rome + museum.”</td>
</tr>
</tbody>
</table>
| 2. Selection Researcher: | How do you feel now?  
I think I am clear on what I have to do.  
I searched Rome and I linked to the first one.  
I am also looking for what they have. | Click the first link. |
| Searcher: | | Went back to Google, and changed the keywords to “Rome + impressionist + painting.” |
| 3. Exploration Searcher: | Now I can't find it. I'm a little bit confused.  
I am going back to Google again.  
I am checking the first link. | Looked at a photo but it is not what he wants. |
| | | Reformulated the search terms to “Rome + impressionist + museum.” |
| 4. Formulation Researcher: | Still feel optimistic you can get it?  
Okay, I got a lot.  
I'm checking out the first one.  
What's this? **Okay**! I'm checking out the building now. | Looked at the excerpt in the first link.  
Copied “National museum of Rome” from the excerpt.  
Used “National museum of Rome + impressionist” as search terms  
Looked closely at the content. |
| Searcher: | | |
| 5. Collection Searcher: | I used this museum as a keyword, and I found this map.  
**Oh! My God!**  
I forgot I have to….. | Looked at the results but had problems in determining which one was considered to be the “best” art museum with impressionist paintings. |
| Searcher: | | |
| Searcher: | I’m browsing the titles.  
**Okay! Check this out!**  
Okay! This is more related.  
I am going to check one more.  
**One more!**  
If it is a more difficult task I will link more than 4 links.  
I found a list of museums, but I am not sure.  
Actually I don’t know that painter.  
I can’t see the word “impressionist” here.  
This one has a lot of paintings.  
Seven have paintings.  
This is a National museum.  
I found some paintings. It looks okay, but I am not sure if its impressionist or not. | Used the “Find” function in Internet Explorer to determine whether the content contained the word “impressionist”.  
Looked at a Webpage with names of museums. |
| Searcher: | | |
| Searcher: | | |
| Silence. | | |
| 6. Presentation Searcher: | I will use other resources.  
Whenever I search I click 3-4 links.  
If I cannot find it, I will use other resources.  
Search engines are mostly the same so I will use different resources. | Stopped searching |

**Case four: Searcher in the combined-language condition who did not complete the search tasks**

<table>
<thead>
<tr>
<th>ISP</th>
<th>Dialog</th>
<th>Actions</th>
</tr>
</thead>
</table>
| 1  Initiation Researcher: | Do you feel optimistic?  
I feel optimistic | Typed in “羅馬”.  
Search two sets of keywords using two windows.  
Typed in “羅馬” in one window and “impressionists art museum” in the other window. |
| Searcher: | | |
| 2. Selection Searcher: | I do not know which one is the best. | Looked at the results but had problems in determining which one was considered to be the “best” art museum with impressionist paintings. |
| 3. Exploration Searcher: | I need to know something about impressionist, before I find the museum. I feel pessimistic. | Opened new window and typed “印象派” as keyword. |
| 4. Formulation Searcher: | It is unclear.  
I don’t know which artist works in Rome. But I think I should be able to find it in Paris. I feel pessimistic. | Switched between two browser windows to get background information on impressionist paintings. |
Not this one. I thought I could find one here, because it says “impressionist trip”.  
Still not optimistic because the pictures are not impressionist. | Looked at the photos on the Webpage. |
| 6. Presentation Searcher: | I think the “Louvre” has the best impressionist paintings.  
Although Rome art museum might all have some impressionist painting, but they are not the best.  
How do you feel? | Found the Rome national museum had some paintings, but she was not sure they are impressionist paintings. |
| Researcher: | I feel okay. | Based on her knowledge, she felt that the best impressionist paintings were not in |
Appendix B:

While searching, I felt

Optimistic __________ Pessimistic
Confused ____________ Frustrated
Relieved ____________ Clear
Confident ____________ Doubtful
Dissatisfied __________ Satisfied
Pleased _____________ Disappointed
Uncertain ___________ Certain

Why did you choose a certain link? I chose by
(combined-language group)
___ Ranking
___ My first language
___ Both
(single-language group)
___ Ranking
___ Headers and excerpts
___ Both

Why did you choose a certain link? I chose by

When I searched, I paid closely attention to the search results. Strongly agree/Strongly disagree
I study the headers and the excerpt while searching.

Strongly agree/Strongly disagree

Appendix C: Survey Website

Online Searching Survey: Google

When you search at the Google, you may use either English or your native language or both as keywords. Please answer following questions regarding the use of the Google search engine.
*必要

Part 1.

What is your native language? *

- Chinese
- 英语

How long have you even been use the Google search engine? *

- Less than 6 month
- 6 month to 1 year
- 1-2 years
- 2-3 years
- More than 3 years

What language(s) do you use to search at the Google search engine? *

- English
Part III. Please indicate the likelihood of the following problems to occur, when you search at Google:

<table>
<thead>
<tr>
<th>Problem</th>
<th>1</th>
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<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
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</thead>
<tbody>
<tr>
<td>Too much information or information overload *</td>
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<td>Very unlikely</td>
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<td>Very likely</td>
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<td>Search output is not exhaustive *</td>
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<td>Very unlikely</td>
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<td>Very likely</td>
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<tr>
<td>Search results are not up-to-date *</td>
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<td>Very unlikely</td>
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<td>Time-consuming</td>
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<td>Search results can be unreliable *</td>
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<td>Very unlikely</td>
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<td>Very likely</td>
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</tbody>
</table>
Value-based Adoption Intention of Cloud Computing Service

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Abstract. As the IT grows in its usage, the companies at home and abroad pay more attention to the cloud computing service that can effectively manage data overloading problem that has deteriorated. To that end, the more attention the cloud computing get paid, the more studies on the introduction of cloud have been conducted. Most studies, however, reported just the fragmentary perspectives and individual cases about technical characteristics and potential risks of the cloud computing service, difficult to suggest the considerations that should be regarded when the top executives introduce cloud computing on a comprehensive basis. Thus, this study suggested the framework on the intention to introduce cloud computing service based on the value-based adoption model (VAM), where the framework explained the benefits and sacrifices that should be reviewed when introducing cloud computing and which dimension should be applied when reviewing the values of cloud computing.

Keyword: IT, cloud computing, value, framework, value-based adoption model (VAM)

1. Introduction

As the IT grows in its usage, the companies at home and abroad pay more attention to the cloud computing service that can effectively manage data overloading problem that has deteriorated [25].

Cloud computing is a technology which enables to use computing resources on any terminal at anytime and anywhere available to access to the Internet; since users can use computing resources in a service form through the Internet without installing computing resources in his/her computer, cloud computing enables to make users to use computing resources at much less expenses than the cost that has been paid for the existing IT products and service [30]. In addition, users can reduce the entire resources and cost by sharing IT resources and efficiently use idle resources as well as improve work efficiency and productivity by establishing permanent cooperative system [27]. Those characteristics enable cloud computing to attract attention from IT industry in the world. In 2010 Gartner Group cited cloud computing in the Top Strategic Technology as the priority of technologies list that should be used strategically by companies in 2010 [8].

In line with such tendency, each country in the world has progressed the introduction, planning and embodiment of cloud computing, which is led in a government wide [10, 24]; in South Korea, the Korea Communications Commission, the Ministry of Public Administration and Security, the Ministry of Knowledge Economy, and etc. announced and have implemented the comprehensive plan to expand the occupancy rate in the domestic and foreign markets through the activation of inter-government wide cloud computing [29]. Likewise, cloud computing is one of the key services that grow the market continuously, become the foundation of the companies’ ICT service, play a role as driving force in IT growth, change the paradigm of IT service, and lead next-generation digital era; expected to bring about huge changes in information revolution [24, 25].

With more attention to cloud computing paid, many studies has been also conducted on the introduction of cloud. Most of the studies, however, just arranged fragmentary perspectives and individual cases about technical characteristics and potential risks of cloud computing service; it is difficult to suggest considerations that the top executives should regard on a
comprehensive basis when they introduce cloud computing. Thus, this study presented the framework on the intention to introduce cloud computing service based on the value-based adoption mode (VAM); this framework explained the benefits and sacrifices that should be reviewed for the purpose of introducing cloud computing and on which dimension the value of cloud computing should be reviewed.

It would be a very essential and interesting topic for researchers to study which feature of product or service makes the prospective purchasers buy it when such new product or service is launched because companies or service providers desire to find out and put emphasis on, or eliminate, the features that they consider important or worried when they supply product or service, resulting in accelerating acceptance and expansion of consumers for product and service as well as helping predict the future demands as the product and service develop thanks to the analysis on the present perspective of consumers [23]. Therefore, the study was to find out which key feature of cloud computing service affects the decision making of companies to select cloud computing: that is, how the key features of cloud computing affect the intention of companies to introduce cloud computing service.

2. Theoretical background and preliminary research

2.1 Definition of cloud computing service

Generally, the definition of cloud computing service has been provided largely by IT dedicated institutions and service providers than the academic world; the definition is different from each research institution. Gartner defined cloud computing as computing to provide IT resources with high-level extendability to multiple customers as a service using Internet technologies; Forester Research defined it as a form to provide standardized IT-based functions through IP, be allowed to access anytime, be variable depending on the change in demand, supply accounting model based on usage volume or advertisement, and provide web or programmatic interface. Table 1 shows the various definitions of cloud computing.

<table>
<thead>
<tr>
<th>Researcher</th>
<th>Definition</th>
</tr>
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<tbody>
<tr>
<td>Gartner</td>
<td>Computing to provide IT resources with high-level extendability to multiple customers as a service using Internet technologies</td>
</tr>
<tr>
<td>Forester Research [19]</td>
<td>A form to provide standardized IT-based functions through IP, be allowed to access anytime, be variable depending on the change in demand, supply accounting model based on usage volume or advertisement, and provide web or programmatic interface</td>
</tr>
<tr>
<td>CPNI</td>
<td>An collective form of IT services that have been provided to customers, which have the ability to expand or reduce demands from customers through the network based on the lease</td>
</tr>
<tr>
<td>NIST</td>
<td>A model to provide access to the common pool of computing resources anytime on a convenient and necessary basis through network; available to rapidly provide computing resources with the least management effort or the interaction with service providers</td>
</tr>
<tr>
<td>IEEE</td>
<td>A paradigm to make information permanently stored in the servers on the Internet and temporarily stored in the clients such as desktops or portable devices</td>
</tr>
<tr>
<td>IBM</td>
<td>An environment to distribute and process mass storage database on the virtual space of the Internet using web-based application software, and to load and process such data on various terminals such as a computer, mobile phone, or PDA</td>
</tr>
</tbody>
</table>
Table 1 shows that users can use IT resources such as applications, storage, OS, and security that users are necessary to use anytime they want at the expenses which the service deserves even without any professional knowledge and technology about cloud computing [26, 28]. Cloud computing is variably classified depending on the kind of service resources that are generally supplied [25]; its detailed service forms are largely divided into three: SaaS, PaaS, and IaaS [6, 14, 24, 30]. SaaS (Software as a Service) is to provide servers or storages to users as a service; PaaS (Platform as a Service) is to provide standardized platform as a service, which is a model that enables users to easily use necessary development factors on the web; and IaaS (Infrastructure as a Service) is a service-type software where among various functions only the service that users need is available.

2.2 Technology introduction and innovation expansion

2.2.1 Technology Acceptance Model (TAM)

The theory on technology acceptance has its starting point when the human beings decide to introduce any technology on a reasonable basis. Davis [2] suggested the technology acceptance model (TAM) in order to model user acceptance of information technology, which used two attitudes of perceived usefulness and perceived ease of use as major related variables for information technology acceptance act to explain behavior intention, and reported that they affected the actual use. Perceived usefulness was defined as the degree to believe that the use of a certain system by a user can improve work performance; perceived ease of use was defined as the degree to believe that any additional efforts were not necessary when users used a certain system.

In addition, Davis [3] found the direct effects of perceived usefulness and perceived ease of use on behavior intention in the initial TAM model, suggesting a new TAM model omitting behavior variable.

2.2.2 Value-based adoption model (VAM)

TAM consists of a simple structure but has high ability to explain, which has been wide accepted among researchers. But TAM is basically a mandatory system and technology: that is, a model established assuming a situation where users must use a certain IT artifact in order to perform duty when he/she belongs to an organization [11]. With these characteristics, TAM has a limit to observe user acceptance in a situation where a user is a technology user and service user at the same time [11].

Since TAM model has much more individual characteristics, the model has a limit when making an access from a corporate perspective; as well, it only deals with the elements in benefits aspect, impossible to measure other elements. Kim et al. [11] recognized that there be a scope that could not be dealt with structurally by the existing TAM and suggested the value-based adoption model (VAM) as shown in Figure 1 in order to complement such scope. VAM uses the perceived value reported by Zeithmal [21] as its central axis; that is the perspective which the perceived value users feel on goods or service is calculated by summing up the benefits and expenses arising from the use of such goods or service.

What is the most important in VAM is perceived value, which means the value that users feel when he/she uses goods or service, and is calculated by summing up the benefits obtained
when using goods or service and the sacrifice (=cost) occurred until or during the use of such goods or service [21]. And such perceived value has been confirmed to have positive effects on purchase intention of consumers [13, 20].

2.3 Value of IT business

IT business value can be defined as the contribution of to enhance the business performance of the organization, which, however, varies its concept and scope depending on situations and contexts [4, 9, 15, 16] and can be classified into four categories to measure performance index (KPI) of the balanced scorecard as follows: first, the emphasis on financial performance such as sales and profits depending on the perspective to view business performance to which IT contributes; second [4]; second, the focus on middle-stage business performances such as process efficiency and productivity of management hierarchy [9]; third, the emphasis on non-financial and intangible effects such as communication with customers, organizational behavior of members, transparency inside the organization, and cooperative relations between departments [15]; and finally, the focus on the company wide and strategic perspective value such as corporate strategic alignment or competitive advantage [16]. Likewise, the perspectives to view IT business values vary and their concepts and scopes have been continuously expanded.

Balanced scorecard is one of the comprehensive measurement indices which can measure and manage corporate mission and strategy, and plays a role in not only evaluating the current corporate situation but also warning the future, important information when companies establish business strategy. Therefore, the author conducted the study from the four perspectives of the balanced scorecard including finance, process, customer, and business strategy in order to examine from various angles from which perspective companies feel necessary to introduce cloud computing. Multidimensional analysis helped progress more in-depth research on values, suggesting much clearer ground to explain the intention of introducing cloud.

3. Research model

Prior to conducting the study, the author found the variables selected by VAM not appropriate for cloud computing, and selected new variables to the extent that the existing model was not that much changed, where each variable was selected based on the strengths and weaknesses of cloud computing mentioned in the preliminary study on cloud computing.

3.1 Managerial easiness
Many studies on strengths and weaknesses of the effects of introducing cloud computing on companies have been progressed. Francesco Maria Aymerich et al. [7] reported that from a technical perspective, cloud computing could be controlled, and maintained and restored easily without additional hardware when it was overloaded; and that from a corporate perspective, IT hardware and software could be effectively invested and easily used. As well, Sean Marston et al. [18] reported that companies could easily control the organization if they introduced cloud computing; Peter Mell and Tim Grance [17] maintained that the corporate could use efficiently software if they introduced cloud computing; and Neal Leavitt [12] mentioned largely the availability of cloud computing. Likewise, the strengths selected by many researchers when introducing cloud computing were reduced into the easiness of control, maintenance, and restoration; the study regarded it as managerial easiness which was adopted as an independent variable.

3.2 Obtainment of capability

Francesco Maria Aymerich et al. [7] reported that from a technical perspective, cloud computing had a processing power and that from a user perspective, it was not limited to a certain device; and that from a corporate perspective, it could produce better outcome, access remotely, and cooperate in real time. Sean Marston et al. [18] cited imminent access available to hardware resources as a key benefit of cloud computing and maintained that when introducing cloud computing companies could enjoy the opportunities to easily use high-tech applications and realize new web services through integration of various contents or services. The advantages of cloud computing mentioned in such preliminary studies focused on new capability that can be enjoyed when introducing cloud computing. Thus, the study adopted obtainment of capability as an independent variable.

3.3 Cost efficiency

Francesco Maria Aymerich et al. [7] presented that from a structural perspective and a corporate perspective, cost reduction would be the advantage of cloud computing; Sean Marston et al. [18] cited lower cost for small- and mid-sized companies to advance into the appropriate market as another core advantages of cloud computing and mentioned that companies could enjoy the advantages of cloud computing without much investment when introducing cloud computing; and Peter Mell and Tim Grance [17] maintained that companies could reduce cost when introducing cloud computing. Therefore, the study adopted cost efficiency as an independent variable to examine the effects of cost efficiency on values.

3.4 Service quality

Sean Marston et al [18] reported that cloud computing was not possible to provide high-quality service and was short of standards, which could be an threatening factor, and mentioned that there were the regional, national, and international regulation factors; ENISA [5] cited compliance risks as one of the elements that were likely to threaten cloud computing; and the Financial Security Agency [22] also cited the compliance with applicable laws and regulations as one of the elements that were likely to threaten cloud computing. To that end, the study adopted service quality as an independent variable considering the fact that the harder standardization due to various regulations has caused not to provide high-quality service.
3.5 Management risk

Top threats to cloud computing V1.0 selected by CSA [1] consisted of seven problems in total, among which four problems such as abuse and inappropriate use of cloud computing, malicious internal personnel, data loss and leakage, and robbery of account, service and traffic were related to management risk. ENISA [5] mentioned threatening elements to cloud computing: lack of management, dependency on service provider, data protection, data deletion threat, and malicious internal personnel, which were all related to management risk; the Financial Security Agency [22] cited many issues related to management risk such as threat to certification and authorization, assurance of security level, and difficulty in responding accidents. Therefore, the study adopted management risk as one of the elements affecting values.

3.6 Technical security

Top threats to cloud computing V1.0 selected by CSA [1] dealt with the problems related to technical security such as unsafe application programming interface, vulnerability of common technology, data loss and leakage, and robbery of account, service and traffic. As well, ENISA [5] reported the problems related to technical security such as data protection and data deletion threat; and most of the issues dealt with by the Financial Security Agency [22] were related to technical security such as data loss and leakage threat, data modification threat, system and network security threat, and virtual machine security threat. Therefore, the study adopted technical security as one of the elements affecting values.

The author drew variables by analyzing the strengths and weaknesses of cloud computing and the opportunities and risk factors arising from the introduction of cloud computing, and applied such variables to VAM and established their own research model. In addition, for the various-angled analysis on perceived values, they added four more perspectives such as finance, process, customer, and business strategy. Figure 2 shows the research model.

**Fig. 2. Research model**

4. Future research

4.1 Design of measuring items
The study set variables as shown in Figure 2 following the analysis on the strengths and weaknesses of cloud computing which mentioned in the preliminary study. The author set six independent variables in total for benefits and sacrifice, each of which had three variables, suggesting such six variables affected perceived value and also influenced adoption intention. The author revealed that they would develop the measurement items for empirical studies on each variable in the future.

4.2 Method to collect materials

The author conducted the survey on the IT related experts and middle-class managers working in private and public institutions, all of whom have possessed the knowledge about cloud computing to a certain level and at the same time have had significant influential power to IT investment-related decision making of the organization, deemed the most appropriate subjects to measure the value of cloud computing service. The survey was conducted to measure the responses to the overall questions about demographical characteristics and organizational attention to cloud computing, whose questionnaire consisted of questions measured by the Likert 7-point scale.

5. Conclusion

The contributions of the study are inferred as follows:

First, even though many studies on the introduction of cloud computing have been conducted, such preliminary studies mostly focused on the fragmentary perspective and individual cases about technical characteristics and potential risk of cloud computing service, difficult for top executives to decide which elements should be considered on a comprehensive basis when introducing cloud computing. Thus, the study suggested the framework about adoption intention of cloud computing service based on the value-based adoption model (VAM), where the framework explained what was the benefit and sacrifice to be reviewed for the introduction of cloud computing and on which dimension the value of cloud computing should be reviewed.

Second, the study analyzed from various angles the value which was the variable affecting the introduction of cloud computing. To explicitly measure the effects of the concept of value which could be said a core to this paper on the introduction of cloud computing, the author adopted four perspectives from the balanced scorecard that was one of the comprehensive measurement indices to measure and manage corporate mission and strategy—finance, process, customer, and business strategy—and conducted analysis from various angles. Those multidimensional analysis helped progress in-depth research on value, suggesting more explicit ground for the adoption intention of cloud computing by the corporate.

Third, the study extracted and improved the core part of various advantages and disadvantages mentioned in the preliminary studies on cloud computing to the extent that the existing could be fit for cloud computing characteristics. Among the variables selected in VAM—usefulness, enjoyment, technicality, and perceived fee—‘enjoyment’ was eliminated since it had nothing to do with cloud computing. Usefulness was reviewed from two perspectives: managerial easiness and obtainment of capability. Perceived fee, a variable which belonged to the existing sacrifice, was moved to benefit and changed into cost efficiency, which was deemed more appropriate considering the features of cloud computing. As well, service quality that could not be disregarded in the features of cloud computing was added and technicality was also changed into technical security, which was deemed more
appropriate considering the features of cloud computing. Finally, management risk that felt more sensitive to security-related issues in corporate sector than in technical sector was added. Since the author analyzed the strengths and weaknesses of cloud computing from the preliminary studies and adopted appropriate issues as an independent variable, the form consisting of benefit and sacrifice that were two independent variable categories which affected perceived value in VAM model could be maintained intact; and since the core parts of strengths and weaknesses mentioned in the preliminary studies other than personal opinions were extracted, the study maintained its objectivity.
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Information Technology 3
Abstract: Research on developing pricing mechanisms for telecommunications has been going on for decades but what is being done in practice? We address this question in the context of non-profit telecommunications service providers in many states in the United States. This study begins with a discussion of several pricing schemes proposed in the literature, including cost-based pricing, pricing for best effort service, and pricing with Quality of Service guarantees (QoS), followed by an analysis of various pricing mechanisms adopted by 18 state network organizations. We describe nine rate card options in use which include five rate card options for cost-based pricing, two for best-effort pricing, and two for QoS pricing.

Keyword: Pricing, Telecommunications, Networks, State Network Organizations

1. Introduction

Appropriate telecommunication pricing is a primary key to success for a telecommunication services business. A concise and practical pricing mechanism that can improve revenue or at least recover the costs for telecommunications companies and consequently support the service differentiation is a critical necessity. Additionally, changes in the use of the Internet from the transport of traditional files to video or real time interaction traffic are essential factors to be considered in the pricing mechanism. Consequently, current Internet cost-based pricing schemes, such as flat rate pricing or the Fully Distributed Cost (FDC) pricing, may not be adequate for service providers to maintain the current infrastructure and integrate new technologies and service offerings (Courcoubetis & Weber, 2003).
Just like commercial service providers, non-profit organizations established to support the telecommunications needs of educational institutions and government entities also require a pricing mechanism that is suitable for their organizational structure and pricing objectives. Many states in the United States and indeed around the world have at least one non-profit organization that is responsible for providing network services to schools, colleges, and other state agencies. These agencies are sometimes known as “state network organizations.” Usually these state network organizations operate as an enterprise-type fund, meaning that even if they receive financial support from various sources such as state, federal, or university funding, they must recover at least some of their costs by billing their members or by justifying appropriations from the respective state authorities.

Although many pricing schemes have been introduced in the literature to price telecommunications networks, an appropriate pricing mechanism depends on each organization’s pricing objective, as there is no one pricing scheme that fits all organizations. Additionally, there are no telecommunications pricing schemes designed only for non-profit organizations. As a result, many state network organizations and also many commercial service providers adopt cost-based pricing schemes in order to simplify the rates charged to their members and the billing process.

A state network organization may have to assess its pricing policy along the following lines: Are the current rates adequate to recover its costs of operations? Do the current rates provide identifiable value to its members and compete with other service providers? Are the current rates fair to its members or do light users subsidize heavy users? Is its current network architecture ready for adopting other pricing mechanisms? What should the organization charge its members for services when it attempts to differentiate itself by adopting best effort or Quality of Service (QoS) pricing? To provide appropriate answers to those questions as best practices for these state network organizations, there is a need for an evaluation model to compare pricing schemes against the pricing objectives of each organization.

The purpose of this study is to provide an analysis of various telecommunications pricing mechanisms and propose a three-dimensional evaluation model to help state network organizations evaluate their pricing strategy to ensure that their services to members are priced efficiently and effectively. To the best of our knowledge, this is the first study to compile a comprehensive analysis of rate card options currently in place for state network providers. Although we present this research in the context of state network
organizations, it is equally applicable to other telecommunications service providers.

This paper is organized as follows: Current telecommunications pricing schemes proposed over the last decade are reviewed in section 2. These pricing schemes can be classified into three categories: cost-based pricing, pricing for best effort service, and pricing with Quality of Service guarantees. In section 3 we discuss our research methodology. Section 4 presents and summarizes pricing structures from various state network organizations including organizational objectives, members and services, funding sources, and rate options. A discussion of our overall results (including a three-dimensional model) and our conclusions are presented in section 5.

2. Current Telecommunications Pricing Schemes

This section briefly summarizes the literature on telecommunications pricing. The pricing schemes proposed over the last decade can be classified into three main categories: cost-based pricing, pricing for best effort services, and pricing with QoS guarantees. The following subsections contain an overview of the major telecommunications pricing models in each category.

2.1 Cost-based pricing

Cost-based pricing refers to prices that are directly related to costs. Some of the cost-based pricing models that have been proposed include Fully Distributed Cost (FDC) pricing, Ramsey pricing, and Flat rate pricing.

2.1.1 Fully Distributed Cost (FDC) pricing. FDC pricing allocates the total common and shared costs that the firm incurs among the services produced. Using the firm’s existing cost accounting records, FDC pricing is widely used due to its simplicity and the ability to audit the price construction. However, there are two major drawbacks of FDC pricing (Courcoubetis & Weber, 2003). First, prices are not optimal or stable, as the coefficients used to apportion the common cost factors are constructed without considering information about the operation of the facility. Second, FDC pricing does not include information on excess capacity and inefficient operation, out-of-date equipment, bad routing, and resource allocation.
2.1.2 Ramsey pricing. Ramsey pricing is another linear pricing scheme that can be used to maximize social welfare and minimize economic misallocation under the constraint of recovering costs. Ramsey prices are sustainable when service providers charge different prices to different customer groups (Berg, 1998). However, Ramsey pricing may not be sustainable if any service is priced below marginal cost and the economies of scale are not great enough (Courcoubetis & Weber, 2003). Additionally, some coalition customers with inelastic demands may end up paying more than the stand-alone costs of serving them, compared to customers with elastic demands. For a technical summary see (Mitchell & Vogelsang, 1991).

2.1.3 Flat rate pricing. Flat rate pricing is commonly used by service providers. A customer pays a fixed amount for a service at the time the contract is purchased regardless of the actual usage. Customers are charged the average cost of other customers in the same customer group. Customers can predict the resource usage and purchase the minimum contract that accommodates their needs. Also, pricing is usually through flat monthly or annual rates depending upon access speed (Courcoubetis & Weber, 2003). Even though flat rate pricing is simple to implement and can minimize the accounting overhead, it tends to produce high social cost due to the waste of resources and it generally does not offer service differentiation (Li & Wang, 2005). Also, flat rate pricing can generate the perception of unfairness to individual customers when some users tend to overuse the resources (Courcoubetis & Weber, 2003). This type of problem, however, can be solved by policing the users’ traffic when it exceeds the maximum resources allowed by the contract.

2.2 Pricing for Best Effort Service

“Best effort” refers to a network service that treats all types of traffic indifferently with no delivery guarantee and with the possibility of traffic loss (Shin, F. Cope, F. Cope, & Tucci, 2006). In this “best effort” pricing section, five major pricing schemes are discussed: Usage-based pricing, Smart Market, Congestion Discount, charging flexible contracts, and Paris Metro Pricing.

2.2.1 Usage-based Pricing. The basic idea of usage-based pricing is to charge the customers for what they actually consume (Courcoubetis & Weber, 2003). Three main factors, including time, volume, and distance, are commonly used in this pricing model (Li & Wang, 2005). Additionally, this pricing scheme can be used to (1) allocate service classes to different uses, (2) prioritize usage of a congested resource so that customers who value the access the most will get the highest priority, and (3) recover costs of providing services (Jeffrey K.
MacKie-Mason & Varian, 1995). However, poorly-designed usage-based prices can cause a problem when the benefits the firms provide exceed the accounting and transaction costs.

2.2.2 Smart Market. Smart Market is one of the congestion pricing schemes that imposes a per-packet-charge reflecting marginal congestion costs. MacKie-Mason and Varian (1993) defined “Smart Market” as “a price for packet access to the net that varies minute-by-minute to reflect the current state of the network congestion” (p.25). First, users assign a “bid” value for each packet to indicate the amount the sender is willing to pay for sending it. Second, each packet has a probability of being admitted if the bid exceeds the current threshold bid value among the routers in the network. This probability depends on the congestion level at the particular router. Finally, users pay the market-clearing price, which is the highest threshold value that the packet passed through.

2.2.3 Congestion Discount. Keon and Anandalingam (2005) propose a new pricing approach using price discounts as an incentive to “shift demand from congested to uncongested periods in telecommunications systems” (p.261). Their congestion discount model consists of three main steps: the evaluation of the time to offer the discounting scheme, the discount rate estimation, and the prediction of the proportion of customers who will accept the discount. In this case, customers have an option to accept the discount rate and delay the use of service or reject the discount offer and use the service immediately.

2.2.4 Charging Flexible Contracts: Flexible service contracts can benefit both service providers and customers in many ways. The customers can vary the amount of resources by changing their willingness to pay more without the need to predict and reserve maximum resource requirements. Meanwhile, the service providers may not need to reserve the resources and can accommodate more services to customers. Normally, contracts with flexible guarantees are appropriate for elastic application, referring to adaptation to a varying availability of network resources (Courcoubetis & Weber, 2003).

2.2.5 Paris Metro Pricing: Odlyzko (1999) proposed the Paris Metro Pricing (PMP) model as the simplest differentiated service solution. The general idea of PMP is to split a network into several logically different channels with a fixed fraction of the network capacity. In each channel, packets using similar protocols are treated equally. Customers are charged based on the channel
chosen to send their packets. The higher the price for the channel, the less the channel congestion, which means the better the service provided.

Additional pricing models discussed in the literature are Shadow pricing, Edge pricing, and Zone-based cost sharing (Nguyen & Armitage, 2005), Priority pricing and the Game theory models (N. J. Keon & Anandalingam, 2003; Sumbwanyambe, Nel, & Clarke, 2011), and Peak-load pricing mechanism (Batubara, Huat, & Singh, 2010). These pricing schemes aim to solve the problem of charging and pricing in a best effort network.

2.3 Pricing with Quality of Service Guarantees

Quality of Service (QoS) refers to networks that are capable of “providing better service to selected network traffic over various technologies” by (1) providing different priorities to different users or data flows, (2) ensuring no traffic loss, and (3) providing timely delivery guarantees (Guerrero-Ibanez, Contreras-Castillo, Barba, & Reyes, 2010; N. J. Keon & Anandalingam, 2003; Shin, et al., 2006). As the best effort service cannot provide all the characteristics of Quality of Service (QoS) where customers demand, the following enhancements have been proposed: Integrated Services (IntServ), Differentiated Service (DiffServ) architectures (Shin, et al., 2006), multiclass based network pricing (Zhang & Verma, 2011), customer loyalty based pricing model (Biczok, Kardos, & Trinh, 2010). Another method used in differentiated service is the allocation of a fixed bandwidth to each priority class (Nguyen & Armitage, 2005). In this section, only two major pricing schemes, the IntServ and DiffServ, are discussed. For greater detail, see (McKnight & Boroumand, 2000).

2.3.1 Pricing for Integrated Services (IntServ): The IntServ architecture was an early system that used the Resource Reservation Protocol (RSVP) for reserving network resources. This IntServ model focuses on per-flow resource reservation and is based on mathematical guarantees (Shin, et al., 2006). Karsten et al. (1998) propose an embedded charging model in the RSVP architecture for an integrated services network (Karsten, Schmitt, Wolf, & Steinmetz, 1998). Frankhauser et al. (1998) also present RSVP charging and accounting in the IntServ network (Fankhauser, Stiller, Christoph, & Plattner, 1998). Both of these studies aim to develop an understanding of the basic framework of a charging and accounting approach for an RSVP-based QoS reservation in the IntServ network. Essentially, PATH and RESV messages in RSVP transmit pricing information between senders and receivers. First,
PATH messages carry information on the amount the senders are willing to pay; meanwhile the current market prices of the QoS the senders request are updated into the price field. If the receivers agree with the price requested by the senders, RESV messages are returned to the senders with the calculated prices (Nguyen & Armitage, 2005).

2.3.2 Pricing for Differentiated Service (DiffServ): Unlike the IntServ model, the DiffServ model provides low latency guaranteed service by focusing on supporting QoS for flow aggregates (Shin, et al., 2006). Bouras and Sevasti (2005) present a model for the service provisioning procedure for the deployment of DiffServ-based Service Level Agreements (SLAs) in a bilateral fashion. The pricing of the contracted service is determined by the SLA between a member and a service provider (Bouras & Sevasti, 2005). Ercetin and Tassiulas (2005) propose DiffServ pricing strategies for content delivery networks. The optimal pricing strategy for monopolistic surrogates, which offer several service classes to the publishers, is investigated. The publishers of the Internet content refer to the web sites, which are the original servers. The investigation of this optimal pricing problem is divided into three main procedures in order to find the number of service classes the surrogate should offer to maximize its benefit. These three procedures include (1) determining the optimal number of service classes given to publishers, (2) finding the optimal resources allocated to each service class, and (3) formulating an optimal resource tariff.

The brief literature review in this section is intended to provide an overview of various pricing schemes which are available for the telecommunications service providers. Our study finds that only a few pricing schemes have actually been implemented by state network organizations. Many of these pricing schemes are viewed as alternatives and have not been practically adopted by any state network organization. The next section briefly discusses the research methodology of this study.

We collected information on pricing mechanisms in practice by working with two organizations, StateNets and The Quilt. StateNets is a Net@EDU working group, operating under EDUCAUSE, a nonprofit association providing services for public sector organizations by promoting the intelligent use of information technology (see http://educause.edu/StateNets). The mission of StateNets member organizations is to operate statewide networks to serve a substantial portion of states’ K-12 schools, higher education institutions, libraries, and state and municipal governments. The StateNets group is composed of state network organizations in the U.S. which focus on the same common interests. The Quilt is another coalition of advanced regional network organizations aiming at promoting advanced networking services throughout the research and education network community (see www.thequilt.net).

Recently, StateNets and The Quilt began a collaborative project to document business models through surveys. Data from these surveys, combined with phone interviews and email, were used for this study. Thirteen participating organizations were interviewed by The Quilt group but only seven case studies were used for pricing analysis. The participating organizations were asked to provide an overview of their business, a financial plan, the services and pricing strategy, management and operations, lessons learned, and finally, their future plans. The StateNets group sent its survey to all 30 members but only seven state network organizations completed the survey. The participating organizations were asked to provide information on organizational structure, services and constituents, scope of business, revenues, expenses, funding, and pricing. Four other state network organizations agreed to share their business model and pricing strategies via email and phone interviews.

As a result, 18 state network organizations were involved in providing pricing information. Table 1 lists the participating state network organizations and their locations, which are from all regions of the United States. Even though this was a limited convenience sample rather than an exhaustive review of all 50 states, incomplete surveys from the other 32 state network organizations and information gathered from search engines and their websites implied pricing structures similar to those presented in this study. Thus, we believe that pricing formulas and rate card options summarized from the 18 state network organizations represent the prevalent pricing structures for other state network organizations as well.
Table 1: Participating State Network Organizations

<table>
<thead>
<tr>
<th>No.</th>
<th>State</th>
<th>Network Org.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Kansas</td>
<td>Kan-ed</td>
<td>Kansas Board of Regents</td>
</tr>
<tr>
<td>2</td>
<td>Kansas</td>
<td>KanREN</td>
<td>Kansas Research and Education Network</td>
</tr>
<tr>
<td>3</td>
<td>Ohio</td>
<td>OSCNet</td>
<td>Ohio Super Computing network</td>
</tr>
<tr>
<td>4</td>
<td>Wisconsin</td>
<td>WisNet</td>
<td>Wisconsin Research and Education Network</td>
</tr>
<tr>
<td>5</td>
<td>Missouri</td>
<td>MoreNet</td>
<td>The Missouri Research and Education Network</td>
</tr>
<tr>
<td>6</td>
<td>Michigan</td>
<td>MeritNet</td>
<td>Michigan Research and Education Network</td>
</tr>
<tr>
<td>7</td>
<td>Illinois</td>
<td>ICN</td>
<td>Illinois Century Network</td>
</tr>
<tr>
<td>8</td>
<td>New York</td>
<td>NYSERNet</td>
<td>New York State Education and Research Network</td>
</tr>
<tr>
<td>9</td>
<td>Rhode Island</td>
<td>OSHEAN</td>
<td>A coalition of the Rode Island Technology Community Network</td>
</tr>
<tr>
<td>10</td>
<td>Northeast</td>
<td>NEREN</td>
<td>Northeast Research and Education Network</td>
</tr>
<tr>
<td>11</td>
<td>New Jersey</td>
<td>Njedge.net</td>
<td>New Jersey Higher Education Network</td>
</tr>
<tr>
<td>12</td>
<td>Georgia</td>
<td>SLR/Sox</td>
<td>Southern Light Rail (SLR) and Southern Crossroads (SoX)</td>
</tr>
<tr>
<td>13</td>
<td>Oklahoma</td>
<td>OneNet</td>
<td>Oklahoma State Regions for Higher Education</td>
</tr>
<tr>
<td>14</td>
<td>Florida</td>
<td>FLR</td>
<td>Florida LambdaRail, LLC</td>
</tr>
<tr>
<td>15</td>
<td>Texas</td>
<td>LEARN</td>
<td>Lonestar Education and Research Network</td>
</tr>
<tr>
<td>16</td>
<td>North Carolina</td>
<td>NCREN/MCNC</td>
<td>North Carolina Research and Education Network</td>
</tr>
<tr>
<td>17</td>
<td>California</td>
<td>CENIC</td>
<td>The Corporation for Education Network Initiatives in California</td>
</tr>
<tr>
<td>18</td>
<td>Utah</td>
<td>UEN</td>
<td>Utah Education Networks</td>
</tr>
</tbody>
</table>

4. Observed Pricing Models

Table 2 provides a comparative framework regarding the legal form of organization, funding sources, and network information among 18 state network organizations. The organizations are listed in random order (not the same order as in Table 1) and labeled as State 1-State 18 to protect their identity.
<table>
<thead>
<tr>
<th>Name</th>
<th>Funding</th>
<th>Network Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>State 1</td>
<td>Government funding</td>
<td>Leased line networks</td>
</tr>
<tr>
<td>State 2</td>
<td>80% funded by state appropriation and 20% recovered from its members and service fees</td>
<td>Leased fiber networks, Frame Relay networks, and ATMs networks</td>
</tr>
<tr>
<td>State 3</td>
<td>State Universal Service fund (SUSF) and State General Funds (SGF)</td>
<td>Leased and owned fiber network</td>
</tr>
<tr>
<td>State 4</td>
<td>Government funding and member funded network</td>
<td>Leased networks from Cogent, Qwest, Abilene/Internet2</td>
</tr>
<tr>
<td>State 5</td>
<td>Grants and fees for services</td>
<td>Leased fiber networks</td>
</tr>
<tr>
<td>State 6</td>
<td>100% funded by its members</td>
<td>Indefeasible Right of Use (IRU) fiber networks</td>
</tr>
<tr>
<td>State 7</td>
<td>Government and member funded network</td>
<td>Leased fiber, NLR Topology, and Leased Lambda</td>
</tr>
<tr>
<td>State 8</td>
<td>Funded by its members</td>
<td>Leased and owned fiber network</td>
</tr>
<tr>
<td>State 9</td>
<td>Funding through member institutions (State is not involved)</td>
<td>Owned fiber networks</td>
</tr>
<tr>
<td>State 10</td>
<td>State appropriation funds, State Universal Service Fund (SUSF), private funding</td>
<td>Owned fiber (19.8%), Indefeasible Right of Use (IRU) (2.4%), and Leased fiber (77.8%)</td>
</tr>
<tr>
<td>State 11</td>
<td>The state board of regents and low interest loan</td>
<td>Dark fiber DWDM and IRUs networks</td>
</tr>
<tr>
<td>State 12</td>
<td>Endowment and state legislation</td>
<td>Resilient ring – fiber, Owned fiber (0.6%), Indefeasible Right of Use (IRU) (19.9%), Leased fiber (97.5%)</td>
</tr>
<tr>
<td>State 13</td>
<td>100% funded by its members</td>
<td>100% Leased fiber networks</td>
</tr>
<tr>
<td>State 14</td>
<td>Member funded network</td>
<td>NLR fiber networks: a 20 year Indefeasible Right of Use (IRU) on 1,540 miles of fiber optic cable</td>
</tr>
<tr>
<td>State 15</td>
<td>Member funded network</td>
<td>Owned fiber-Ethernet as backbone (Metro-Dark fiber networks)</td>
</tr>
<tr>
<td>State 16</td>
<td>State appropriation funds</td>
<td>Indefeasible Right of Use (IRU) networks, 1 Gbps backbone ring, Leased-T1 Frame Relay, Leased-ATM</td>
</tr>
<tr>
<td>State 17</td>
<td>100% funded by its members</td>
<td>Leased-on dark fiber</td>
</tr>
<tr>
<td>State 18</td>
<td>State appropriation funds and fees for services</td>
<td>Leased ATM switch and Frame Relay network with owned fiber</td>
</tr>
</tbody>
</table>

### 4.1 Rate Card Options

Based upon its legal form of organization and its organizational structure, pricing structures vary depending mainly on network architecture, organizational objectives and funding sources. Normally, rates for services are set on a yearly basis; however, possible rate changes may take place based on the organization’s financial position. Some state network organizations offer
multi-year rates. Some states do not offer multi-year rates, but rather monthly rates. As presented in Table 3 and Figure 1, cost-based pricing is used by 14 state network organizations, while two state network organizations have moved to best effort pricing and the other two have adopted QoS pricing. Nine rate card options have been derived from the 18 state network organizations: five rate card options for cost-based pricing, two rate card options for best-effort pricing, and two rate card options for QoS pricing. Table 4 summarizes the use of various rate card options across the respondents. Each rate card option from the different pricing schemes is explained as follows.

Table 3: Pricing Schemes and Rate Card Options

<table>
<thead>
<tr>
<th>Name</th>
<th>Pricing Schemes</th>
<th>Rate Card Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>State 1</td>
<td>Cost-Based Pricing</td>
<td>Flat member fee plus ISPs or &quot;Last Mile&quot;</td>
</tr>
<tr>
<td>State 2</td>
<td>Cost-Based Pricing</td>
<td>Flat member fee plus ISPs or &quot;Last Mile&quot;</td>
</tr>
<tr>
<td>State 3</td>
<td>Cost-Based Pricing</td>
<td>Flat member fee plus ISPs or &quot;Last Mile&quot;</td>
</tr>
<tr>
<td>State 4</td>
<td>Cost-Based Pricing</td>
<td>Class based rate</td>
</tr>
<tr>
<td>State 5</td>
<td>Cost-Based Pricing</td>
<td>Class based rate</td>
</tr>
<tr>
<td>State 6</td>
<td>Cost-Based Pricing</td>
<td>Class based rate</td>
</tr>
<tr>
<td>State 7</td>
<td>Cost-Based Pricing</td>
<td>Bandwidth based rate</td>
</tr>
<tr>
<td>State 8</td>
<td>Cost-Based Pricing</td>
<td>Bandwidth based rate</td>
</tr>
<tr>
<td>State 9</td>
<td>Cost-Based Pricing</td>
<td>Bandwidth based rate</td>
</tr>
<tr>
<td>State 10</td>
<td>Cost-Based Pricing</td>
<td>Bandwidth based rate</td>
</tr>
<tr>
<td>State 11</td>
<td>Cost-Based Pricing</td>
<td>Bandwidth based rate</td>
</tr>
<tr>
<td>State 12</td>
<td>Cost-Based Pricing</td>
<td>Bandwidth based rate</td>
</tr>
<tr>
<td>State 13</td>
<td>Cost-Based Pricing</td>
<td>Fixed three-year Bandwidth based rate</td>
</tr>
<tr>
<td>State 14</td>
<td>Cost-Based Pricing</td>
<td>Class, FTE and Bandwidth based rate</td>
</tr>
<tr>
<td>State 15</td>
<td>Best Effort Pricing</td>
<td>Flat member fees plus actual physical connection fee, participation fee, and lambda fee</td>
</tr>
<tr>
<td>State 16</td>
<td>Best Effort Pricing</td>
<td>Bandwidth based pricing with surcharge for over bandwidth usage and &quot;charging flexible contract&quot; options</td>
</tr>
<tr>
<td>State 17</td>
<td>QoS Pricing</td>
<td>FTE-based pricing with QoS service</td>
</tr>
<tr>
<td>State 18</td>
<td>QoS Pricing</td>
<td>Individual-based with QoS service</td>
</tr>
<tr>
<td>Rate Card Options</td>
<td>State Network Organizations</td>
<td>No. of States</td>
</tr>
<tr>
<td>-------------------------------------------------------</td>
<td>----------------------------</td>
<td>---------------</td>
</tr>
<tr>
<td>1. Flat member fee plus last mile</td>
<td>State 1 - State 3</td>
<td>3</td>
</tr>
<tr>
<td>2. Class-based rate</td>
<td>State 4 - State 6</td>
<td>3</td>
</tr>
<tr>
<td>3. Bandwidth-based rate</td>
<td>State 7 - State 12</td>
<td>6</td>
</tr>
<tr>
<td>4. Fixed three-year bandwidth-based rate</td>
<td>State 13</td>
<td>1</td>
</tr>
<tr>
<td>5. Class, FTE, and bandwidth-based rate</td>
<td>State 14</td>
<td>1</td>
</tr>
<tr>
<td>6. Flat rate plus actual usage</td>
<td>State 15</td>
<td>1</td>
</tr>
<tr>
<td>7. Charging flexible contract-based rate</td>
<td>State 16</td>
<td>1</td>
</tr>
<tr>
<td>8. Individual QoS based rate</td>
<td>State 17</td>
<td>1</td>
</tr>
<tr>
<td>9. QoS, Class, and FTE based rate</td>
<td>State 18</td>
<td>1</td>
</tr>
</tbody>
</table>

Figure 1: Pricing Schemes and Rate Card Options
4.1.1 **Rate Card Option 1: Flat rate member fees plus Last Mile Costs**

We found that three state network organizations use cost-based flat fee plus Last Mile pricing. This rate card pattern varies among organizations depending on the level of service provided, various types of costs, the cost allocation model, and funding sources. Each member organization contributes a certain amount for a core program (no services included). However, the amount paid to Internet Service Providers (ISP) as the Last Mile connection is billed separately from the participant fees depending on the level of bandwidth subscribed to.

4.1.2 **Rate Card Option 2: Class-based flat rate**

Another form of cost-based pricing in which the rate is set is the class-based flat rate. Three of the respondents have adopted this option. The way to define “class” varies among organizations. The bandwidth for a member is set on an individual basis, meaning that two members in the same class paying the same annual membership fee may or may not have the same size of connections depending on the service-level agreement between the state network organization and the member. Table 5 presents an example of a class-based flat rate for a particular state network organization in which seven classes are defined. Members are also responsible for additional charges such as installation fees and other value-added services fees, which are not part of the cost allocation model.

Table 5: Sample Rate Card Option 2 (Class-Based Flat Rate)

<table>
<thead>
<tr>
<th>Institution Type</th>
<th>Annual Membership Fee</th>
<th>Additional Charges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class A Large research and university</td>
<td>$20,000-80,000</td>
<td>Additional charges include installation fees, and support services such as video services, and internet appliance</td>
</tr>
<tr>
<td>Class B Large community colleges</td>
<td>$15,000</td>
<td></td>
</tr>
<tr>
<td>Class C Small community colleges</td>
<td>$7,500</td>
<td></td>
</tr>
<tr>
<td>Class D Large libraries, nonprofit orgs</td>
<td>$6,000</td>
<td></td>
</tr>
<tr>
<td>Class E Small libraries, K-12</td>
<td>$1,000</td>
<td></td>
</tr>
<tr>
<td>Class F Consortium/intranet connected sites</td>
<td>$200</td>
<td></td>
</tr>
</tbody>
</table>
4.1.3 Rate Card Option 3: Bandwidth-based rate

In this option, the rate fees are set on a bandwidth basis in which each bandwidth level has the same underlying cost in dollars per Mbps per month. We found that this bandwidth-based rate is one of the most common rate card options; it is used by six state network organizations. Some state network organizations may set up an annual flat membership or participation fee in addition to the bandwidth connection fees. The level of bandwidth-based rates varies among organizations depending on their service offerings and network architecture. For instance, one state network organization offers nine bandwidth-based tier charges as presented in Table 6, while another state network organization offers nineteen bandwidth-based tier rates.

**Table 6: Sample Rate Card Option 3 (Bandwidth-Based Rate)**

<table>
<thead>
<tr>
<th>Bandwidth Type</th>
<th>Baseline BW</th>
<th>Annual Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>56K</td>
<td>56 Kbps</td>
<td>$3,156</td>
</tr>
<tr>
<td>T1</td>
<td>1.5 Mbps</td>
<td>$6,168</td>
</tr>
<tr>
<td>Ethernet</td>
<td>10 Mbps</td>
<td>$24,396</td>
</tr>
<tr>
<td>DS3-Dedicated Circuit</td>
<td>44.73 Mbps</td>
<td>$42,120</td>
</tr>
<tr>
<td>Fast Ethernet</td>
<td>100 Mbps</td>
<td>$27,600</td>
</tr>
<tr>
<td>OC-3</td>
<td>155 Mbps</td>
<td>$60,000</td>
</tr>
<tr>
<td>OC-12</td>
<td>622 Mbps</td>
<td>Individual Case Basis</td>
</tr>
<tr>
<td>Gigabit Ethernet</td>
<td>1 Gbps</td>
<td>Individual Case Basis</td>
</tr>
<tr>
<td>10 Gigabit Ethernet</td>
<td>10 Gbps</td>
<td>Individual Case Basis</td>
</tr>
</tbody>
</table>

The first three rate card options are derived from the allocation of individual and shared costs among members. For flat rates, all members in the same group share the same amount of cost, while class-based rates and bandwidth-based rates involve the allocation of cost into each class or bandwidth level, meaning that all members in the same class or subscribing to the same bandwidth share the underlying costs. Since all state network organizations are non-profit organizations that mainly provide services to research and educational institutions, the ultimate goal is to recover the costs of operations. Thus, as presented in equation 1, the pricing structure ideally starts with the goal of zero profit, meaning that the total cost of operations for an organization ($C_{TOTAL}$) will be recovered by funding support ($F_{FUNDING,i}$) and revenue gathered from its members ($R_i$) through the rate card options presented in Tables 4, 5, and 6, where “T” refers to the total number of members of an organization and “n” refers to the total number of funding sources.

$$ C_{TOTAL} = \sum_{i=1}^{T} R_i + \sum_{i=1}^{n} F_{FUNDING,i} $$  \(1) \]
Whether funding support is from the members or state governments, equations 2, 3, and 4 presents the pricing formula that represents many state network organizations’ cost-based pricing structure.

\[ R_{1,i} = M_i + E_i + S_i + L_i \]
\[ = \frac{A + F + O + N + L}{t} + E_i + S_i + L_i \]  
\[ (2) \]

\[ R_{2,i}(c) = \left( \frac{G_i}{\sum G_i} \right) \cdot (A + F + O + N + L) + E_i + S_i \]
Where \( R_i \in c \) where “c” refers to the class of members, \( c = 1, 2, 3, \ldots, k \)  
\[ (3) \]

\[ R_{3,i}(s) = \left( \frac{B_i}{\sum B_i} \right) \cdot (A + F + O + N + L) + E_i + S_i \]
Where \( R_i \in s \) where “s” refers to the class of bandwidth subscription, \( s = 1, 2, 3, \ldots, j \)  
\[ (4) \]

For the rate card option 1, Flat Fees plus Last Mile, The rate charged to member “i” \((R_{1,i})\) is derived from a fixed member fee \((M_i)\) plus individual Last Mile \((L_i)\) and other costs associated with providing the services to individual member such as equipment cost \((E_i)\) and service cost \((S_i)\). All members pay the same fixed member fee \((M_i)\), which is derived from the equal allocation of various types of costs including total administrative cost \((A)\), total fixed cost \((F)\), total operations cost \((O)\), and total network cost \((N)\).

Because of the different bandwidths (56K, T1, DS3, Ethernet, Fast Ethernet, OC3, OC12, or Gigabit Ethernet) and different types of members (academic and research institutions, state-government agencies, libraries, hospitals, and for-profit organizations), the allocation method for rate card options 2 \((R_{2,i})\) and 3 \((R_{3,i})\) varies based on a group weighting factor \((G_i)\) and a bandwidth scaling factor \((B_i)\). Table 7 presents an example of group weighting factor \((G_i)\), where “c” is equal to 1, 2, 3, and 4 and Table 8 presents an example of bandwidth scaling factor \((B_i)\), where “s” is equal to 1 to 7.

The term \( \frac{G_i}{\sum G_i} \) in equation 2 provides a weighted average of class-based weight factors for a particular client in class “c”. Similarly \( \frac{B_i}{\sum B_i} \) in equation 3 provides a weighted average of bandwidth based weight factors for a particular client subscribing to bandwidth level “s”. By summing the factors across all clients, the denominator becomes a weighted sum of the factors based on number of clients in each category. These terms allow the relevant costs to be
allocated to a specific client based on the clients’ member class “c” and bandwidth level “s”. These are described further in the next few paragraphs.

According to equation 3, $G_i$ refers to a group weighting factor assigned to individual member “i” who is responsible for sharing the administrative cost (A), fixed cost (F), operations cost (O), network cost (N), and Last Mile (L). The term $\sum_i(G_i)$ adds the group weighting factors on the basis of number of members, who are responsible for sharing those associated costs in each member class. Similarly, $B_i$ in the equation 4 refers to a bandwidth scaling factor assigned to individual member “i” when $\sum_i(B_i)$ adds the bandwidth scaling factors on the basis of number of members, who are responsible for sharing the administrative cost (A), fixed cost (F), operations cost (O), network cost (N), and Last Mile (L) in each bandwidth class.

### Table 7: Sample Group Weight Factor ($G_i$)

<table>
<thead>
<tr>
<th>Member Class (c)</th>
<th>Member Class Description</th>
<th>Group Weighting Factor ($G_i$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Higher Education and Research Inst.</td>
<td>0.4</td>
</tr>
<tr>
<td>2</td>
<td>K-12</td>
<td>0.3</td>
</tr>
<tr>
<td>3</td>
<td>Other Not-For-Profit Organizations</td>
<td>0.2</td>
</tr>
<tr>
<td>4</td>
<td>Other For-Profit Organizations</td>
<td>0.1</td>
</tr>
</tbody>
</table>

### Table 8: Sample Bandwidth Scaling Factor ($B_i$)

<table>
<thead>
<tr>
<th>Bandwidth Class (s)</th>
<th>Bandwidth Class Description</th>
<th>Baseline Bandwidth ($B_i$) - (Mbps)</th>
<th>Bandwidth Scaling Factors ($B_i$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>56K</td>
<td>0.056</td>
<td>0.19</td>
</tr>
<tr>
<td>2</td>
<td>T1</td>
<td>1.5</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Ethernet</td>
<td>10</td>
<td>2.58</td>
</tr>
<tr>
<td>4</td>
<td>DS3</td>
<td>44.736</td>
<td>5.46</td>
</tr>
<tr>
<td>5</td>
<td>Fast Ethernet</td>
<td>100</td>
<td>8.16</td>
</tr>
<tr>
<td>6</td>
<td>OC-3</td>
<td>155</td>
<td>10.17</td>
</tr>
<tr>
<td>7</td>
<td>Gigabit Ethernet</td>
<td>1000</td>
<td>25.82</td>
</tr>
</tbody>
</table>

### 4.1.4 Rate Card Option 4: Fixed three-year bandwidth-based rate

In addition to the traditional flat rate, class-based rate, and bandwidth-based rate, one state network organization is considering charging its members the same fixed costs three years in a row with unlimited bandwidth access to the Internet.
Generally, members pay a surcharge for over-bandwidth usage for the next fiscal year’s contract. However, with this new pricing strategy, every member pays a uniform membership fee (Ü) plus network access fees (Ñ) determined by the average fees from comparable educational members with close student ratios (S_r) for three consecutive years. A member may need to purchase an additional Last Mile (L_i), also known as a data circuit or Internet transport, in order to meet bandwidth needs.

4.1.5 Rate Card Option 5: Class, FTE and bandwidth-based rate

As the majority of state network members are academic institutions, one organization includes full time enrollment (FTE) as one of the factors in pricing its members. Table 9 presents the examples of class, FTE and bandwidth-based rates where the member fee structure varies depending on the type of member. K-12 and higher education fees are calculated based on a combination of size of school and size of connection. Library fees are based on tax revenues, and affiliate fees are based on size of connection.

Table 9: Sample Rate Card Option 5 (Class, FTE, and Bandwidth-Based Rate)

<table>
<thead>
<tr>
<th>K-12 Enrollment (FTE)</th>
<th>up to 3 Mbps</th>
<th>&gt;3-10 Mbps</th>
<th>&gt;10-20 Mbps</th>
<th>…………</th>
<th>&gt;80-100 Mbps</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-249</td>
<td>$2,250</td>
<td>$3,488</td>
<td>$4,725</td>
<td>…………</td>
<td>$9,675</td>
</tr>
<tr>
<td>250-499</td>
<td>$3,487</td>
<td>$4,725</td>
<td>$5,962</td>
<td>…………</td>
<td>$10,913</td>
</tr>
<tr>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>8,000+</td>
<td>$9,675</td>
<td>$10,913</td>
<td>$12,150</td>
<td>…………</td>
<td>$17,100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Higher Education (FTE)</th>
<th>Member Service Fee</th>
<th>Network Connectivity</th>
<th>Connection Related Fees</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 1,500</td>
<td>$5,000</td>
<td>$562 per Mbps</td>
<td>Additional charge such as installation Fees, and line charge</td>
</tr>
<tr>
<td>1,501 to 5,000</td>
<td>$9,000</td>
<td>$562 per Mbps</td>
<td></td>
</tr>
<tr>
<td>5000+</td>
<td>$13,400</td>
<td>$562 per Mbps</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Library Tax Revenue</th>
<th>Local Cost Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than $24,999</td>
<td>$300</td>
</tr>
<tr>
<td>$24,999 - $74,998</td>
<td>$600</td>
</tr>
<tr>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>$2,999,999 or greater</td>
<td>$12,000</td>
</tr>
</tbody>
</table>
Equation 5 presents the rate \( R_{5,i} \) charged to member “i”, which is based on (1) the allocation of member fees \( M_F \) and connection management fees \( C_{CM} \) and (2) individual Last Mile or tail circuit costs \( L_i \) and for-fee-services \( S_i \) for individual member “i”. Member fees \( M_F \) for individual member “i” are set by member classes, which are based on the size of the connection and the size of the organization \( \hat{S}_i \) as measured by number of students (FTE) and tax revenue. The member fees include the administrative cost, fixed cost, operations cost, and other related network cost, i.e. the cost of managing and supporting the current network such as Internet 2, training, online resources support, and E-rate support. Connection management fees \( C_{CM} \) for individual member “i” are based on actual total annual costs of circuit and connection equipment management, the total number of connections \( \hat{I} \), and number of circuits and connections for member “i” \((N_{CC})_i\). Last Mile or tail circuit costs \( L_i \) refers to costs paid to telecommunications providers for tail circuit connections and for related equipment and maintenance. Lastly, for-fee-services \( S_i \) are based on an estimated three-year effort and cost for the service and three-year projected sales, in which pricing varies by volume.

\[
R_{5,i} = M_F \left( \frac{\hat{S}_i}{\sum_i \hat{S}_i} \right) + C_{CM} \left( \frac{(N_{CC})_i}{\sum_i (N_{CC})_i} \right) + L_i + S_i \\
= \left( A \frac{g_i}{\sum_i g_i} + F \frac{b_i}{\sum_i b_i} + O \frac{b_i}{\sum_i b_i} + \left( N \frac{g_i}{\sum_i g_i} \right) \left( \frac{\hat{S}_i}{\sum_i \hat{S}_i} \right) \right) + C_{CM} \left( \frac{(N_{CC})_i}{\sum_i (N_{CC})_i} \right) + L_i + S_i
\]

(5)

As presented in equations 2-5, the majority of state network organizations have adopted a cost-based pricing scheme as the simplest solution because not only it does not need an additional accounting architecture, but also the organizations have an accurate way to predict and control costs and revenues, respectively.

In contrast to the cost-based pricing, however, two state network organizations attempt to differentiate themselves by adopting best effort pricing through usage-based pricing and charging flexible contracts with the organizational goal of (1) increasing network efficiency, as the flat rate encourages resource waste resulting in less resource utilization, (2) prioritizing usage, meaning that those who value access the most get the highest priority, and especially (3) supporting an economic point of view by providing the ability to charge members based on their actual use of network resources. For instance, one state network organization indicates that its previous flat rate model has a major flaw: penalizing light-use members with respect to heavy-use ones. The rate
card options adopting best effort pricing are explained in sections 4.1.6 and 4.1.7.

4.1.6 Rate Card Option 6: Flat rate plus additional usage fees

Each member is responsible for a flat membership fee which is based on fixed expenses associated with the network access services. These expenses are divided among all members. Members are also invoiced for services beyond their bandwidth subscriptions. Rates are based upon actual bandwidth usage. However, the charge per Mbps varies among types of members. For instance, beyond the membership fee, any for-profit organizations are charged a higher rate compared to non-profit organizations such as research and educational institutions. In addition, connection fees are paid by each member that deploys an actual physical connection to the organization’s backbone.

As presented in equation 6, usage-based pricing has been developed from the traditional cost-based pricing structure as presented in equation 2 by including actual bandwidth usage \((B_A)\) into the model. However, a penalty charge or surcharge \((P)\) may be applied when member “\(i\)” consumes resources over the baseline bandwidth subscription \((B_s)\).

\[
R_{6,1}(c, s) = \frac{A \cdot G_i}{\sum_i G_i} + F \cdot \frac{B_i}{\sum_i B_i} + O \cdot \frac{B_i}{\sum_i B_i} + E_i + S_i + L_i + \left( \frac{B_i}{\sum_i B_i} \right) \left( \frac{P(B_{A,i} - B_{s,i})}{100} \right)
\]

(6)

Pricing with a congestion discount is commonly used by Internet Services Providers (ISPs). However, no state network organizations appear to have implemented it yet. Rather they view it as one of the best effort pricing alternatives as presented in equation 7.

\[
R_{6,1}(c, s) = \frac{A \cdot G_i}{\sum_i G_i} + F \cdot \frac{B_i}{\sum_i B_i} + O \cdot \frac{B_i}{\sum_i B_i} + E_i + S_i + L_i + \left( \frac{B_i}{\sum_i B_i} \right) \left( \frac{P(B_{A,i} - B_{s,i})}{100} \right) + C_{CONG,i}
\]

(7)

Where, \(C_{CONG,i}\) – Congestion control charge for member “\(i\)”
4.1.7 **Rate Card Option 7: Charging Flexible Contract-based rate**

As presented in Table 10, bandwidth-based rate fees are based on the bandwidth level that members subscribe to. A set amount is determined for the bandwidth in different tiers such as Tier 1 (0-20 Mbps), Tier 2 (21-40 Mbps) and Tier 6 (301-400 Mbps). Tier 2 carries a heavier cost than Tier 1.

Table 10: Sample Rate Card Option 7 (Bandwidth-Tier Based Rate)

<table>
<thead>
<tr>
<th>Tier</th>
<th>Bandwidth-Low (Mbps)</th>
<th>Bandwidth-High (Mbps)</th>
<th>Rate per Mbps</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>20</td>
<td>Annual Fixed Fees plus Multiple-Year Rate Options</td>
</tr>
<tr>
<td>2</td>
<td>21</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>301</td>
<td>400</td>
<td></td>
</tr>
</tbody>
</table>

One state network organization applies a non-linear pricing technique as presented in equation 8. The rate charged to member “i” \( R_i \) is the function of the baseline bandwidth subscription \( B_i \) in the form of exponential functions with an incremental, tiered pricing structure, where \( b_0 \) is a constant, \( b_1 \) is a regression coefficient, \( b_2 \) is the exponent of \( B_i \), and \( C \) is the incremental constant number. For instance, the rate charged to a member who subscribes to a 45 Mbps bandwidth is equal to \( b_0 + b_1 (B_{i,1} b_2) \) for the first 20 Mbps, plus \( \frac{b_0 + b_1 (B_{i,2} b_2)}{C} \) for the next 21-40 Mbps, and plus \( \frac{b_0 + b_1 (B_{i,3} b_2)}{C^2} \) for the next 41-100 Mbps.

\[
R_{i,1} = b_0 + b_1 (B_{i,1} b_2) \quad \text{for the first 20 Mbps} \tag{8}
\]

The minimum bandwidth for a particular member is specified by the contracted bandwidth fee, plus any additional charge for the actual peak bandwidth used each month. The additional charge may be applied when the specified bandwidth fee is higher than the fee for the peak bandwidth used that month. If the member uses more than the baseline bandwidth amount in three consecutive months, the highest amount used during those months will become the new baseline bandwidth.

In order to serve members who are willing to pay more to improve the performance on demand such as high performance data and video capabilities, we found that two state network organizations deploy Multiprotocol Label Switching (MPLS) technology including an ATM router or ATM switch across
the state to support Quality of Service (QoS) guarantees. For instance, one state network organization with a very large network typically has more than 15,000 ATM switch ports with 6-10 links to the state network organization’s hub sites or any other remote sites in order to not only provide proper management of network delays, bandwidth requirements, and packet loss parameters, but to also compete with any other ISPs in the state. The rate card options adopting QoS pricing are explained in sections 4.1.8 and 4.1.9.

4.1.8 Rate Card Option 8: Quality of Service (QoS) based rate

The QoS rate is calculated on an individual basis depending on service subscription. For instance, a member who subscribes to a guaranteed data rate for services such as video or voice, which require a high priority of service and timing control with high performance parameters (Constant Bit Rate – CBR), is responsible for a higher rate compared to a member who subscribes to a non-guaranteed grade of service (Unspecified Bit Rate – UBR). Equation 9 presents the QoS pricing structure for this state network organization, which incorporates best effort pricing and cost-based pricing perspectives into the model. The $C_{QoS,i}$ is calculated based on the percent of ATM bandwidth used and the Ethernet Virtual Circuit (EVC) class, such as basic service, priority data, or real time services with different bandwidth (Mbps) offerings.

$$R_{B,i}(c,s) = A \frac{g_i}{\sum g_i} + F \frac{b_l}{\sum b_l} + O \frac{b_l}{\sum b_l} + E_i + S_i + L_i + \left( N \frac{g_i}{\sum g_i} \left( \frac{b_l}{\sum b_l} \right) (1 + \frac{P(b_{K,i} - R_{B,i})}{R_{B,i}} \times 100) \right) + C_{QoS,i}$$

Where $C_{QoS,i}$ – Quality of Service (QoS) charge for member “i”

4.1.9 Rate Card Option 9: QoS Class and FTE based rate.

As presented in Table 11, rate fees are based on the different types of members, full time enrollment (FTE), and bandwidth levels. For instance, one state network organization offers different service rates between primary constituents (research and educational institutions) and non-primary constituents (state and government agencies and hospitals). For primary constituents, the rate is based on the number of students or FTE and the baseline bandwidth offering, while non-primary constituents are responsible for the bandwidth they subscribe to. Both constituents are also accountable for any services beyond their designated bandwidth subscriptions.
All state network organizations that use cost-based pricing and best effort pricing schemes operate their backbone through either leased-line fiber networks or state-owned fiber networks; these networks are not capable of any Quality of Service (QoS) when compared to the state network organizations that have established ATM or Frame Relay switches throughout the network. Furthermore, in order to support best effort or QoS pricing, it is necessary to implement additional architectures and models for traffic measurement in order to improve generation and transport of session records for storing accounting data and billing procedures. Traditional leased-line fiber networks or an organization’s owned dark fiber networks cannot cope with these issues effectively.

Table 11: Sample Rate Card Option 9 (QoS: Class and FTE-Based Rate)

| Primary Constituents: Public and Private K-12, Colleges, Universities, and Libraries |
|----------------------------------------|----------------------------------|-------------------------------|
| Enrollment (FTE) | Baseline Bandwidth (Mbps) | Rate | Additional Bandwidth (Monthly) |
|-----------------|----------------------|-------------------------------|
| 1-999 | 1.5 | Annual Fixed Fees | Amount Charge per Mbps |
| 1,000 - 1,999 | 3 | Annual Fixed Fees | Amount Charge per Mbps |
| " | " | " | " |
| 22,000 + | 30 | Annual Fixed Fees | Amount Charge per Mbps |

| Non-Primary Constituents: Hospitals and Municipalities |
|----------------------------------------|----------------------------------|-------------------------------|
| Connection Type | Baseline Bandwidth (Mbps) | Rate | Additional Bandwidth (Monthly) |
|-----------------|----------------------|-------------------------------|
| 56K | 56 Kbps | Annual Fixed Fees | Amount Charge per Mbps |
| 56K Frame Relay | 56 Kbps | Annual Fixed Fees | Amount Charge per Mbps |
| " | " | " | " |
| OC3 | 155 Mbps | Annual Fixed Fees | Amount Charge per Mbps |
| Gigabit | 1 Gbps | Annual Fixed Fees | Amount Charge per Mbps |

5. Overall Results and Discussion

One of the main objectives of this study is to review many pricing schemes introduced in the literature over the last decades and propose a comparative framework of various pricing schemes by analyzing pricing mechanisms from many state network organizations as a case study. Based on our findings, there is a gap between theoretical pricing models suggested in the literature and pricing models practically implemented by these state network organizations.
In this study, we observed 14 state network organizations currently implementing cost-based pricing schemes such as Fully Distributed Cost (FDC) and flat rate pricing. None of these state networks organization uses the Ramsey pricing model, another pricing model proposed in the literature, perhaps because Ramsey pricing is primarily used to maximize social welfare and minimize economic misallocation under the constraint of recovering costs (Berg, 1998), while the goal of all state network organizations as non-profit organizations is to just recover the costs of operations.

Pricing for best effort services is also not favored among state network organizations, as only two currently implement best effort pricing through usage-based pricing and charging flexible contracts. Even though many best effort pricing schemes have been proposed over the last decade, such as smart market, congestion discount, Paris Metro pricing, Shadow pricing, Edge pricing, Zone based cost sharing, Priority pricing and the Game theory models, none of these pricing models has been actually used by state network organizations because of the complexity in implementation. Lastly, because of network architecture and other technical issues such as charging and billing systems, pricing with QoS is also not favored among state network organizations, as only two states consider QoS in pricing networks. While pricing for Quality of Services (QoS) as proposed in the literature mostly concerns charging for IntServ, DiffServ, and RSVP architectures; managing QoS pricing parameters such as peak rate, loss rate, and maximum delay; or specific QoS pricing algorithms, the QoS pricing models from these two state network organizations focus on the cost to provide the QoS services such as priority data or real time services. Thus, the QoS pricing is simply derived from the ratio of QoS bandwidth usage including the allocation of shared costs among members.

As a result, the critical questions facing network pricing designers and researchers that arise from this study are why the pricing models suggested in the literature are not put into practice and what criteria organizations should consider in making any pricing decision. Some might argue that many pricing models proposed in the literature are not applicable for non-profit organizations, which provide service to education and other governmental entities, compared to commercial Internet Service Providers (ISPs) that serve various types of customers. This might be true as the pricing mechanisms depend on each organization’s pricing objective, organizational structure, members and services provided, and funding sources.
REFERENCES


A study of information asymmetry and relationship quality

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Abstract. The purpose of this study is to explore the relationship among information asymmetry, relationship benefit, relationship quality and customer loyalty. Three hundred and seventy effective surveys were received from customers of the financial industry. The data was analyzed by factor analysis, reliability analysis, using the Structural Equation modeling (SEM) to measure the relationship amongst the constructs.

The results show that the information asymmetry has positive influence on relationship quality and customer loyalty. Relationship benefit has a positive influence on relationship quality and customer loyalty. Information asymmetry through the mediating effects of relationship quality, impacting a significant positive on customer loyalty; relationship benefits through the mediating effect of relationship quality, impacting a significant positive effect on customer loyalty.

As a result, it is suggested that customer relationship quality and relationship benefit can increase customer loyalty.

Keyword: Information asymmetry, Relationship benefit, Relationship quality, Customer loyalty

1 Introduction

With the 1997 Asian financial crisis, the US subprime mortgage crisis of 2007, the bankruptcy of the Lehman Brothers in 2008, the subsequent global stock market crash, and the closure of a number of financial institutions, a panic has spread among the investing public. Blaming financial consultants could not change the fact that investments had been lost, and eventually, investors attributed their losses to the lack of a complete understanding of the actual statuses of financial products. Financial operators are worried that the loss of customers will affect their future prospects.

This demonstrates that in consumption, the greatest issue is often information asymmetry. Before consumers purchase a product or obtain a service, they will often attempt to gather complete information but fail to
succeed. Depending on the degree of information asymmetry, products and services can be divided into three types: search goods, experience goods (Nelson, 1970), and credence goods (Darby & Karni, 1973). In terms of credence goods, consumers have difficulty judging the quality of the product or service even after purchase, which can lead to an extremely high degree of asymmetry between the seller and the buyer. Enabling customers to feel that they have all the relevant information and helping them believe that the products or services are reliable will make them more likely to become loyal long-term customers. This is a crucial issue for companies.

To promote the growth of profit, companies generally encourage employees to market products actively by setting various objectives, rewards, and punishments. At this point, customer loyalty is a critical matter. Loyalty refers to the willingness of customers to frequent a certain company for specific products or services due to past experience and future expectations (Lee & Cunningham, 2001). Loyalty can also be regarded as an indication of the trust of customers; companies that can gain commitment from their customers, obtain customers that are worthy of concern (Frederick, 2000).

There are a number of methods to enhance loyalty, one of which is increasing relationship benefits. Relationship benefits refer to the extra benefits that buying and selling parties can derive, in addition to core services, from a long-term cooperation. Customers generally hope to gain various benefits from a long-term relationship with a company. These benefits may be either economic (such as discounts) or psychological (such as less waiting time or special treatment from service personnel). To become a privileged customer is the desire of many consumers because they can receive special temporal or pecuniary treatment. Furthermore, the maintenance of a long-term relationship and the relationship quality accumulated can eliminate uncertainties and the susceptibility to frustration as well as reduce risk (Berry, 1995). Smith (1998) indicated that relationship benefits are the key factors to loyalty on a long-term basis.

Relationship quality is also associated with customer loyalty, including the three dimensions of trust, satisfaction, and commitment (Wulf et al., 2001); the interaction between customers and companies can be assessed using relationship quality as a variable. Relationship quality encompasses the trust and satisfaction that customers feel towards the company in question. If service providers develop a friendly relationship with customers, they can induce or increase trust and satisfaction in the customers (Price & Arnould, 1999) and reduce uncertainty. In general, companies can maintain good relationships with their customers by providing good service; this earns the trust and satisfaction of customers, thereby enhancing loyalty (Heskett et al., 1994).
The relationship between companies and customers is a concern in all sectors. Good relationships bolster a company’s reputation and brand name, increase the customer base, enhance customer loyalty, and enable companies to increase product turnover and profits. This study focused on investigating the customers of financial institutions using four dimensions: information asymmetry, relationship benefits, relationship quality, and customer loyalty. Using these dimensions, we strove to understand how a company can maintain customer relationships and quality, enhance customer loyalty, and promote a win-win situation between companies and the investing public, all while striving to understand information asymmetry in financial products.

2 Literature review and research hypothesis

2.1 The information asymmetry and relationship benefit for the relationship quality

Zhang Jing Shan (2011) defines the information asymmetry to the difference between the information of the transactions required for both parties. The master information of the party for more information superiority, and the mastery of less information party belong to information advantage. During the transaction, no matter quality or quantity, the service provider always had the advantage of the level of information asymmetry than the customers (Li Hairong, Shen Ming Exhibition, 2011). Therefore, the products of the same property, it has different information asymmetry level between individual consumers. Those were relative with relevance and involvement (Schiffman, & Kanuk, 2001) and familiarity. Customers use different way to evaluate different products or service. In general, it was easy to estimate the quality of products which is belong to search for attribute; due to the situation of information asymmetry is more apparent, service sector deviate to experience and trust attribute (Zeithaml, 1981).

What is called relationship quality? To eliminate the uncertainty of purchasing products or services from provider, customers based on past performance of satisfactory sales staff and together with the confidence of future performance, and then trust the service providers and increase the future relationship for both sides (Crosby et al., 1990).

Therefore, we can see, with higher degree of information asymmetry, the more unpredictable quality after purchase, it is likely to cause psychological gap to the customers. Because this study about information asymmetry is based on Krishnan, & Hartline (2001) research practices, with higher scores indicating higher degree of awareness on the commodity, thus hypothesis 1:
Hypothesis 1: The information asymmetry is a significant positive impact on relationship quality.

"Relationship quality" is actually the quality of relationship marketing. To express the use of relationship marketing approach to establish a good relationship with customers, furthermore, to reduce customer transaction uncertainty (Fletcher, et al., 2000). Black box type of service is difficult to assess the intangible, complex or technical nature, would create uncertainty and possible injury, the level of trust in the relationship can be reduced these above results (Berry, 1995), if the service provider can develop the friendship relationship with customers so that customers can make trust and feel satisfaction (Price & Arnould, 1999), and you can reduce uncertainty and increase satisfaction. In order to increase the transfer of emotional or cognitive obstacles, the organization will provide the special interests (Fornell, 1992), part of the customer can increase loyalty, reputation and commitment (Selnes, 1993). It can be deduced to hypothesis 2:

Hypothesis 2. The relationship benefit is a significant positive impact on relationship quality.

2.2 The information asymmetry and relationship benefits for the customer loyalty

Information asymmetry is a continuous strip concept (Zeithaml, 1981), the smallest degree is the search attribute which usually know the relevant information before buying; another is trust attribute, because it is difficult to comment good or bad. Therefore, we want to know the level of trust of customer from service provider, we can be known whether or not from the customer high degree of attention on transaction relationship (Morgan & Hunt, 1994). This transaction relationship also has a sense of commitment and loyalty (Moorman, et al., 1992). Liu Zhaobo (1999) account that: information asymmetry is usually more beneficial for service providers, with more information is often on advantage site. In order to decrease the trust level of both sites, more inclined to maintain power as a monopoly of information sources, and increase the monitoring costs of the other behavior in many specifications. Because this study about information asymmetry is based on Krishnan, & Hartline (2001) research practices, with higher scores indicating higher degree of awareness on the commodity, it can be deduced hypothesis 3:

Hypothesis 3: The information asymmetry has a significant positive impact on customer loyalty.
Bove, & Johnson (2000) consider that the customer would transfer trust to a high degree of loyalty of particular service, and the specific service to the degree of increase is to occur in more closely with the relationship between a particular service; means that the customer attention can be increased with the customer's emotion, and get close the distance between buyers and sellers. In virtually have to rely on services provided by a cordial, caring attitude (Thorbjørnsen et al., 2002). Dick & Basu, (1994) also proposed that brand loyalty will become larger due to more positive emotional response. The relationship benefit is the key factor of long-term loyalty, loyal customers may purchase additional products or services, or by positive word of mouth for the company to bring new customers (Patterson & Smith, 2001); customer perception from the long-term relationship trust and emotion to the relationship between the interests of the company, these attitudes with the establishment, will further affect customer loyalty behavior (Xie Jing & Wu Jiahui, 2004). It can be inferred from the above literature hypothesis 4:

Hypothesis 4: The relationship benefits have significant positive impact on customer loyalty.

2.3 The relationship between relationship quality and customer loyalty

Heskett, et al (1994) believes that customer satisfaction and reliability by the value of services provided. It can also affect customer loyalty, thereby affecting the surplus of the enterprise. Lin Mengzhang, Zhuang Shijie and Chen Guiying (2004) using internet retail customer targeted research, found that the higher the relationship quality between customer and vendor awareness, the transaction costs will be reduced. In order to maintain the low transaction costs, customer repeat purchase behavior would be enhanced. The final response to customer loyalty in the store business owners cognitive network will tend to be higher; explore the operating characteristics of home stay by Wu Wei Bang & Yang Hui ling (2011) while home stay business as the title, the relationship between customer value and relationship quality. The results showed that to establish a good relationship with the customer, it can not only reduce the uncertainty of customer transactions but also maintain a good relationship quality, and generate loyalty. Hypothesis 5 from the above can be inferred:

Hypothesis 5: The relationship quality has a significant positive impact on customer loyalty.

2.4 The mediation effect of relationship quality
Based on Krishnan, & Hartline (2001) definition of information asymmetry, product attributes can be divided into search, experience and trust of three attributes. Intangible services were tend to experience and trust properties, so the relationship quality between the service provider and customer was very important. Relationship quality includes trust, satisfaction and affective commitment (Roberts, Varki & Brodie, 2003), in which trust relationships can be regarded as the key to the intermediary variable number before to purchase and after purchase behavior. It can also guide out of the customers long-term loyalty, and do close relations link to both transaction sides (Singh & Sirdeshmukh, 2000). Satisfaction and commitment based on the product or service, the customer was willing to maintain long-term relationship with the owners. It can be deduced hypothesis 6:

Hypothesis 6: Information asymmetry through the mediating effect of relationship quality, positive impact on customer loyalty.

In order to obtain the time or money for a special treat, many customers eager to be the relationship customers (Berry, 1995). For example, do not need to wait in a long line and have the extra discount and so on. This will make customers receive the services or products meet or greater than the one party to the desired standard, but also keep the close relationship you want with each other and willing to make the greatest efforts to maintain it (Chen Kuan-Chung, 2007). Those were regarded as the highest quality of relationship between buyer and owner. It also got a positive loyalty effect to the company (Li Shu, 2007). It can be deduced hypothesis 7:

Hypothesis 7: The relationship benefit through the mediating effect of relationship quality, positive impact on customer loyalty.

3 Research design and methods

3.1 Research framework

Based on the motivation of this study, research purposes, and comprehensive analysis of relevant literature review, proposed a study chart shown in Figure 1. In this study, "information asymmetry", "relationship benefit" as the independent variable, "customer loyalty" as the dependent variable, and the "relationship quality" as the mediated variable.
3.2 The research variables of the operational definition and measurement

**The information asymmetry** In this study, information asymmetry is based on Krishnan & Hartline (2001) research practices. The properties of the financial products and services are divided into three attributes: searching, experience and trust. And points points before and after purchasing these two dimensions, which will also be the definition of information asymmetry. Due to the level of information and attributes was different, each product divided into search, experience and trust of three properties and funds, insurance, foreign exchange, loan, credit cards, ordinary deposits, financial advisory and stock market investment of eight business and list. According to the situations before or after purchasing and experience by respondents, and answer the feeling to every financial products and services. Using Likert scale to evaluate, "1" represents "strongly disagree", "2" stands for "no", "3" stands for "ordinary", "4" stands for "agree", "5" represents "strongly agree"; The higher score expresses that the feelings of the information asymmetry is more easy to assess. If before purchasing is easy to assess and after purchasing is difficult to evaluate, its belong to the experience attributes; if before purchasing is easy to evaluate and after purchasing is easy to assess, its belong to the search attribute; if before purchasing is difficult to assess and after purchasing is difficult to assess, its refer to the trust attributes.
The relationship benefit In this study, using Gwinner, Gremler, & Bitner (1998) empirical analysis as reference, to divided relationship benefit into three factors. Respectively, define the "social benefit" to expand to the friendship between the level of staff and customer relationship; "confidence benefit" defined as those who supply services or products that enable customer trust; "special treatment of benefit" as defined in a variety of feedback for the customer due to corporate long-term relationship. This scale was according to Xie, Jing, Wu Jiahui (2004) which characteristics of financial services companies and further modified Gwinner, Gremler, & Bitner (1998) study questionnaire. Restructured was also accordance with this research required. Because of that "confidence benefit" measure items similar to "trust" items of "relationship quality", deleted this factors to avoid collinearity problems. By Likert scale to measure, "1" represents "strongly disagree", "2" stands for "no", "3" stands for "ordinary", "4" stands for "agree", "5" represents "strongly agree"; The higher scores, indicating that the higher degree of positive feelings of the customer relationship benefit.

The relationship quality In this study intend to use the "trust", "satisfied" and "commitment" three factors. To defined "trust" as the customer believe and rely on the degree of consciousness; "satisfied" as services or products from getting more expectations, resulting in emotional expression that is willing to maintain good relations; "commitment" is to have one of the parties to do their utmost to maintain this relationship. The scale refer to Crosby, et al. (1990) and Roberts, et al. (2003) to measure variables measuring relationship quality, with the project, "trust" or "satisfied" and "commitment to the three factors measured, by Likert scale to measure, "1" represents "strongly disagree", "2" stands for "no", "3" stands for "ordinary", "4" stands for "agree", "5" represents "strongly agree"; the higher scores, expressed the higher level of the relationship quality of customer and employee.

The customer loyalty The subjects of this study are banking customers, and same as the Ganesh, Arnold, & Reynolds (2000) study segments, so the use of the research methods were divided loyalty into two factors, namely "positive loyalty" and "passive loyalty". And then, define the "positive loyalty" of its own initiative or deliberately engaged in the purchase and spread positive word of mouth without any benefit for the customer; "passive loyalty" to change the situation vulnerable to environmental changes in customer buying behavior. The scale was referred to Ganesh, Arnold, & Reynolds (2000), Gronholdt, Martensen, & Kristensen (2000) and so on. In our study, we divided loyalty into "positive loyalty" and "passive loyalty". By Likert scale to measure, "1" represents "strongly disagree", "2" stands for "no", "3" stands for "ordinary", 

335
"4" stands for "agree", "5" represents "strongly agree"; The higher scores, the higher degree of response of customer loyalty.

3.3 The questionnaire sample and effective structure

This study is based on the financial industry customer objects to study the variable contains information asymmetry, relationship benefit, relationship quality, and customer loyalty.

The distribution location were at the public and private banks in Taiwan, First Commercial Bank, Land Bank, Cathay United Bank, Chang Hwa Bank, Yuanta Securities, Cosmos Bank, Sunny Bank, Hua Nan Commercial Bank, Taiwan Cooperative Bank, Mega Bank. The objects were customer between the purchase of financial products and business relationship. The questionnaire issuance delivers by bank staff and financial consultants, the customers of the banks in accordance with the actual experience to conduct the assessment. There got 370 recover in the end. All items of the questionnaire answer were completed, and did not leakage the answer.

Samples for this study in the age distribution of more than 31 years old (70.1%), 31-35 years and 41 years old accounted for 22.2% and 28.4%, show the financial industry customers are mainly young population; in terms of academic qualifications, samples of university / college, the proportion was 67.8%, much higher than high school and below (accounting for 19.2 %) and master's and above (13.0%). It has showing between the customer base is generally for the university / college graduates. In occupation, financial industry and services industry accounted for 32.1%. It seems that most of the customers were similar to the professional nature, the representative may be the career of a similar nature, and increase the wishes of the financial business dealings of products bearing. From the monthly income view, $ 1,001-2,000 accounted for 70.6%, in line with the general public generally monthly income, monthly income of customers in the financial industry is the general segments of the population-based, higher income of the top VIP customers are still not in the majority. Working experience, 5-20 years of working together accounted for 56.2%, 2 years at least, only 8.9% of the sample of the population working for some time may have savings, will have the financial situation of the business dealings.

3.4 The scales of the factor analysis, reliability analysis and validity analysis

In this study, four constructs are "information asymmetry", "relationship benefit"," relationship quality "and" customer loyalty "were by confirmatory factor analysis and reliability analysis. The two factors of information
asymmetry are "before purchasing" and "after purchasing" their Cronbach α values were 0.930 and 0.932. All items loading and CR values were significant standard. The two factors of relationship benefit are "social benefit" and "special treatment benefit". The Cronbach α values were 0.919 and 0.926, and all items loading and CR values were also significant standard. The three factors of relationship quality are "trust", "satisfaction" and "commitment" their Cronbach α value were 0.849, 0.889 and 0.909, all items loading and CR values were significant standard. Furthermore, Customer loyalty, these two factors "positive loyalty" and "passive loyalty" in Cronbach α values were 0.921 and 0.874; all items loading and CR values were also significant standard.

In each constructs of the discriminant validity analysis, all the questionnaires in this study are according based on the research scholars and comments. And in fact, evidence and archive research are made public, so the constructs of the basic scales and the overall research framework have been with the content and construct validity. The construct validity of the convergent validity is generally based on chi-square value and its value with degree of freedom (df), goodness of fit index (GFI), the normal fit index (NFI) and root mean square residuals (RMR) to measure. So the above constructs from the analysis results, the convergent validity of the study reached the level of significance and the standard value. In the construct validity of the discriminant validity refers to a construct with other constructs in the nature of the differences in degree. In order to measure the discriminant validity, Chi-square difference test analysis and comparison with non-restricted mode of $\chi^2$ and restriction mode of $\chi^2$ difference were using in this study. According to these constructs, the values of Chi-square difference test analysis shown very significant level (***P<0.001, $\Delta \chi^2 \geq 10.83$), indicating the scale of this study have good discriminant validity, no collinearity problems.

According to confirmatory factor analysis from these four constructs of "information asymmetry" "relationship benefit" and "relationship quality" and "customer loyalty" of research results, collect the whole of the scale values in Table 1. We can take the result which can learn from the various constructs of the GFI, CFI are greater than 0.9, while the RMR less than 0.05 are also in line with the following standard in Table 1. It can also seen in this study scale to have a good construct validity; Moreover, the constructs of the Cronbach α values are greater than 0.7 high reliability standards; in addition, NC ($\chi^2$/df) of less than 3 are also standard, so we can say that this study has good reliability, validity and goodness of fit.
Table 1. The Constructs of General Model of Confirmatory Factor Analysis

<table>
<thead>
<tr>
<th>Testing parameters</th>
<th>Constructs</th>
<th>Information asymmetry</th>
<th>Relationship benefit</th>
<th>Relationship quality</th>
<th>Customer loyalty</th>
</tr>
</thead>
<tbody>
<tr>
<td>χ²</td>
<td>219.941</td>
<td>31.625</td>
<td>74.372</td>
<td>37.361</td>
<td></td>
</tr>
<tr>
<td>DF</td>
<td>87</td>
<td>17</td>
<td>46</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>χ² / DF</td>
<td>2.528</td>
<td>1.860</td>
<td>1.617</td>
<td>2.874</td>
<td></td>
</tr>
<tr>
<td>P value</td>
<td>0.000</td>
<td>0.017</td>
<td>0.005</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>RMR</td>
<td>0.025</td>
<td>0.016</td>
<td>0.013</td>
<td>0.023</td>
<td></td>
</tr>
<tr>
<td>GFI</td>
<td>0.933</td>
<td>0.978</td>
<td>0.969</td>
<td>0.975</td>
<td></td>
</tr>
<tr>
<td>AGFI</td>
<td>0.896</td>
<td>0.953</td>
<td>0.948</td>
<td>0.931</td>
<td></td>
</tr>
<tr>
<td>NFI</td>
<td>0.955</td>
<td>0.980</td>
<td>0.979</td>
<td>0.985</td>
<td></td>
</tr>
<tr>
<td>CFI</td>
<td>0.972</td>
<td>0.994</td>
<td>0.992</td>
<td>0.990</td>
<td></td>
</tr>
<tr>
<td>RMSEA</td>
<td>0.064</td>
<td>0.048</td>
<td>0.041</td>
<td>0.071</td>
<td></td>
</tr>
<tr>
<td>Cronbach α</td>
<td>0.947</td>
<td>0.942</td>
<td>0.945</td>
<td>0.924</td>
<td></td>
</tr>
</tbody>
</table>

4 The results and discussion

4.1 The constructs of the basic characteristics analysis
In this study, the average numbers of factors are greater than 3, as shown in Table 2, the relationship between financial services companies and customers establish direct significant impact on customer loyalty. Especially the ethics of the sales staff was the most important point which customers generally pay attention. If employees with good character can be trusted, compared to other quality products and services more customer-favorite; study pointed out that financial products belong to the search attribute, although the purchase of a better understanding of the contents of this product. In general, the customer is more difficult to understand the commodity with its own fitness, interaction and trust with the sales staff has become the critical point to decide purchase or not. In today's financial industry, it had turned to the sale of derivatives in pursuit of higher profit trends, hiring good staff ethics in order to obtain the favor of the customer to the company, customers will not arbitrarily change the exchange company any more.
### Table 2. The Basic Information of Each Constructs And Their Factors

<table>
<thead>
<tr>
<th>Constructs</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information asymmetry</td>
<td>3.603</td>
<td>0.594</td>
</tr>
<tr>
<td>Before purchasing</td>
<td>3.500</td>
<td>0.694</td>
</tr>
<tr>
<td>After purchasing</td>
<td>3.705</td>
<td>0.609</td>
</tr>
<tr>
<td>Relationship benefit</td>
<td>3.309</td>
<td>0.785</td>
</tr>
<tr>
<td>Social benefit</td>
<td>3.355</td>
<td>0.845</td>
</tr>
<tr>
<td>Special treatment benefit</td>
<td>3.263</td>
<td>0.831</td>
</tr>
<tr>
<td>Relationship quality</td>
<td>3.330</td>
<td>0.689</td>
</tr>
<tr>
<td>Trust</td>
<td>3.422</td>
<td>0.634</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>3.527</td>
<td>0.575</td>
</tr>
<tr>
<td>Commitment</td>
<td>3.166</td>
<td>0.779</td>
</tr>
<tr>
<td>Customer loyalty</td>
<td>3.372</td>
<td>0.611</td>
</tr>
<tr>
<td>Positive loyalty</td>
<td>3.285</td>
<td>0.721</td>
</tr>
<tr>
<td>passive loyalty</td>
<td>3.375</td>
<td>0.809</td>
</tr>
</tbody>
</table>

### 4.2 The Pearson correlation analysis of various constructs

Pearson correlation analysis to verify the relationship between four constructs of "information asymmetry", "relationship benefit" relationship quality "and" customer loyalty ". The correlation between the constructs of the SEM was the coefficient strength calculation of linear algebra methods, the correlation coefficient between each variable from 0.2 to 0.83. In case of moderate correlation (Chen Kuan-chung, 2007), indicating that each measurement constructs, no correlation is too high and no collinear problem. This study was to measure the correlation coefficients of the variables were between 0.2 to 0.83, which indicating that each measure is not too high in collinear variable, and meet the basic fit standard.

### 4.3 The overall model analysis

In this study, we use AMOS statistical software to analysis by whole model, to further evaluate the relation among "information asymmetry", "relationship benefit" and" relationship quality " and " customer loyalty ". Therefore, in this
study, whole model goodness of fit values was in Table 3. In the absolute goodness of fit test in, GFI, AGFI, RMR and RMSEA are in compliance with assessment criteria. This study has good absolute goodness of fit, incremental goodness of fit, NFI, RFI, IFI, TLI and CFI are very good as well. In the parsimonious goodness of fit, PCFI, PNFI although smaller than the standard 0.5; but the NC standard has declared that the parsimonious goodness of fit is acceptable. Due to all those three kinds of adaptation of the standard above had indicated that the whole model fit in this study to achieve a good degree of adaptation of the standard.

Table 3. Analysis of Overall Model Fit

<table>
<thead>
<tr>
<th>Goodness of fit type</th>
<th>Index</th>
<th>Evaluation Criteria</th>
<th>Goodness of fit value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absolute fit measures</td>
<td>$\chi^2$</td>
<td>Smaller the better</td>
<td>40.328</td>
</tr>
<tr>
<td></td>
<td>GFI</td>
<td>&gt;0.9</td>
<td>0.977</td>
</tr>
<tr>
<td></td>
<td>AGFI</td>
<td>&gt;0.9</td>
<td>0.934</td>
</tr>
<tr>
<td></td>
<td>RMR</td>
<td>&lt;0.05</td>
<td>0.012</td>
</tr>
<tr>
<td></td>
<td>RMSEA</td>
<td>&lt;0.08</td>
<td>0.064</td>
</tr>
<tr>
<td>Incremental fit measures</td>
<td>NFI</td>
<td>&gt;0.9</td>
<td>0.983</td>
</tr>
<tr>
<td></td>
<td>RFI</td>
<td>&gt;0.9</td>
<td>0.963</td>
</tr>
<tr>
<td></td>
<td>IFI</td>
<td>&gt;0.9</td>
<td>0.990</td>
</tr>
<tr>
<td></td>
<td>TLI</td>
<td>&gt;0.9</td>
<td>0.977</td>
</tr>
<tr>
<td></td>
<td>CFI</td>
<td>&gt;0.9</td>
<td>0.990</td>
</tr>
<tr>
<td>Parsimonious fit measures</td>
<td>PCFI</td>
<td>&gt;0.5</td>
<td>0.440</td>
</tr>
<tr>
<td></td>
<td>PNFI</td>
<td>&gt;0.5</td>
<td>0.437</td>
</tr>
<tr>
<td></td>
<td>NC($\chi^2$/df)</td>
<td>1&lt;NC&lt;3</td>
<td>2.520</td>
</tr>
</tbody>
</table>

Ps. (1) Loading used in the table are standardized.
(2) * CR> 1.96; ** CR> 2.58; *** the CR> 3.29; A representative of the setting is 1.

Furthermore, the basic goodness of fit measure is the model series of errors, input errors or problems such as test methods to identify their measure of error can not be negative, and the factor loading must be greater than 0.5 and up to a significant standard. The construction observed variables of the factor loading and CR values shown in Table 4. Through these four structure surface: the "information asymmetry", "relationship benefit" and "relationship quality" and "customer loyalty", each observed variable's factor loading are greater than 0.5, CR values are very significantly greater than the 3.29 standard. In this case, all variables in line with good basic goodness are fitness.
Table 4. The Basic Goodness of Fit

<table>
<thead>
<tr>
<th>Constructs</th>
<th>Observed variables</th>
<th>Factor loading</th>
<th>CR values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information asymmetry</td>
<td>Before purchasing</td>
<td>0.806</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>After purchasing</td>
<td>0.824</td>
<td>12.113</td>
</tr>
<tr>
<td>Relationship benefit</td>
<td>Social benefit</td>
<td>0.877</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Special treatment</td>
<td>0.856</td>
<td>20.264</td>
</tr>
<tr>
<td></td>
<td>benefit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relationship quality</td>
<td>Trust</td>
<td>0.904</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Satisfaction</td>
<td>0.846</td>
<td>21.691</td>
</tr>
<tr>
<td></td>
<td>Commitment</td>
<td>0.932</td>
<td>19.833</td>
</tr>
<tr>
<td>Customer loyalty</td>
<td>Positive loyalty</td>
<td>0.898</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>passive loyalty</td>
<td>0.678</td>
<td>13.929***</td>
</tr>
</tbody>
</table>

Relationship between the constructs of the verification, the mode of the path in Figure 2 can be seen, "information asymmetry" on the "relationship quality" has significantly positive impact ($\Gamma_{11} = 0.120$, CR value = 2.244), therefore hypothesis 1 had established in this study. It seems that the stronger degree of goods, the more relationship quality will be positive. "Relationship benefit" on the "relationship quality" has significantly positive effect ($\Gamma_{12} = 0.770$, CR value = 12.903) therefore, hypothesis 2 was established in this study, showing the relationship benefit tended to more able to value-added relationship quality; "information asymmetry" on the "customer loyalty" has significantly positive impact ($\Gamma_{21} = 0.168$, CR value = 2.966), and therefore hypothesis 3 of the research was established as well, showing that stronger degree of feeling and customer loyalty degree as the more positive relationship; "relationship benefit" on the "customer loyalty" has a significant positive effect ($\Gamma_{22} = 0.246$, CR value = 2.611), therefore, hypothesis 4 in this research was established, show that relationship benefit of the higher, more customer loyalty high; "relationship quality" on the "customer loyalty" has significantly positive effect ($\beta_{21} = 0.560$, CR value = 5.595), and therefore the establishment of the research hypothesis 5, showing the development of relationship quality can be a positive influence on loyalty.
Preacher & Hayes (2004) suggested a significant test whether mediating variables can use Sobel test. Table 5 shows that the mediating variables in this study is the relationship quality, respectively, if "information asymmetry" through "relationship quality" of the mediating results, positive impact of "customer loyalty" and "relationship benefit" through "relationship quality" of the mediating effect, positive effect on "customer loyalty". In terms of information asymmetry, information asymmetry in this study assumed through the mediating effect of relationship quality, positive effect on customer loyalty. Figure 2 and Table 5 show that the indirect effect is 0.067, the total effect of 0.235. Calculated by Sobel test, input the information asymmetry CR value of relationship quality, relationship quality 2.244 and the CR value 5.595 of customer loyalty, the value will be t = 2.083, P value = 0.037, indicating "information asymmetry" through "relationship quality" of the" customer loyalty "has a significant positive effects. Thus hypothesis 6 of this study was established, show that the feelings and cognitive process of goods by interaction with the sales staff, a significant positive impact on customer loyalty. In relationship benefit, this research had made the hypothesis that through mediating effect of relationship quality will make a positive impact on customer loyalty. From Figure 2 and Table 5 show that the indirect effect is 0.431, the total effect is 0.677. Calculated by Sobel test, input the relationship benefit CR value of relationship quality, relationship quality 12.903 and the CR value 5.595 of customer loyalty, the value will be t = 5.133, P value = 0.000, which indicating "relationship benefit" through "relationship quality" of the "customer loyalty" has a significant positive effect. Therefore, the hypothesis 7 of this study was established. The feeling of relationship benefit through the customers from sales staff will give by interactive process,

Fig. 2. The Relationship between the Variables in the Overall Theoretical Framework
customer loyalty significant positive impact on a significant mediating effect of relationship quality in this.

**Table 5. The Relationship of Hypothesis Path and Test Results**

<table>
<thead>
<tr>
<th>Assuming path</th>
<th>Direct effect</th>
<th>Indirect effect</th>
<th>CR values</th>
<th>Corresponds hypothesis</th>
<th>Test results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information asymmetry → Relationship quality</td>
<td>Γ11=0.120</td>
<td></td>
<td>2.244</td>
<td>Hypothesis 1</td>
<td>Established</td>
</tr>
<tr>
<td>Relationship benefit → Relationship quality</td>
<td>Γ12=0.770</td>
<td></td>
<td>12.903</td>
<td>Hypothesis 2</td>
<td>Established</td>
</tr>
<tr>
<td>Information asymmetry → Customer loyalty</td>
<td>Γ21=-0.168</td>
<td></td>
<td>2.966</td>
<td>Hypothesis 3</td>
<td>Established</td>
</tr>
<tr>
<td>Relationship benefit → Customer loyalty</td>
<td>Γ22=0.246</td>
<td></td>
<td>2.611</td>
<td>Hypothesis 4</td>
<td>Established</td>
</tr>
<tr>
<td>Relationship quality → Customer loyalty</td>
<td>β21=0.560</td>
<td></td>
<td>5.595</td>
<td>Hypothesis 5</td>
<td>Established</td>
</tr>
<tr>
<td>Information asymmetry → Relationship quality → Customer loyalty</td>
<td>Γ11β21=-0.067</td>
<td></td>
<td></td>
<td>Hypothesis 6</td>
<td>Established</td>
</tr>
<tr>
<td>Relationship benefit → Relationship quality → Customer loyalty</td>
<td>Γ12β21=0.431</td>
<td></td>
<td></td>
<td>Hypothesis 7</td>
<td>Established</td>
</tr>
</tbody>
</table>

The total effect of Information asymmetry → Relationship quality → Customer loyalty were 0.235.
The total effect of Relationship benefit → Relationship quality → Customer loyalty were 0.677.
5 Conclusion and suggestions

5.1 Conclusion

Findings of primary theoretical model configuration  The results of this study support the majority of the presented hypotheses. Moreover, relationship quality was proven to play an important intermediary role in the framework of this study; when relationship benefits can be presented using relationship quality, customer loyalty can be enhanced. In addition, our findings support the viewpoint of Allison and Philip (2004), that the impact of perceived satisfaction and perception of consumers on corporate image further influences consumer loyalty. Relationship quality is the perceived quality of service personnel; higher quality indicates more satisfaction towards the service. The service personnel of the financial industry often have the foremost and most direct interaction with the customers. The quality of their relationships with the customers influences customer impressions toward the company, and therefore, relationship quality is often associated with the theory of relationship marketing; relationship quality is often regarded as the quality of relationship marketing (Fletcher et al., 2000). A number of studies have proven that good relationship quality can assist companies in formulating effective marketing strategies and execution measures.

In terms of the importance of relationship quality to relationship benefits, the KMV model presented by Morgan and Hunt (1994) indicates that that relationship benefits have direct impact on relationship quality; this study confirmed a positive correlation between the two dimensions. We speculate that this is because relationships are perhaps more important in business dealings in Chinese society, social benefits and special treatment go further in promoting a long-term business partnership. Development in the current trend of financial products is limited; the preferences and discounts provided by competing companies show little difference, and customers will consider them more or less the same after comparison. For this reason, it is necessary that systematic satisfaction surveys be administered on a long-term basis to understand what kinds of relationship benefits will enable customers to express trust, satisfaction, and commitment to a company. Furthermore, operational strategies, product marketing, and the methods of training personnel can be adjusted accordingly. The ultimate goals of these measures are to maximize customer loyalty, increase company profits, and enhance competitiveness.

Verify the framework of this study  We measured the goodness of fit in the model and framework and performed confirmatory factor analysis using AMOS. The results indicated that absolute fit measures and incremental fit
measures were within the acceptable range. Although the framework did not achieve the more parsimonious PCFI and PNFI fit measures, the basic goodness-of-fit test, the goodness-of-fit of the internal structure of the model, and the relationships among the dimensions of the overall framework reached standards. Therefore, the framework of this study is confirmed.

5.2 Implications and suggestions

**Academic implications** Despite the many studies that prove vital connections among relationship benefits, relationship quality, and customer loyalty, information asymmetry has never been included in related research. Previous studies employed information asymmetry to simply categorize financial products into search goods, credence goods, and experience goods. In comparison, we also investigated customer experience before and after purchase to determine whether customers gain further knowledge of the product following purchase. Our results show that the products were all search goods, meaning that consumers obtained more complete information concerning the product or service prior to purchase and that the degree of asymmetry in information was lower. Moreover, the consumers better understood the product or service after purchase. This shows that although service providers generally have the advantage over customers in information asymmetry (Li & Shen, 2011), well-developed information media enables consumers to acquire more information than they were able to before they had access to the internet.

Thorbjørnsen et al. (2002) indicated that when service providers are friendly and caring, customers will feel valued and there will be a narrowing of the distance between buyers and sellers. When customers and certain service personnel develop close relationships, trust transforms into a high degree of loyalty towards the said personnel (Bove & Johnson, 2000). This loyalty makes the customer less willing to take their patronage elsewhere, thereby increasing the revenue and benefits to the company. The results of this study support relevant research, in that relationship benefits, relationship quality, and customer loyalty exhibit a positive correlation. This indicates that good relationship quality can indeed maintain customer-provider relationships, increase customer satisfaction, and further increase customer loyalty towards the company. We presented a linear structure relationship model that demonstrates how relationship benefits influence customer loyalty with relationship quality as a mediator.

**Practical implications** The liberalization and internationalization of financial business in recent years have enabled the establishment of many new
financial holding companies. In their struggle for asset management business, many measures have been implemented to attract customers. Maintaining customer loyalty and developing new clientele have become the keys to success.

The results of this study show that trust has significant impact on relationship quality. Due to the intangibleness of service and the complexity of the financial concerns, the degree of trust that customers hold towards sales personnel is a dominant factor. Therefore, it is imperative that special attention be paid to the level of trust that customers have in bank employees. In addition to selecting employees with good character and ethical conduct, building customer trust in bank employees is also a focal point in increasing clientele. In this aspect, setting standards for employees, requiring them to possess professional finance certification, and enabling them to gain the trust of customers using their professional knowledge are essential. Moreover, the company itself must also be careful not to emphasize only short-term income from handling fees during employee evaluation. Such an emphasis may cause employees to market products using whatever means necessary and neglect what customers truly need.

This is one of the problems associated with the recent financial crisis, in which financial advisors withheld information about high risks related to certain high-yield products in order to deliver outstanding performance. Their lack of caution when evaluating appropriate products for customers led to considerable losses for investors. Negative reports regarding employee embezzlement, insider trading, and overpriced mortgages have also undermined public confidence in the financial industry, damaging the corporate image of many companies. To maintain a long-lasting and good relationship with customers, employees must be educated on how to provide customers with safe and suitable financial products as well as good financial planning. In this manner, the good reputation earned through long-term operations will not be damaged by a single unpleasant transaction, and the relationship between company and customer may continue stably.

With regards to customer loyalty, our findings show that passive loyalty is more significant than active loyalty. This shows that the longer a company-customer relationship is maintained, the higher the degree of trust and satisfaction. In addition to willingly continued patronage, loyal customers will still choose to patronize their original company over competitors when the offered benefits are similar. Therefore, good relationship quality is crucial. Companies must identify the means to employ relationship quality, integrate relationship benefits, and interact with customers in the way they desire in order to inspire loyalty.
5.3 Limitations of the study and suggestions for future research

Limitations of the study Due to time limitations, the questionnaires of this study were only distributed to customers of 10 banks’ branches. However, the purchase of financial products (such as insurance, credit cards, personal loans) does not only occur in financial institutions. Some companies post sales at service stations in malls or department stores. Future studies can conduct further investigations on customers contacted at other locations or by other means, such as users of internet banking.

Future research The hypotheses presented in this study were tested using structural equations. Although this is a practical statistical method, future studies can also analyze and compare company-specific levels and customer-specific levels, include other statistical methods for multi-level analysis, differentiate customers from the general populace and those from a higher socio-economic class, and compare differences between corporate and customer perspectives.

Future studies can also include reputation and the degree of involvement as variables. Kordupleski et al. (1993) proposed that positive reputation has impact on potential customers and enables companies to obtain new customers or maintain existing customers. Sajeev and Wong (2003) indicated that high involvement on the consumers’ part influences the types of relationship benefits selected. Therefore, the inclusion of these two perspectives in future research will benefit the research framework of overall empirical investigation.

The framework of this study can be applied to various industries to investigate customers from differing environments and cultural backgrounds. We believe that this framework holds high value in the empirical investigations of customer relationship management in a wide range of industries.

From the perspective of personnel in finance, trust, satisfaction, and reliable commitment are almost equivalent to credit business, business development, and collateral acquisition, respectively. These are the fundamental concepts of risk management and business development in banking. Therefore, the means by which relationships can control risk is also an issue worthy of further research academically and practically.

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A Framework for Identifying Influential Groups in Social Question Answering Sites

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Abstract
With the rapid development of Internet and Web 2.0 technology, social Question & Answering (SQA) websites have become essential knowledge-sharing platforms. These platforms provide knowledge community service, allowing users with common interests or expertise to form a knowledge community where community members can collect and share Q&A knowledge (documents) related to their interests. Although much research has been devoted to identifying influential users, few studies have undertaken to discover influential groups. Identifying influential groups is critical, since this information can affect which groups users decide to join. For developing applications based on group perspectives, the discovered results can also be applied. For instance, in order to effectively conduct targeting advertising programs on an SQA site, advertisers can choose to place their ads in top influential groups, and the diffusion of information, by systematically targeting certain top influential groups, could be more effective. In this paper, we present an overview of research in progress that emphasizes the framework for discovering influential groups in an SQA site by looking for link (interaction) analysis, reputation analysis and active level analysis.

1 Introduction

With the ubiquity of the Internet and the rapid development of Web 2.0 technology, increasing numbers of individuals and organizations are searching for needed information on the Internet. The growth of Web 2.0 has enabled social Q&A (SQA) websites to become important knowledge sharing platforms. In SQA sites, users can interact with the Q&A systems to ask and answer questions, as well as evaluate (rate) knowledge content. Questions submitted to SQA sites have useful answers, ratings and comments appended [9]. The most popular social Q&A sites include Yahoo! Answers (http://answers.yahoo.com), and AnswerBag (http://www.answerbag.com).

SQA websites are becoming increasingly popular knowledge sharing platforms because users can post natural language questions, as well as share miscellaneous information directly from the website. User participation and sharing have enriched the information resources of such websites. Yahoo! Answers Taiwan website (also called Yahoo! Knowledge Plus) provides a knowledge group service, which is a more closed community platform comprising people who share a common interest. In a knowledge group, a
member can share knowledge by posting articles, or collect high quality articles and interact with other group members. Members can represent the knowledge group to answer questions, as shown in Figure 1, so every group has its own expert domains: one is the expert domain of answering questions, and the other is the expert domain of posting articles.

![Figure 1: A knowledge group in Yahoo! Answers Taiwan](image)

As of April, 2012, there were 8,620 knowledge groups in Yahoo! Answers Taiwan. Therefore, a means of choosing which good knowledge groups to join is a critical problem for users. Existing group ranking mechanisms are adopted by their platform rank groups, according to the number of collected knowledge articles, number of posted knowledge articles and number of best answers within one week/90 days. However, these ranking mechanisms are easily manipulated by some knowledge groups, who attempt to collect/post huge numbers of irrelevant knowledge articles to their groups.

Recently, several studies [1-3, 14, 16] have developed influence models in order to calculate the influence score of users. Few studies, however, have reported on discovering influential groups. We argue that influence gives a better measure of the knowledge level of a group. We use the influence metric to rank knowledge groups by looking for link (interaction) analysis, reputation analysis and active level analysis.

Because influential users’ contents and activities attract other users, Bao and Chang [4] developed an influence-based diffusion model for propagating hints to match advertisements for each influenced user. Our study proposes an approach for discovering influential groups, which could be applied in group-based recommender systems, word-of-mouth marketing, targeting advertising, etc.
2 Related work

2.1 Users’ connectivity in social Q&A sites

A social network can be represented as a graph: $G = (V, E)$. Each node in set $V$ represents a user or customer in the network, and an edge $(u, u_c)$ in set $E$ models a certain type of interaction between the users or customers represented by nodes $u$ and $u_c$. In many domains, the social network structure includes links that are explicitly declared by users, and links that are implicit and have to be inferred. For example, in online social networking sites, individuals can declare explicitly their “friends”, “follow” a user, etc. However, these explicitly declared links may be incomplete and may not describe all of the relationships in the network [5].

Implicit connections can be discovered from user’s activities by analyzing extensive and repeated interactions between users. Users’ interaction activities among each other play an important role for the identification of influential users in SQA sites. However, the literature states that there may be stronger and weaker connections between users in social networks [13], and particularly in online social networks [10, 15, 17]. In general, strong connections between users are, for instance, more likely to be activated for information flow, and will be more influential [7]. Interaction links are usually assumed to be directed, since interaction activity requires an initiator and a receiver, e.g., one user asks a question and another user answers that question; one user posts an article and another user recommends that article. Several studies have utilized link analysis in SQA sites; however they only consider “question-answer” interaction. In this study, we consider more than one type of interaction.

2.2 Influence analysis

Several researchers have analyzed social network data to find patterns of influence in various domains.

Many analyses have focused on the blogging and microblogging domains [1, 3, 16]. However, few studies have been performed on the SQA domain. Bakshy et al. [3] considered the influence of a user to be the user’s ability to post URLs which were diffused through the Twitter follower graph. They quantified the influence of a given post by the number of users who subsequently reposted the URL, meaning that they could be traced back to the originating user through the follower graph. They used a regression tree model to predict influence using an individual’s attributes and past activity. Wu and Ren [16] designed models to learn both sentimental influencing probabilities and influenced probabilities for Twitter users. They found that there was a high
correlation between Twitter users’ influencing probabilities and their influenced probabilities, and that the majority of users kept a sentimental balance of both.

Gruhl et al. [11] characterized four categories of individuals based on their posting behavior within the lifecycle of a topic, and then developed a model for information diffusion based on the theory of the spread of infectious diseases, capturing how a new topic spreads from blog to blog. Their approach was able to identify particular individuals who were highly effective at contributing to the spread of infectious topics. Tang and Yang [14] argued that identifying influential users in the online healthcare forum, and tracking the information spreading in such online communities could be an effective way to understand the public reaction toward disease. They proposed an algorithm to identify influential users from online healthcare forums, which combined content analysis and link analysis techniques to identify influential users.

3 Proposed influence analysis for groups

3.1 Overview of the approach

Our proposed framework for discovering influential groups in Yahoo! Answers Taiwan is shown in Figure 2.

The data was collected from the Yahoo! Answers website in Taiwan. Five multithread crawlers were developed to download the behavior data of users and groups in Yahoo! Answers Taiwan: Paragraph Crawler, Article Crawler, Question Crawler, Answer Crawler and Knowledge Group Crawler. The first four crawlers are used to download individual users’ behavior data. The Knowledge Group Crawler is used to download knowledge groups’ behavior data. Downloaded web pages were then parsed and stored in a database.

We constructed the social network according to users’ interactions (implicit relation) and social relations (explicit relation). Link analysis [6] was used in links between individuals and links between groups. The influence scores of users and groups were obtained by this step. We further calculated a group’s aggregate influence score by aggregating its members’ influence scores. During this step, the user’s member weight was considered, since the importance of each member in a group differs.

The active level of a group is another factor reflecting a group’s influence; it can be measured by the recency, frequency, as well as monetary value (RFM) it generates, i.e., how recently / often / many times a group has answered questions (A), collected articles (C) and posted articles (P). Finally, we integrated the three scores (aggregate influence score, group influence score and active level score) of a group to derive its influence score.
3.2 Constructing the social network

For forum and Q&A sites, the influence model has to find implicit relationships by mining user interactions because explicit links cannot tell how often two users interact, or the nature of their interactions. In this study, we consider both explicit and implicit links, but focus mainly on implicit relationships, which signify that an implicit link between two users will be amplified if they also have an explicit relationship, such as a “fan” relationship.

A. Implicit link perspective

We assess the relationship between two users by the frequency and type of their interactions, as shown in Eq. (1). For our Q&A application (Yahoo! Answers Taiwan), users can ask questions, and their questions will be answered, evaluated (+, -, normal), criticized and commented on by other users. The interactions and their weights between users are considered in this research. The rationale behind the weight is that we consider the content length of their responses: the longer the content length, the greater the weight. In general, the answer content is longer than that of comments in our dataset.

$$Weight'(u_r, u_c) = \sum_{I_k \text{ is a type of actions that } u_r \text{ performs responses}} \delta[\text{type}(I_k)]$$  

(1)
where \( Weight'(u_r, u_c) \) is the interaction weight of edge \( u_r \rightarrow u_c \) in the social network; \( I_k \) is the \( k \)th interaction between \( u_r \) and \( u_c \); \( \delta[\text{type}(I_k)] \) is a weighting function given to the interaction type where \( I_k \) occurs. We represent a graph in terms of its adjacency matrix, and the input to our ranking algorithm (Section 3.3) is the row-normalized adjacency matrix.

**B. Explicit link perspective**

In our SQA application, users can explicitly declare their “fans” and “friends” in their knowledge circle. If User \( A \) considers User \( B \) knowledgeable, then User \( A \) can add User \( B \) to his/her friend list after getting User \( B \)’s permission, and User \( A \) is also added to User \( B \)’s fan list. If User \( C \) considers User \( A \) knowledgeable, then User \( C \) can add User \( A \) to his friend list, and User \( C \) is then also added to User \( A \)’s fan list.

In this study, we mainly focus on users’ interaction links. However, if two users have interactions and also an explicit link, then we consider that the interaction link between them should be amplified, as shown in Eq. (2). We gave an additional \( \varepsilon \) (e.g. 5%) weight to the interaction link if an explicit link also existed between \( u_r \) and \( u_c \).

\[
Weight(u_r, u_c) = Weight'(u_r, u_c) \times (1 + \varepsilon) \tag{2}
\]

**3.3 Calculating individual influence score**

The PageRank algorithm provides a computationally simple and effective way to identify important nodes in the connected graphs \([8, 12]\). We modified the PageRank algorithm to calculate the individual influence score for each user, as shown in Eq. (3). Unlike the original PageRank algorithm, our approach incorporates the interaction weight between users in order to derive the influence score of user \( u_c, I_{u_c} \):

\[
I_{u_c} = (1 - d) + d \sum_{u_r; u_r \rightarrow u_c} p(u_c | u_r) \times I_{u_r} \tag{3}
\]

\[
p(u_c | u_r) = \frac{Weight(u_r, u_c)}{\sum_{u_r; u_r \rightarrow u_c} Weight(u_r, u_c)}
\]

where \( d \) is a constant, typically between 0.8 and 1.0, and \( p(u_c | u_r) \) is the transition probability from \( u_r \) to \( u_c \). The weight of each edge is derived from Eq. (2).
4 Deriving group influence score

To calculate the group’s influence score, we first constructed a group social network, and then conducted link analysis in that constructed social network. Since a group’s performance can be aggregated from its members’ performance, we further aggregated the members’ influence score to obtain the aggregate influence score of a group. We also considered the group’s active level as another factor that could reflect its influence.

4.1 Group to group link analysis

Members from different groups might have some interactions, as shown in Figure 3. We summarized the interactions and their weights between groups in Table 1. Interactions between two groups forming several links between two groups will be aggregated and normalized to 0 ~ 1. To construct links between groups, we considered the following patterns:

A. Early-late collection patterns: In the historical data, for example, Groups x and y have collected 30 articles in common or on the same topic. We can compare their collection timestamps: of 30 articles, x collected 20 of them earlier than y, and 10 of them later than y. We can say, then, that x usually collects useful articles earlier than y does.

B. Early-late posting patterns: This pattern is similar to the above but considers the article posting behavior.

C. Recommend patterns: This calculates the number of recommendation activities initiated by members of group y and received by members of Group x; if a member of Group y posts an article a member of Group x can then vote for that article. This behavior is like “dig” in Digg.com.

D. Best answer patterns: This calculates the number of best answer activities initiated by members of group y and received by members of Group x; if a
member of Group y asks a question, a member of Group x can then represent Group x to answer that question. We only consider the answer activities that are selected as the “best answer” by the askers.

We also use the PageRank algorithm to derive the influence score of group $x, I_{gs}$ based on the interaction weights between groups, as with calculating the individual influence score (Eq. 3).

<table>
<thead>
<tr>
<th>Action</th>
<th>Collecting the same or similar article</th>
<th>Posting the same or similar article</th>
<th>Recommend</th>
<th>Reply</th>
<th>Answer (A member represents the other group to answer questions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collecting an article for a knowledge group</td>
<td>0.5</td>
<td>0.8</td>
<td>0.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Posting an article within a knowledge group</td>
<td></td>
<td>0.8</td>
<td>0.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asking a question</td>
<td></td>
<td></td>
<td></td>
<td>0.9</td>
<td></td>
</tr>
</tbody>
</table>

4.2 Aggregate from individual members

Usually, influential groups intend to recruit influential users. Therefore, we can aggregate the influence of individual members within a group as the other measure of group influence, called $AI_{gs}$, meaning the aggregate influence score of group $x$, so that one group becomes a more influential group if it has more influential users. In Eq. (4) we also consider the weight of a member $u_r$ within group $x$, because a member can join several groups, and his contribution might differ in different groups. To obtain $MW_{wu_r}$, we consider user $u_r$’s reputation on articles collected ($RAC_{wu_r}^{gs}$) within a group $x$, $u_r$’s reputation on articles posted ($RAP_{wu_r}^{gs}$) within a group $x$ and $u_r$’s reputation on questions answered by representing a group $x$ ($RQA_{wu_r}^{gs}$). To obtain $RP_{wu_r}^{gs}$ and $RC_{wu_r}^{gs}$, the concept of link analysis is adopted. For example, as shown in Figure 4(a), a knowledge document is collected/posted by Member 1 for his group, and Members 3, 4 and 5 recommend this document, represented by an edge from the document, to each of the recommenders. We summarize the relationships between users in Figure 4(b). This graph contains vertices representing the users and omits the actual documents that connect the users. With Figure 4(b), the PageRank algorithm is applied to calculate the reputation score.
\[ AI^{R_s}_{u_r} = \frac{\sum_{u_r \in G_x} I_{u_r} \times MW^{R_s}_{u_r}}{\sum_{u_r \in G_x} MW^{R_s}_{u_r}} \quad , \]

where \( MW^{R_s}_{u_r} \) is the importance of a member \( u_r \) within group \( x \), and \( I_{u_r} \) is the influence score of an individual \( u_r \). \( G_x \) is the set of users in group \( x \).

\[ RAC^{R_s}_{u_r} = \gamma \times \sum_{u_r \in G_x, u \in u_r} \frac{RAC^{R_s}_{u_r}}{Outlink(u_r)} + (1 - \gamma) \times \frac{1}{N} \quad (5) \]

where \( \gamma \) is the damping factor, which is the probability that a random surfer will follow one of the links on the present page.

The \( RAP^{R_s}_{u_r} \) is also obtained by using the PageRank algorithm, as with calculating \( RAC^{R_s}_{u_r} \). \( QOA^{R_s}_{u_r} \) is derived as Eq. (6), and we consider the fraction of best answers awarded to a member who represents his/her group to answer questions over the maximum of all other members in the same group. Finally, we integrate \( RAC^{R_s}_{u_r}, RAP^{R_s}_{u_r} \) and \( QOA^{R_s}_{u_r} \), as shown in Eq. (7).

\[ RQA^{R_s}_{u_r} = \frac{GBestAns^{R_s}_{u_r}}{Max_{u_r \in G_x} GBestAns^{R_s}_{u_r}} \quad (6) \]

\[ MW^{R_s}_{u_r} = \max_{u_r \in G_x} \left[ \lambda \times RAC^{R_s}_{u_r} + (1 - \lambda) \times RAP^{R_s}_{u_r} \right] \times QOA^{R_s}_{u_r} \quad (7) \]
4.3 Group activity score

The active level of a group can be measured by the recency, frequency and monetary value (RFM) it generates, i.e., how recently, often and many times a group has answered questions (A), collected articles (C) and posted articles (P). In other words, little or no group activity suggests little group influence; thus, the group is non-influential. Hence, a large number of RFM indicates that the group is involved in the Q&A community, actively contributing their knowledge such that it garners wide attention from community members; therefore, it can be more influential.

A. Recency

How recently a group has answered questions, posted articles, collected articles. \( r_{gs} \) is the current time minus the most recent time that the group \( x \) has activities; the Min-Max normalization is computed by:

\[
xg_{r'} = \frac{r_{max} - r_{gs}}{r_{max} - r_{min}}
\]

where \( r_{g_s}' \) and \( r_{gs} \) represent the normalized and original recency values, while \( r_{max} \) and \( r_{min} \) represent the largest and smallest recency value of all groups.

B. Frequency

The frequency value is defined as the number of times that a group posted articles, collected articles and answered questions (represented a group to answer) within a specific period:

\[
f_{g_s}' = \frac{f_{gs} - f_{min}}{f_{max} - f_{min}}
\]

where \( f_{g_s}' \) and \( f_{gs} \) represent the normalized and original frequency values, while \( f_{max} \) and \( f_{min} \) represent the largest and smallest frequency value of all groups.

C. Monetary

We define monetary as the number of articles posted, number of articles collected and number of questions answered (represented a group to answer) of a group:

\[
m_{g_s}' = \frac{m_{gs} - m_{min}}{m_{max} - m_{min}}
\]
where \( m'_{gs} \) and \( m_{gs} \) represent the normalized and original monetary values, while \( m_{\text{max}} \) and \( m_{\text{min}} \) represent the largest and smallest monetary value of all groups.

Finally, we average the scores of the three factors \( (r, f, m) \) to derive the RFM score of group \( x \) (\( RFM_{gs} \)), as shown in Eq. (11)

\[
RFM_{gs} = \frac{r'_{gs} + f'_{gs} + m'_{gs}}{3}
\]  

(11)

### 4.4 Hybrid group influence score

To compose the group’s influence score, we first integrate \( I_{gs} \) and \( RFM_{gs} \). \( I_{gs} \) is complemented by \( RFM_{gs} \) because the influence of a group may change over time, and \( RFM_{gs} \) is used to consider the recent active level of a group. Some groups have garnered a large influence, but due to less activity in answering questions from others recently, their influence should be discounted. Therefore, we use harmonic mean to integrate \( I_{gs} \) and \( RFM_{gs} \), as shown in Eq. (12). Finally, Eq. (13) shows the hybrid influence score of a group \( x \) (\( HI_{gs} \)) by integrating \( RFMI_{gs} \) and \( AI_{gs} \).

\[
RFMI_{gs} = \frac{2 \times I_{gs} \times RFM_{gs}}{I_{gs} + RFM_{gs}}
\]  

(12)

\[
HI_{gs} = \alpha \times RFMI_{gs} + (1 - \alpha) \times AI_{gs}
\]  

(13)

where \( \alpha \) is the parameter used to adjust the relative importance of \( RFMI_{gs} \), and aggregate influence score (\( AI_{gs} \)).

### 4.5 Current status and plans

#### 4.5.1 Current status

We have collected data from Yahoo! Answer Taiwan. 18 Knowledge groups were selected from the “computer and network” category, and the top 20 active members were selected in each knowledge group. The size of these downloaded web pages is about 16GB. We developed the parsers to extract the data we want, and store it in the database.
We are still in the process of conducting link analyses of the social graph, and we plan to recruit a few participants (< 5) to browse the behavior data from group members and each group. We will show the scores calculated by our system, like, for example, the active level scores. After they understand each knowledge group, they will be asked to rank these knowledge groups. Thus, standard influence rankings of groups by human judges will be obtained.

4.5.2 Plans

A. Evaluation metrics

To measure the degree of similarity between two rankings (one is generated by our approach, and the other is from human experts), we plan to use the Spearman correlation coefficient ($\rho$), Kendall rank correlation coefficient ($\tau$) and Rank distance ($d$) as our evaluation metrics.

We will calculate the $\rho$, $\tau$ and $d$ of our proposed approach by comparing its group ranking results with group rankings obtained by human experts, thereby obtaining these outcomes. We plan to use the average of these outcomes as the final evaluation result.

B. Methods to be compared

We plan to compare the performance of using $AI_g$s alone, against using both $AI_g$s and $RFM_g$s, and against using both $AI_g$s and $I_g$s. We will also evaluate the effectiveness of explicit links.

5 Future work

Although much research has been devoted to identifying influential users, few studies have undertaken to discover influential groups. Identifying influential groups is critical since this information can affect which groups users decide to join. The discovered results can also be applied to developing applications based on the group perspective. For instance, to conduct targeting ad programs in an SQA site, advertisers can choose to place their ads for top influential groups, as the diffusion of information by systematically targeting certain top influential groups could be more effective. Our work presents an overview of research in progress that emphasizes the framework for discovering influential groups in an SQA site by looking for link (interaction) analysis, reputation analysis and active level analysis in our research framework. We plan to use three evaluation metrics to evaluate our proposed approach, and to compare different methods in future work.
6 Acknowledgements

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References

Information Technology 4
Computer and Service Online Shopping Management System

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Abstract. KTCS store (KT Computer and Service store) is a computer store and IT services. The IT services including computer repair and get claim the warranty product. All computer spare part and equipment which used for selling, repairing and claiming are from our stock.

KTCS’s IT services range from getting non-functional computer, repairing until issuing the receipt, the process is running day by day conservatively without any IT management.

After careful analysis it was found that 3 parts of the system can be improved by IT management, including sales, IT service and transportation.

Computer and Service Online Shopping Management System (CSOSMS) is an electronic commerce (EC) which consists of front end and back end. Front end is an interface for making an order, management repairing queue and check the warranty of the product. Back end is designed for inventory checking, managing the repair queue and issue the invoice.

This paper presents CSOSMS case using QFD to design phase of an e-commerce construction project as a tool of improvement for technique specification of e-commerce.

Keywords: E-commerce, E-commerce systems, QFD, QoH

1 Introduction

Traditional markets, having some physical infrastructure is necessary for customer needs (Lindsay, 2000). Many ECs have attention on clicks and mortar strategies to take advance of existing physical and human resources in adoption of EC. Some EC models select the way to offer goods and services in only virtual mode with no reliance on actual infrastructure or actual human (Timmers, 1999) but model development led to weaker relation between customers and vendors (Schneider and Bowen, 1999). So EC model should develop base on an ongoing relationship with customer (Bouwman and Hin, 2000). So to analysis customer relationship and to focus at Customer acquisition to get in contact with the customer, Customer retention to develop the relationship with the customer (Calkins, Farello and Smith, 2000), Learning from customer to exchange information with customer (Peppers, Rogers and Drof, 1999) and Value proposition to strengthen the customer relationship (Shapiro and Varian, 1999). In order to build a quality EC, Quality Function
Development (QFD) is a method of customer-oriented design to assure the design quality and when appropriately applied, QFD has reduced development time (Akao, 1990). QFD uses a matrix in each of four phases of product development to translate customer requirements from product planning stage and product design, process planning, and process control planning (Cohen, 1995). In order to implement each of phrases of QFD process involves putting together in a house of quality (Hauser and Clausing, 1988).

This paper improves design CSOSMS using QFD to ensure e-commerce design characteristics are translated from customer desires.

2 KTCS Issues

2.1 Selling Computer Device

KTCS store want to jump on to the online shop but why should go to an online shop rather than the brick and mortar shop and online stores don’t close with customers but brick and mortar close with customers. The first question is online shops have CRM and classification products following generation x, y and z for the convenience of shopping whenever they want to order. They don’t need traveling required. They don’t have to drive or take a public transportation, deal with traffic jam, bad weather and so on. All correspondence’s customers can be made through e-mails and mobile phone. And the last question is online stores are newer and seem to be really competitive right now. As a result, many discounts can be found for online stores that can’t be used at a brick and mortar store. And payment, customers can pay via credit card over the internet.

2.2 IT Servicing

KTCS store has technicians who are experienced for a long time and also well perform to repair any well known brand hardware at a reasonable price. But why customers still prefer to take repairing services over the internet more than direct repair at the store. It because online services can offer personalizing service and repair track system which are brick and mortar cannot response their need. Customers will not waste their time to waiting at the store anymore.

2.3 Transportation

Customers want to get what they order right away. In other words, they have to wait for items when they want the item delivered quickly, yet KTCS store doesn’t have the item delivery. Most likely customers will pay shipping fees. They need to consider the shipping fees when they try to decide for a really
great price. After send product, some time, product may be returned; many online stores offer free returns. Customers can sent the item that doesn’t fit back to online stores at no cost to them. But many online stores don’t offer free return. Customers end up paying for the item to go back to them, even if they send customer the item wrong. But if customers purchase items from brick and mortar stores, they must bring the item right back to the stores by themselves which take time and take money like fee return.

3 Quality Function Deployment (QFD) and House of Quality (HoQ)

If developers want to build a quality product, they have to consider and address on customer’s requirements (CR). CRs only show what they want but developers need to know how to design a product or service which correspond with customers how’s. These customers what’s need to be translated into developer how’s. QFD (Beacker Associates Inc, 2000) is one of tools that can translate customers what’s to developer how’s by using a series of matrixes which consist of a vertical column of customers what’s and a horizontal row of developers how’s which build in HoQ (Houser and Clausing, 1988) in many shapes such as the one show below.

![HoQ in QFD](menks.jpg)
3.5  Customer Requirements

The first step in a QFD e-commerce is to determine and analysis what fact data from customers on the requirements of CSOSMS in three issues which want to have for the products and services on e-commerce. In order to organize and evaluate data into information, the result shown that CSs consists purchase system, IT service system, payment system, transportation system and membership system.

Table 1. Customer Requirement

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<tr>
<td>Transportation System</td>
<td>○ ● ● ● ○ ○ ○ ○ ○</td>
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<td>Membership System</td>
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</tbody>
</table>

3.6  Customer Importance Ratings

In this step of the QFD process, to understand how customers product and service rates of KTCS shop which in e-commerce in relation to the competition by measure from frequency ask question from customers. Maximum relationship for customer importance is 9 in QFD. The maximum value of purchase and payment order is 9. The value of IT service system is 7 and the minimum value of transportation and member system is 6.
Table 2. Customer Importance Rating

<table>
<thead>
<tr>
<th>Weight Chart</th>
<th>Relative Weight</th>
<th>Customer Importance</th>
<th>Maximum Relationship</th>
<th>Functional Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>24%</td>
<td>9</td>
<td>9</td>
<td>Purchase system</td>
</tr>
<tr>
<td></td>
<td>19%</td>
<td>7</td>
<td>9</td>
<td>IT Service system</td>
</tr>
<tr>
<td></td>
<td>24%</td>
<td>9</td>
<td>9</td>
<td>Payment System</td>
</tr>
<tr>
<td></td>
<td>16%</td>
<td>6</td>
<td>9</td>
<td>Transportation System</td>
</tr>
<tr>
<td></td>
<td>16%</td>
<td>6</td>
<td>9</td>
<td>Membership System</td>
</tr>
</tbody>
</table>

3.7 Technique Specifications

Technique Specification is to develop the technical requirements that can be measured and benchmarked for meeting customer needs and against the competition. All requirements in this step can determine from brainstorming with the members of the design team. CSOSMS requirements consist of product presentation, product search, order tracking, shopping cart, credit card, secure socket layer, PayPal, Google, product warranty, product shipping, product return, stock management, logistic, Generation XYZ, CRM and product repair. The design team considers the direction of movement target value for improvement or optimization for each technique. Direction of improvement can either be maximized”▲”, targeted “◇” and minimize“▼”.
### 3.8 Relationship Matrix

Relationship matrix of CSOSMS is the relationship between CRs and techniques specification which are defined by design team. The team determines from strength of relationship by using frequency ask the question which relationships can either be strong” ●” modulate” ○” and weak” ▽“ and carry a number value 9, 3 and 1. Organization difficulty is a max relationship, if maximum rate in each column is strong, rate of the design attribute is 9 but if maximum rate in each column is modulate, rate of the design attribute is 3, the other is 1.

### 3.9 Technical Analysis of Competitor Products

Technical Analysis is to find out technical specification values of CSOSMS for better understand the competition by using reverse engineer competitor product. Target values for technical specification start from 1 to 5 ratings with 5 being the best realized each technical specifications and 1 being the worse realized. The result from technical analysis was developed as shown in chart between technical specification and relative weight in Table 4.

### Table 3. Technique Specifications

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<thead>
<tr>
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<tbody>
<tr>
<td>● ● ● ● ● ● ● ● ● ●</td>
<td>● ● ● ● ● ● ● ●</td>
<td>● ● ● ● ● ● ● ●</td>
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</tbody>
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3.8 Relationship Matrix

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Table 4. Technique Analysis and Competitor Product

<table>
<thead>
<tr>
<th>Technical Assessment</th>
<th>Our Product</th>
<th>Competitor #1: Computer Device</th>
<th>Competitor #2: IT Service</th>
<th>Competitor #3: Product warranty</th>
<th>Competitor #4: Com device and IT Service</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5 5 4 3 5 3</td>
<td>4 3 3 4 4 3 4 4 3 4 4 5 4 3</td>
<td>4 5 4 4 5 3 3 4 4 4 4 5 5 3</td>
<td>4 3 4 3 4 4 3 4 4 3 5 4 4 4 4</td>
<td>4 4 3 4 4 4 3 4 3 4 5 4 5 5 5</td>
</tr>
</tbody>
</table>

3.10 Correlation Matrix

The correlation matrix of CSOSMS is the roof of the HoQ which is used to identify how each of technique specification supports or impact one another. The positively and negatively correlated features help identify technical solutions that are closely related and trade-offs respectively by the design team. The positive and negative ratings are defined by using 1 and -1 ratings, with 1 is strongly supportive to each technique specifications and -1 being the conflicting.
### 3.11 Absolute Importance

The final step of HoQ, the design team calculates the absolute importance of sum all the row numbers each of which is equal to production of relationship rating and customer importance rating. The result numbers are then added up in each column to help identify the importance for each technical specification of CSOSMS.
### Table 6. Absolute Importance

<table>
<thead>
<tr>
<th>Max Relationship</th>
<th>9</th>
<th>9</th>
<th>9</th>
<th>9</th>
<th>9</th>
<th>9</th>
<th>3</th>
<th>3</th>
<th>9</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical Importance Rating</td>
<td>365</td>
<td>705</td>
<td>219</td>
<td>219</td>
<td>219</td>
<td>73</td>
<td>73</td>
<td>195</td>
<td>146</td>
<td>146</td>
</tr>
<tr>
<td>Relative Weight</td>
<td>9%</td>
<td>17%</td>
<td>5%</td>
<td>5%</td>
<td>5%</td>
<td>2%</td>
<td>2%</td>
<td>5%</td>
<td>4%</td>
<td>4%</td>
</tr>
</tbody>
</table>

### 4 Design Improvements

QFD is a systematic to ensure that customer requirements of e-commerce and then translated into relative technique specification. The final result of absolute importance was possible for design team to prioritize and implement the new e-commerce systems following technique specifications and was necessary to increase or decrease following new specification solutions. The result from QoH help to ensure that CSOSMS requirements consist of purchase, IT service, payment, transportation and membership system and the final result of QFD shows level of importance for design team which starts from product search be the best importance to Google payment be the last importance which shown in Table 7.

### 5 CONCLUSIONS

QoH in QFD is a flexible tool for e-commerce developer team to ensure what it is they are designing which are what the customers will expect from it and then translated into technical specifications for each stage of e-commerce development. In the next phrase, e-commerce specifications will be developed using incremental framework which is divided into four major phrases: Inception; Elaboration Construction and Transition to aim for running code at the end of many iterations as possible and iterations can be time boxed which are benefits over traditional process.
Table 7. Design Solution

<table>
<thead>
<tr>
<th>Technique Specification</th>
<th>Level of importance</th>
<th>Design Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Search</td>
<td>17%</td>
<td>Advance Search Engine</td>
</tr>
<tr>
<td>Product presentation</td>
<td>9%</td>
<td>Customer Relationship Management</td>
</tr>
<tr>
<td>Generation x y z</td>
<td>9%</td>
<td>Customer Relationship Management</td>
</tr>
<tr>
<td>CRM</td>
<td>9%</td>
<td>Customer Relationship Management</td>
</tr>
<tr>
<td>Product repair tracking</td>
<td>8%</td>
<td>IT Service</td>
</tr>
<tr>
<td>Order Tracking</td>
<td>5%</td>
<td>Customer Relationship Management</td>
</tr>
<tr>
<td>Shopping Cart</td>
<td>5%</td>
<td>Customer Relationship Management</td>
</tr>
<tr>
<td>Credit card</td>
<td>5%</td>
<td>Payment</td>
</tr>
<tr>
<td>Secure Socket Layer</td>
<td>5%</td>
<td>Payment</td>
</tr>
<tr>
<td>Product warranty</td>
<td>5%</td>
<td>IT Service</td>
</tr>
<tr>
<td>Product Shipping</td>
<td>4%</td>
<td>Transportation</td>
</tr>
<tr>
<td>product return</td>
<td>4%</td>
<td>Transportation</td>
</tr>
<tr>
<td>Logistic</td>
<td>4%</td>
<td>Transportation</td>
</tr>
<tr>
<td>PayPal or Google</td>
<td>4%</td>
<td>Payment</td>
</tr>
</tbody>
</table>

References


A study of partner relationship management within e-Procurement platform by system simulation

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Abstract
This study ran three simulations to examine whether the management of partner relationships in electronic commerce could strengthen the collaboration capabilities and overall competitiveness of companies under the electronic purchase ecosystem. The result demonstrated that applying the PRM concept in the electronic purchase ecosystem can improve the service level to the clients and increase income, and that the effect on service level in the dynamic PRM concept is higher than the fixed PRM concept. Through our simulation process, industries could know the supplier selection procedure under the PRM concept. By continuously simulating trades within the supply chain, enterprises in various industries will find their most valuable partners, and can engage them in long term relationships.

Keywords: Partner Relationship Management (PRM), Electronic Purchase (EC), Computer Simulation

1 Introduction

The relationship between buyers and suppliers was hostile in the past. Buyers and suppliers were in a zero-sum competition; they built fortifications in order to survive the competition. A relationship of mutual trust between enterprises and their suppliers is not easy to establish; the relationship will increasingly become more tense than ever. Even if an enterprise has the best competitive advantages, the rocky relationship will damage long term development of the enterprise, and that enterprise will be unable to deal with challenges of the changing world.
For long term survival, enterprises must have innovations, and also must work together to co-evolve with buyers. Hostile relationships between buyers and suppliers become rare, replaced by the establishment of common interdependence and mutual trust. More and more enterprises develop more in-depth cooperation with their buyers because they recognize that they should truly focus on the customer instead of product prices and should focus on how to increase their ability to meet the customer’s expectations.

Supply chain management is a very important issue. As Victor Fung (2008) pointed out in the Li & Fung Group experience, for enterprises to win in this era of globalization, they must change their initial concept of competition from one-on-one competition into a competition among the supply chain. Enterprise dominance in the competition depends on the use of the resources of the entire supply chain. If the enterprise integrates their supply chain and further builds mutual trust in the entire supply chain, long term cooperative partnerships will be able to bring management, technical and financial benefits.

This study is to examine whether the management of partner relationships in electronic commerce will strengthen the collaboration capabilities and overall competitiveness of companies under the electronic purchase ecosystem. Therefore, we developed an electronic purchase system prototype which included the concept of PRM. After that, we designed three system simulations to deal with the research problem. The simulations are: 1) the transactions in the electronic purchase system without PRM, 2) the transactions in the electronic purchase system with fixed PRM, and 3) the transactions in the electronic purchase system with dynamic PRM.

2 Relative Research

2.1 Partner relationships

In the book “Getting of Partnering Right” describe the Partner relationship as follows: 「True enterprise transformation is an activity, participants are unity and cooperation in the organization together to create value to change, to work together to create a new cooperative mode of operation in order to assist enterprises to achieve unprecedented profitability and competitiveness. Even if the partners still in the initial stage of a relationship, the effectiveness of many companies from this new relationship will be far more than the reduction of the cost-effectiveness of organizational downsizing or tissue reconstruction」. The relationship is called a "Partner relationship" [6]. When both partners agree to change the individual mode of operation, mutually integrating control of a
portion of total enterprise system and the shared interests, the "Partner relationship" is formed.

2.2 Types of Partner relationships

Morgan and Hunt [5] proposed four types of partner relationships from the perspective of relationship marketing. According to the cooperative relationship with the object, the partnership is divided into four main categories: supplier partnerships, buyer partnerships, internal partnerships, and partnerships formed with other companies. Physical goods suppliers and service providers are two major actors in supplier partnerships. Final customers and intermediate customers play important roles in buyer partnerships. The roles in the internal partnerships are employees, business units and sub-companies. Partnerships formed with other companies include members such as governments, non-profit organizations and competitors. Thus, when companies face a variety of different types of partners, they must apply a different partner relationship management strategy to each.

2.3 Partnership building process and partnership life cycle

The establishment of the partnership can be roughly arranged into five stages from the perspective of the buyer: awareness, exploration, expansion, commitment and dissolution. In the awareness stage the buyer will be the first to identify a group of potential suppliers. In the exploration stage, enterprises assess potential suppliers and conduct the negotiations of the contract, and place orders for small quantities of product. Enterprises begin to sign long term contracts for bulk purchases in the expansion phase. Enterprises will realize that there is a gap between the value brought from partner suppliers and the value brought from other suppliers at this stage. In the commitment stage, the buyers and sellers are willing to make sacrifices and concessions in order to maintain long-term partnerships and will continue efforts to create a win-win situation. Finally in the dissolution stage, the relationship will be terminated when the original goals of cooperation have been reached or no longer exist [1].

2.4 Strength of Partner Relationships

Lijander and Strandvik [4] used 10 “bindings” to measure the strength of customer relationships. Those ten are the binding forces of: law, economics, science, technology, time, geography, knowledge, society, culture, consciousness, and mind. Li, Tseng and Lu [3] conducted a study which was trying to find the critical “bonds” between business partners. They identified 15 bonds to categorize partner relationships and to differentiate the degree of
integration between business partners. Those bonds are: legal, economic, custom, culture, faith, preferences, technology, processes, knowledge, resources, time, geography, familiarity, structure, and dedication. In the system simulations in our study, we adopted the economic, technology and time bonds proposed by Li et al. [3].

1. Economic Bond: Companies will select the best product prices and will trade with their most interested vendors in order to achieve the maximum business profit.
2. Technology Bond: Both sides, providers and consumers, have interdependent science, technology or products. Once a lack of supply or support results in the inability to complete jobs, patents are often transferred between business partners in order to eliminate the problems.
3. Time Bond: Most of the companies have existing restrictions on time or systems to provide service. Customers use the service only during service hours.

3 Simulations

This study is to examine whether the management of partner relationships in electronic commerce will strengthen the collaboration capabilities and overall competitiveness of companies under the electronic purchase ecosystem. Therefore, we developed an electronic purchase system prototype which included the concept of PRM. Then we designed three system simulations to examine the research problems.

Simulation 1: The transactions in the electronic purchase system without PRM. The priority of shipment to buyers is FCFS (First Come First Served). That means shipments are delivered in sequence according to the order of receipt of the order forms.
Simulation 2: The transactions in the electronic purchase system with fixed PRM. The bonding scores of buyers are listed first and the shipping order is in accordance with the order of the bonding scores. The word “fixed” means once the sequence of buyers is sorted in the list, the list is not changed.
Simulation 3: The transactions in the electronic purchase system with dynamic PRM. At the beginning, the priority of shipment is FCFS (First Come First Served). Then, the priority is changed every half year according to the bonding scores of buyers.

3.1 Assumptions
System simulation must not include all parameters in the real world. In order to facilitate this study, we made the following assumptions:

(1) There is only one seller with 10 products, and there are 10 buyers.
(2) The unit of time in this study is one week.
(3) There may be multiple orders per unit time. The distribution of the orders is Poisson distribution, Poi(3), This means that each buyer will place three orders on average during each unit of time.
(4) For each order belonging to only one buyer, the probability of each order belonging to a particular buyer is 0.1. U(1,10).
(5) There is only one kind of product in each order. The probability of each product belonging to a particular order is 0.1. U(1,10).
(6) The quantity in each order is a normal distribution with a mean of 30,000 and a standard deviation of 5,000. N(30,5).
(7) The cost of each product is a normal distribution with a mean of 90 and a standard deviation of 20. N(90,20).
(8) The price of each product is a normal distribution with a mean of 200 and a standard deviation of 20. N(200,20).
(9) All orders coming from same time unit are acknowledged together.
(10) The upstream supplier will immediately supply all required raw materials.
(11) There is no price discount in our scenario.

3.2 Measurements

Seven measurements are used in our simulations as follows:

(1) Income: The income of the company in the simulations is defined as the price of the product item multiplied by the quantity on the order sheet.
(2) Net Income: Net income of the company in the simulations is defined as per the following formula: Net Income = (Price of product item – Cost of product item) * Quantity on order sheet.
(3) Net Loss: In the simulations, the company’s net loss occurs only when the orders come from buyers are not fulfilled is defined as per the following formula: Net Loss = (Price of product item – Cost of product item) * Unfulfilled portion of Quantity on order sheet.
(4) Service Level: We measure the service level by the percentage of order fulfillment. A higher service level indicates higher customer satisfaction. Service level is defined as per the following formula: Service level = (The number of order sheets – The number of unfulfilled order sheets) / The number of order sheets.
(5) Score of Economic Bond: The concept of Economic Bond is that companies will select the best product prices and will trade with their most
interested vendors in order to achieve maximum business profit. Thus, we define the score of economic bond as the count of order sheets which bring the highest net income for a particular buyer.

(6) Score of Technology Bond: There are common goods and high technology goods in simulation scenarios. We measure the score of technology bond by the quantity of high technology product items on all order sheets.

(7) Score of Time Bond: There are time or systems restrictions on the service provided. Customers use the service only during service hours. We measure the score of time bond by the count of order sheets within the service hours.

3.3 Simulation Process

Stage 1: Initialization. The purpose of this stage is to set up parameters of productions and buyers. The details are as follows: 1) initialize the bonding scores of buyers, 2) set selling price and cost of each product, and 3) set the weekly production capacity for each product. The trading period is set to 6 years in the simulations.

Stage 2: Running Simulations. There is no PRM concept in Simulation 1. The bonding scores are never changed in Simulation 2. We adjust the bonding scores based on the trading results every half year of simulation time in Simulation 3.

4 Results

Simulation 1: Because the FCFS rule is applied, the service levels are highest for the first buyer and the lowest for the last buyer. The average service level is 0.574. We also found that buyers A, B, C, D, E and F were bringing positive net income and buyers G, H, I and J were bringing a net loss. Thus, if we change the sequence of shipment to buyers, it will bring more business profit.

Simulation 2: The average service level increased to 0.594 and the service levels of the 10 buyers are closer than the service levels in Simulation 1. In this simulation, we demonstrated that the concept of fixed PRM could increase the customer satisfaction average. Simulation 3: The average service level significantly increased to 0.646. That means the dynamic PRM significantly increased customer satisfaction, and the increase from dynamic PRM is greater than the increase from fixed PRM.

Base on those simulation results, we could claim that supply chain with PRM can bring more business profit than the supply chain without PRM, and a supply chain with dynamic PRM contributes more business profit than a supply chain with fixed PRM. These results also indicate that the partnership is a
dynamic relationship between supplier and buyers. The relationship should be monitored and frequently modified in order to maximize business profits.

Our study findings echo the B2B Partnership Lifecycle which was proposed by Heffernan[2] in 2004. At the early stages of trading, the relationship is weak and the bonding score is low. After more and more transactions are accomplished, the relationship between the company and buyers becomes closer and closer, and the company gets more and more profit.

5 Conclusion

In this era of global economics, the competition between companies has changed. Competitions do not exist only between companies but also extend to the supply chain or business alliances. In the trend of global economics, if operational performance within the supply chain is lower than other competitors, the consequences will damage the company’s chances of survival. PRM (Partner Relationship Management) emerged from this competitive situation. Regardless of the industry, PRM has become a critical issue for enhancing total performance in the supply chain. Even traditional industries or high-tech industries have to adapt to the concept of PRM in order to maintain their competition advantage.

This study is to examine whether the management of partner relationships in electronic commerce will strengthen the collaboration capabilities and overall competitiveness of companies in the electronic purchase ecosystem. Firstly, we developed an electronic purchase system prototype which included the concept of PRM. Then we ran three system simulations to examine the PRM concept in the system prototype. Based on the result of this study, we could claim that a supply chain with PRM can bring more business profit than the supply chain without PRM, and a supply chain with a dynamic PRM contributes more business profit than a supply chain with a fixed RPM.

Through this study, enterprises could know the buyer selection procedure under the PRM concept. By continuously simulating trades within the supply chain, enterprises in various industries will find their most valuable partners and engage them in long term relationships.

References

Analysis of the Importance and Classification on PMO role ;Using the Delphi

Abstract. As more and more companies focus on business values brought by relevant projects, roles of Business Department has been steadily increasing in large scale IT projects. This study starts at this point. Because researches regarding to Business PMO has not been deeply studied. I focused on the prerequisites of Business PMO for running successful large scale IT projects. I used the Delphi method, a quotation of specialists in designated areas. According to the results of research, roles of Business PMO are divided into six sections; business relationship management, requirements management, change management, communication management, issue management, and performance management etc. More detaily, roles of Business PMO are 'organizing Business TFT', ‘managing business requirement’, ‘managing executive sponsorship’, ‘managing the role and responsibility of business TFT’, ‘planning change management’, 'managing communication between business TFT and IT Department’, 'defining project initiatives’, ‘managing manpower supply and demand’ and 'supporting final user acceptance test’.

Key Words: Project Management Office, Delphi, Business PMO, Business TFT

1. Introduction

1.1 Research background

As companies increase their investment into IT every year, banks invest hundreds of billions of dollars or more into IT industry on average even though the amount is different from company size. Standish Group said that the success of IT projects was determined considering three aspects: delivered on time, on budget, and required features and functions. That is, the success will be recognized only when a designated time, allocated budget, (business) needs and functions are satisfied[19]. Companies have long been making efforts to complete IT projects within designated time and budget. As a part of their efforts, they pay more attention to project management in order to avoid significant financial loss which is likely to arise from the failure of IT project. In particular, as the projects grow huge, the needs to manage projects on a more sophisticated basis also increase. Moreover, to meet the needs to create
much more business value than investment, companies are in a situation to enhance the control over IT projects than ever. As a method to do so, companies pay more attention to PMO (Project Management Office or PMO) which means an organization that generally manages any and all sectors ranging from quality management to risk and schedule management, and output management, and that supports the success of project by effectively managing not only quality but also risk factors that are likely to occur in the course of establishing systematic project management system and performing project. As projects increase their size and last longer and accordingly the personnel and establishing expenses grow higher, the expertise on managing projects is needed in order to enhance reliability and stability of project and minimize various risks and reverse functions accompanied by IT activities, increasing the needs for PMO. Tonny (1997) conducted a study on success stories of 500 companies designated by the Fortune and maintained that a well-organized PMO helped enhance professionalism and ensure consistence for project management[21]. As the cases where companies operate PMO for success increase, companies often organize a dedicated management body (work-site PMO) for the purpose of systematic management of work-site TFT. It reflects the tendency where the role of work-site departments grows more for the successful realization of IT projects. When it functions on its own as a control tower, the work-site PMO can perform its given role in sincere, which significantly affects the success of project.

1.2 Research purpose

This research is to define the work-site PMO that is necessary for successful performance of projects based on the studies on the project management theory and any related various theories contained in the literature and identify its role and function. The existing studies were conducted often for the generality of PMO such as PMO’s function [2,3,7,8,9,14,16,17], PMO integrated performance management model[20], Project management governance [11]. This study, however, reflected the tendency where PMO has been operated in various forms depending on its role such as portfolio PMO, program PMO and etc., plus the studies which divided the ultimate form of PMO in accordance with project support and control into four—the Scorekeeper, the Facilitator, the Quarterback, and the Perfectionist [13], and going one step forward from PMO generality, examined on an exploratory basis and defined the role and function from the work-site PMO perspective. That is to say, by analyzing the priority and priority of various roles and functions of work-site PMO, it is to substantially help operate work-site PMOs. Finally, if companies operate work-site PMOs in the future, the study can suggest good practices paving the foundation to successfully push ahead with great management innovation and
next-generation project. The purposes of the study are summed up as follows: first, to identify the roles and functions of work-site PMO; and secondly, to analyze the priority and priority of various roles and functions performed by work-site PMOs from various perspectives and views.

2. Study on the literature

2.1 PMO

PMO is defined variously depending on researchers and institutions. PMBOK (2004, 17) defined a PMO as an organization unit to integrate and adjust in the center the project management within the applicable scope: PMO puts its emphasis on works including integrated planning of projects that are integrated to the entire business objectives of a client and sub-projects, designation of priority, and implementation [15]. Ward (2000) defined a PMO as an organization that possessed expertise to support projects, which could support project managers and project team and appropriately control project in accordance with company policy: an organization to generally manage any and all affairs of the company [22]. Some defined a PMO as an organization to go beyond the passive level of project management, to define the existing project experiences on a systematic basis and to provide knowledge necessary for project proceeding using the right personnel in the right place, and accordingly to enhance the efficiency of project management [5,6]. As for the domestic manufacturing business, a PMO has been operated when the conglomerates such as Samsung Electronics, LG Electronics, and POSCO pushed ahead with management innovation or PI project; and the financial circle began gradually introducing a PMO when it experienced next-generation projects in early 2000s. With the introduction of new technology and the provision of new IT services accelerated, the number of mid- and large-sized projects has rapidly grown, resulting in not the existing phenomenon where one project ended and then another project was pushed ahead with as it was, but a new one where one after another project or various projects are pushed ahead with at the similar time or concurrently, which increases more the priority of PMO.

2.2 Work-site PMO

If pushing ahead with management innovation or large-scale projects including PI, ERP or next generation projects, companies inject personnel from the work-site departments, who perform various activities such as management of demands requested on site, user test, change management, and etc. This study defined a work-site PMO as a control tower organization to exclusively manage and lead the work-site TFT which is injected to perform large-scale
project within the company. The work-site PMO defines business demands from a work-site perspective and draws out matters to be improved in the step of defining demands. Besides, in the step of designing, it concentrates on performing verification of IT design output. After the test, the work-site PMO performs its duties focusing on tracking management for demands, test management, change management, and implementation management. Unlike a PMO, a work-site PMO does not serve as a manager of the existing simple project but serve as a manager of the company-wide IT project portfolio, and plays a role of a communication window between work sites and IT department, enabling the realization of IT project more closely engaged in business and narrowing the gap among IT and work-site departments, which can be said a department performing the front line affairs.

3. Research method

3.1 Delphi method

In late 1950s, O. Helmer, researcher from the American Rand Corporation studied and developed the Delphi method which collected group opinions about the urgent matters related to national defense and society including the demand prediction for the national defense technologies and the tendency prediction for social technology development, which was a technique to solve problems and predict the future through experts’ empirical knowledge and also called an expert consensus[8]. This technique collects and exchanges opinions through repeating survey on experts and develops the suggested opinions to predict the future: a method to repeatedly collect and exchange opinions from various experts, and develop the opinions to predict the future.

3.2 Research procedure

Delphi method consists of four rounds: the first round presents a predicting topic to experts and listens to the experts’ opinion; the second round predicts the time to realize each topic based on the questionnaire where a predicting topic is confirmed; the third round receives distribution materials on predicting time of each topic and revises the predicting results drawing from the second round; and the fourth round modifies the prediction again based on the revised opinions of experts on predicting time distribution and predicting times [4]. Most studies, however, revised and used their own Delphi method. Some researchers proceed the method up to the fifth round or more; if the person who conducts a research does not want the opposite opinions from experts that are needed in the third round, other researchers omit the fourth round and only conduct the third round [12]. Thus, the study used the Delphi method
consisting of three rounds. In this study, Delphi method concentrated on the analysis of the significant role of work-site PMO: measuring the major roles of work-site PMO with priority or priority, scoring each role by 7-point measure, and performing two questionnaires (email) and one interview (face-in-face interview).

Fig. 1. Research procedure on work-site PMO roles

3.2.1 Literature review and questionnaire development

Based on the preliminary studies and the literatures on PMO, the study defined the major scopes and detailed roles related to work-site PMO roles; based on these, prepared the questionnaire where a total of 22 questions were drawn from the scopes including work-site operation management, demands management, change management, communication management, issue management, test, and inspection and delivery, etc. But the first questionnaire went through many changes through the preliminary verification process of adequacy for the questions on the first questionnaire. The final questionnaire consisted of 3 questions from work-site operation management, 10 from demands management, 4 from change management, 4 from communication management, 3 from issue management, 2 from performance management, and 7 from design, test, inspection and delivery, and implementation support: 33 questions in total.

3.2.2 Survey

The study examined the context where the next-generation system was in the financial business. The next-generation system is defined as a newly established advanced system by improving and modifying the existing system that is relatively left behind the advanced system in order to accept the more and more complicated and verified process in general. For example, the National Federation of Fisheries Cooperatives has faced increasingly new
demands but its system has a limit to accept such demands; in 2009 it injected 88 billion won to begin establishing next-generation system and operated the system in September of the same year. The cooperatives’ next-generation system secured the system which the rest of the banks had not introduced and has never experienced just one computer problem that generally happens right after operating such next-generation system. Along with this reason, the system has expanded service scopes in the competitiveness aspect and integrated distributed information, enabling to manage on a systematic basis and to provide integrated information for each channel, which is a leading successful next-generation project. The survey of the study was conducted on the CIOs of financial companies, executives in charge of finance of consulting companies, officers for finance in project conductors (SI companies) on the first and second bases; and measured work-site PMOs’ roles by 7-point measure in order to successfully realize large-scale IT projects in the financial business.

3.2.2.1 Expert panel

In Delphi method, it is a very important factor to select expert panel because the panel influences adequacy and reliability of the findings. The study organized 4 groups of expert panel: (1) work-site PMO; (2) IT PMO; (3) external PMO; and (4) project management team (project conducting company). Such division was suggested to perform more objective and balanced research on work-site PMO roles. The study put emphasis on working experience (belonging to a PMO or a project management team for large-scale project) and expertise as the principle to select an expert. Schimidt (2001) requested managers who experienced the successful project from the top executives of major companies and organized an expert panel[18]. Likewise, this study got recommendations of experts and selected the panel. Four CIOs of financial institutions who have performed next-generation projects, six officers in charge of finance of consulting companies, and four officers in charge of finance of the project conducting companies (SI companies) recommended 141 personnel and professionals including personnel in financial institutions, consultants, personnel of the project conducting companies who all have experienced PMO (or work-site PMO) (its response rate was 84%). Those recommended at least twice were selected up to 10 to 18 for each group, 41 in total finally confirmed as a member of the expert panel.

3.2.2.2 Survey method

A total of 22 roles of work-site PMO which were drawn through literature search went through the preliminary verification process on questions by 4 members in the expert panel who have highly experienced and participated
PMO and related questionnaire, resulting in going up the questions to 33. The first step of questionnaire was to develop the major roles of work-site PMO into 33 questions and to send them by email. The expert panel evaluated the priority and priority of the 33 individual questions by a 7-point measure. In addition, the roles of work-site PMO not suggested on the questionnaire were prepared additionally to write an answer in an open form. As a result of the first survey, three more questions were added to the group of the work-site PMO roles considering redundancy, significance, and adequacy; the second questionnaire surveyed about 36 questions. While the first survey was conducted mixing the open type questions to which respondents could answer the question in their own way and the close type questions where respondents should choose given choices, the second questionnaire consisted only of non-close type questions and excluded the expert panel who did not respond to the first survey. Finally, the in-depth interviews were conducted from various angles on four respondents who have highly experienced in working in PMOs or project management teams belonging to large-scale project and showed high response level in the survey: on which background and by which reason did they determine priority, which question did they think difficult to decide, and which direction should additional researches progress in the future. The analysis on the priority or priority of work-site PMO roles required ranking the major scopes and individual questions about work-site PMO roles that were arranged through the survey; and interview survey was conducted on experts about the factors which determined priority of such major roles.

3.2.3 In-depth interview

The third in-depth interview collected and analyzed opinions from 4 experts in the panel about the top 10 items out of work-site PMO roles which had been drawn through the first and second surveys. The interview was progressed to confirm from various angles on which background and by which reason did they determine priority, which question did they think difficult to decide, and which direction should additional researches go to in the future.

4. Results

4.1 Work-site PMO roles and priority from the overall perspective

The first survey sent its questionnaire to 41 in total including experienced experts of work-site PMO, experienced experts of IT PMO, experienced experts of external PMO, project conducting companies, and experienced personnel of project management. Among them, 40 returned their questionnaire showing a high return rate of 98%. The first survey on 33 questions resulted in
no question eliminated and 3 roles of work-site PMO were added through the response to open type questions as follows: (1) rapid decision making support and inducement for project related work-site departments, (2) establishment of methods how the personnel who participated work-site operation were adjusted to the practices and allocated, and (3) establishment and support of freezing methods for work-site operation demands.

The second survey was conducted on 40 who had responded in the first survey, about 36 questions; a total of 37 responded showing a high response rate of 92.5%.

Since the study used Delphi method, variation coefficient was used to analyze stability which meant the time to suspend the survey. When the variation coefficient was more than 0.5 the author had to consider additional surveys. But in the first and second surveys, the variation coefficients were less than 0.5. Besides, the comparison of the results from the first and second surveys showed more stable results in the second survey than the first one.

As shown in [Table] Priority of each work-site PMO scope of Appendix 1, the review on 10 items within the top 10 priorities among work-site PMO roles revealed the distribution: 3 in work-site operation management (1st, 4th, and 9th ranked), 3 in demands management (2nd, 6th, and 6th ranked), 2 in change management (2nd and 5th ranked), 1 in communication management (6th ranked), and 1 in design/test/inspection and delivery/implementation management (9th ranked). Accordingly, the review on work-site PMO’s major roles by scope showed that work-site operation management, demands management, and change management were considered more importantly than the rest of scopes.

The review on work-site PMO roles by scope disclosed the distribution of priority in the order of change management (6.21), communication management (6.17), work-site operation management (6.11), issue management (5.99), demands management (5.92), design/test/inspection and delivery/implementation management (5.80), and performance management (5.79).

The results to analyze the third in-depth interview are as follows:

First, since the necessary work-site TFT personnel and organization type are different in each step, it is important to ‘organize work-site TFT organization which participates into a project and manage changes’ considering such matters. Second, since how perfectly such innovative ideas, suggestions, process improvements, and function improvements in the mind of work-site working personnel can be realized into a system decides the success or failure of the project quality, it is important to ‘effective draw and manage work-site operation related demands.’

Third, large-scale management innovation, PI, or next-generation projects are characterized actually by a business innovation project but in real tend to be recognized as an IT project. To overcome this limit, it is important to ‘secure
and manage the sponsorship from top executives and department heads,’ and it is needed to continuously disclose to and make understand the top executives and department heads, the priority of projects.

Fourth, since work-site TFT consists of personnel from various work-site departments, an organization structure fit for the project should be made. In addition, if not clarifying the responsibility and role of each team, unnecessary conflicts may occur so that the work-site PMO has to play a role of coordinator. Therefore, it is important to ‘define and manage work-site TFT R/R (role & responsibility) which participates into project.’

Fifth, how much business values are created will make or break the project. Thus, since evaluating and monitoring plans after establishing and implementing them are the major roles of work-site PMOs, it is important to ‘plan/implement/evaluate the overall change management.’

Sixth, when TO-BE directivity is closely engaged in demands and how much TO-BE directivity has been completed can be monitored, the qualitative evaluation on project will be possible. Thus, it is important to ‘draw and manage matters to be improved (TO-BE directivity).’

Seventh, if the requests from various work-site departments are not understood and interpreted in business environment and situation, it will be a burden on IT development team so that requests from work-site operating departments should be grouped and sorted out to facilitate IT development. Thus, it is important to ‘lead the operation as a control tower over grouping and filtering of requests collected by multiple users.’

Eighth, since work-site TFT is basically short of the understanding on IT project and has different level of expectations, it is important to ‘manage communication and cooperative work between work-site TFT and IT organization/ major client.’

Ninth, while projects demand much more work-site personnel as they proceed to each stage such as analyze, design, development, test, and implementation, work-site department is also short of personnel and finds itself difficult to secure staff. Thus, it is important to ‘establish plans to secure, and manage, personnel necessary for work-site TFT.’

Tenth, since the final delivery test is the last inspection stage to determine the completeness of system from the user viewpoint and connected to the decision making process of implementation over the entire system, it is important to ‘support the final delivery test.’

4.2 Work-site PMO roles and priority depending on characteristics of research subjects

Aladwani (2002) suggested 6 factors that affected project performance including technology characteristics, project characteristics, duty
characteristics, personnel characteristics, organization characteristics, and work process[1]. The characteristics of technology, project, and duty were the factors from the technology perspective; personnel and organization characteristics, and work process were the factors from the social interaction perspective. This paper sorted out work-site PMO roles which took lead of a successful project considering the features of experts in the panel who participated into the research based on the characteristics from the social interaction perspective. In addition, the paper filtered the respondent groups from various viewpoints to analyze the characteristics arising from different viewpoints from groups. Thus, the respondents of survey were analyzed from various perspectives including (1) experiencing period, (2) role in project he or she participated in, (3) whether he or she has experienced in work-site PMO, and etc.

4.2.1 Priority depending on experiencing period

The study analyzed results by dividing the respondents of surveys based on whether he or she has experienced for more than 15 years. Since 9 questions within the top 10 ones in the order of priority showed the same answers, the difference of response results from experiencing period was not that significant. 9 questions within the top 10 ones in the order of priority revealed the same results each other. But the study noted that the subjects with less than 15-year experience thought it important to support the final delivery test and that the subjects with more than 15-year experience emphasized relatively more the priority to monitor and manage whether to reflect work-site demands to the system.

4.2.2 Priority depending on project participatory roles

The study divided and analyzed the survey subjects based on the roles of three groups such as internal PMO in charge of next-generation project (personnel of financial institutions), external PMO (consultants), and project managing teams (project conducting companies). All of the three groups put emphasis on the organization and change management of project participating work-site TFT, the securing and management of sponsorship from top executives and department heads, the definition and management of project participating work-site TFT R/R, and the establishment and management of plans to secure personnel necessary for work-site TFT, and ranked the items on the top 10 places. But they showed different opinions to some items. While the project management team from the project conducting companies responded it the most important to effectively draw and manage demands from work-site operation, the internal PMO ranked the item on fourth and the external PMO ranked it on ninth. In addition, while the external PMO and the project
management team evaluated on the 7th place, the support and inducement of rapid decision making for project related work-site departments, the internal PMO ranked it on 20th, which explained that when any difficulty occurred in the course of performing a project due to delayed decision making process in the work-site department, the external persons concerned of a financial institution regarded it more significantly but the internal personnel of the financial institution felt it not that much significant. In addition, the comparison of the top 10 items of work-site PMO roles from the overall perspective revealed the internal PMO, external PMO, and project management team had the same roles: 7, 5, and 7, respectively. Among the inconsistent roles, external PMO and internal PMO ranked on the top places the solution and management of business issues related to project and the intervention and communication among branches, head office, and IT department, and they ranked on the same places with the project management team, the plan, implementation, and evaluation of change management and the support and inducement of rapid decision making by project-related work-site department (newly added). Among the roles not consistent with the top 10 roles of work-site PMO roles from the overall perspective, there was no role which the internal PMO and the project management team determined important with the same priority. The items such as the monitoring and management of whether to reflect demands from work-site operation to the system, the establishment and support of freezing methods for work-site demands (newly added), and the report of current status and issues of project to the top executives were ranked within the top 10 places by the internal and external PMOs, and the project management team.

<table>
<thead>
<tr>
<th>Priority</th>
<th>Internal PMO</th>
<th>External PMO</th>
<th>Project management team (project conducting companies)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>work-site PMO role</td>
<td>Aver age Standard devia tion</td>
<td>work-site PMO role</td>
</tr>
<tr>
<td>1</td>
<td>Organization and change management of project participating work-site TFT</td>
<td>6.64 0.93</td>
<td>Organization and change management of project participating work-site TFT</td>
</tr>
<tr>
<td>2</td>
<td>Securing and management of sponsorship from top executives and department heads</td>
<td>6.64 0.63</td>
<td>Securing and management of sponsorship from top executives and department heads</td>
</tr>
<tr>
<td>3</td>
<td>Management of communication and cooperative between</td>
<td>6.54 0.63</td>
<td>Definition and management of project</td>
</tr>
<tr>
<td></td>
<td>work-site TFT and IT organization/major client</td>
<td>participating work-site TFT R/R</td>
<td>work-site TFT R/R</td>
</tr>
<tr>
<td>---</td>
<td>-----------------------------------------------</td>
<td>-------------------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>4</td>
<td>Effective drawing and management of demands from work-site operation</td>
<td>Solution and management of business issues related to project</td>
<td>Securing and management of sponsorship from top executives and department heads</td>
</tr>
<tr>
<td>5</td>
<td>Definition and management of project participating work-site TFT R/R</td>
<td>Establishment and management of the plan to secure personnel necessary for work-site TFT</td>
<td>Plan/implementation/evaluation on overall change management</td>
</tr>
<tr>
<td>6</td>
<td>Solution and management of business issues related to project</td>
<td>Plan/implementation/evaluation on overall change management</td>
<td>Drawing and management of matters to be improved (TO-BE directivity)</td>
</tr>
<tr>
<td>7</td>
<td>Support for the final delivery test</td>
<td>Support and inducement of rapid decision making by project-related work-site department (NEW)</td>
<td>Support and inducement of rapid decision making by project-related work-site department (NEW)</td>
</tr>
<tr>
<td>8</td>
<td>Monitoring and management of whether to reflect demands from work-site operation to the system</td>
<td>Establishment and support of freezing methods for demands from work-site operation (NEW)</td>
<td>Leading of working as a control tower for grouping and filtering of demands collected by multiple users</td>
</tr>
<tr>
<td>9</td>
<td>Intervention and communication among branches, head office and IT department</td>
<td>Effective drawing and management of demands from work-site operation</td>
<td>Report of current status and issues of top executives project progress</td>
</tr>
<tr>
<td>10</td>
<td>Establishment and management of the plan to secure personnel necessary for work-site TFT</td>
<td>Intervention and communication among branches, head office and IT department</td>
<td>Establishment and management of the plan to secure personnel necessary for work-site TFT</td>
</tr>
</tbody>
</table>

**Table 1.** Priority for work-site PMO roles depending on project participatory roles

### 4.2.3 Priority depending on whether to have experience in work-site PMO

The study divided and analyzed the respondents into those with and without experience in work-site PMO, which showed that there was a certain difference
of perspective to view the role of work-site PMO depending on whether or not to have experience in work-site PMO. While those without the experience in work-site PMO determined it the most important to freeze demands during work-site operation, those with the experience in work-site PMO ranked it on the ninth place. In addition, those with the experience in work-site PMO ranked it on the third place to manage communication and cooperative work among work-site TFT and IT organization/ major client; but those without the experience ranked it eleventh. As for the test and the drawing of matters to be improved, those with and without the experience in work-site PMO showed the significantly different perspective each other. The former put emphasis on the establishment and performance of test strategy from the work-site operation perspective (ranked 5th); but the latter regarded it less significant (ranked 23rd). As for the drawing and management of matters to be improved (TO-BE directivity), they revealed a certain different viewpoint each other: the former ranked it 8th and the latter ranked it 21th. The comparison of the top 10 roles of work-site PMO roles from the overall perspective resulted in that those without the experience in work-site PMO showed consistent with only three items and those with such experience showed six items of consistence. To that end, it was suggested that there was difference between the work perceived by those without the experience in work-site PMO and the work actually performed in work-site PMO.

Such difference confirmed that there was a potential conflict factor of project due to the difference in priority perceived by the work-site PMO and the external PMO such as a vendor. For instance, those without the experience in work-site PMO put priority generally on the schedule and cost compliance of project, showing more focus on the items which directly influenced their short-term performance (i.e., the items ranked first through third) than the work-site acceptability of project outcome. In the meanwhile, those who have worked in work-site PMO would regard it more important whether the new process could bring improvement on the site or whether the quality was assured, which could used on site at once (i.e., the items ranked second through fifth). Since there exists such perspective difference between those with and without the experience in work-site PMO, ineffective communication and adjustment of such difference within the PMO organization is likely to threaten the success of project.

<table>
<thead>
<tr>
<th>Priority</th>
<th>role</th>
<th>average</th>
<th>Priority</th>
<th>role</th>
<th>average</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Establishment and support of freezing methods for demands from work-site operation (NEW)</td>
<td>6.85</td>
<td>1</td>
<td>Organization and change management of project participating work-site TFT</td>
<td>6.57</td>
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<td></td>
<td>Establishment and management of the promotion plan on project</td>
<td>6.85</td>
<td>2</td>
<td>Planning and management of process improvement and innovation</td>
<td>6.54</td>
</tr>
<tr>
<td>---</td>
<td>------------------------------------------------------------</td>
<td>------</td>
<td>---</td>
<td>-------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>3</td>
<td>Organization and change management of project participating work-site TFT</td>
<td>6.80</td>
<td>3</td>
<td>Management of communication and cooperative between work-site TFT and IT organization/major client</td>
<td>6.54</td>
</tr>
<tr>
<td>4</td>
<td>Planning and management of process improvement and innovation</td>
<td>6.80</td>
<td>4</td>
<td>Effective drawing and management of demands from work-site operation</td>
<td>6.51</td>
</tr>
<tr>
<td>5</td>
<td>Adjustment and management between project participating work-site TFTs (IT/major client/consulting companies)</td>
<td>6.80</td>
<td>5</td>
<td>Establishment and management of test strategy from work-site operation perspective</td>
<td>6.32</td>
</tr>
<tr>
<td>6</td>
<td>Report of current status and issues of top executives project progress</td>
<td>6.75</td>
<td>6</td>
<td>Establishment and management of the promotion plan on project</td>
<td>6.28</td>
</tr>
<tr>
<td>7</td>
<td>Management of relations between work-site operations (branches and head office)</td>
<td>6.70</td>
<td>7</td>
<td>Support for the final delivery test</td>
<td>6.28</td>
</tr>
<tr>
<td>8</td>
<td>Definition of qualitative/quantitative project goals from work-site operation perspective</td>
<td>6.70</td>
<td>8</td>
<td>Drawing and management of matters to be improved (TO-BE directivity)</td>
<td>6.28</td>
</tr>
<tr>
<td>9</td>
<td>Establishment and management of the plan to secure personnel necessary for work-site TFT</td>
<td>6.65</td>
<td>9</td>
<td>Establishment and support of freezing methods for demands from work-site operation (NEW)</td>
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<td>10</td>
<td>Effective drawing and management of demands from work-site operation</td>
<td>6.60</td>
<td>10</td>
<td>Definition and management of project participating work-site TFT R/R</td>
<td>6.26</td>
</tr>
</tbody>
</table>

Table 2. Priority for work-site PMO roles depending on whether to have experience in work-site PMO

5. Conclusion and implications

5.1 Implications

Reviewing the work-site PMO roles by scope, the roles were divided into: work-site operation management, demands management, change management, communication management, issue management, and performance management. And additionally, PMO performs the role of design/test/inspection and delivery/implementation management, a total of 36 roles surveyed.

The work-site PMO roles by individual item were divided into the top 10 items including the organization and change management of project participating...
work-site TFT, the effective drawing and management of work-site demands, the securing and management of sponsorship from top executives and department heads, the definition and management of project participating work-site TFT R/R, the plan/implementation/evaluation over the entire change management, the management of communication and cooperation between work-site TFT and IT organization/major client, the lead of working as a control tower for grouping and filtering demands collected by multiple users, the drawing and management of matters to be improved (TO-BE directivity), the establishment and management of the plan to secure personnel necessary for work-site TFT, and the support for the final delivery test. Each respondent group showed the difference in priority for work-site PMO roles.

The comparison of priority of work-site PMO roles between those with and without more than 15-year experience revealed that nine items belonged to the top ten items, which suggested that the experiencing period affect not that much the priority of work-site PMO roles. There was also difference between three respondent groups such as internal PMO, external PMO, and project management team, all of which were divided depending on their role when participating into the project. Those three groups ranked five roles on the top places and regarded different roles more important respectively.

The difference between the respondent groups that were divided depending on whether or not to have the experience in work-site PMO revealed the five roles overlapped among the top 10 roles. Reviewing the characteristics of the roles ranked on the top places showed that those without the experience in work-site PMO desired the success of project from the work-site operation perspective and those with such experience imposed importance on work-site PMO roles for the purpose of the project success from the overall perspective.

The study suggests largely three contributions and implications including the identification of work-site PMO roles and the definition of work-site TFT roles: First, companies are operated in various forms and methods such as IT PMO, work-site PMO, and external PMO. The study reflected such situation and re-sorted out work-site PMO roles by scope and respondent characteristics, which provides a clue that will help push ahead with a project more successfully which will be injected large-scale personnel and physical resources. Second, the cooperation between work-site operation and IT department is a key to project success. When financial institutions push ahead with next-generation projects, they inject personnel from the various work-site departments such as depositing, corporate financing, individual financing, foreign exchange, product development, management administration, and branches as well as IT department. In this situation, the work-site PMO plays a role of a co-worker and leader to lead the project to succeed working together
with IT department from beginning to end; and performs various roles including the definition and management of demands arising from work-site operation, the test from the work-site perspective, and the change management. Thus, it is suggested that the work-site PMO roles are very important and the results from the evaluation of priority for work-site PMO roles will contribute to a successful operation of work-site TFT.

Third, the analysis on priority of work-site PMO roles by duty characteristics revealed that the perspective of a vendor and a client on a project were different each other and that accordingly the PMO roles from such two perspectives were different. Thus, it is suggested that such analysis results will contribute to the assistance of communication between two interested persons and will affect the quality of project causing to accomplish the project successfully.

5.2 Future direction of research

The study had its limitations from the aspects including the business and project size of the limited respondent companies, the adequacy and reliability of the survey, and etc. Therefore, the future studies should try to expand the scope industrially, present PMO role performing models fit for individual company’s situation, and to find out the relation between work-site PMO and work-site TFT.

First, the study was conducted on the limited scope of next-generation project in the financial circle. Thus, it is suggested that more studies be necessary to examine work-site PMO roles which can be drawn commonly from various large-scale projects as well as various industries including manufacture, distribution and public sector, not limiting to the financial sector.

Second, it is necessary to present the criteria for work-site PMO operating models appropriate for each company by verifying through substantial survey or case studies, the operating model that has suggested in this study.

Third, it is necessary to conduct studies on how the work-site PMO performances affect the operating performance of work-site TFT that is injected for the project.

Fourth, it is needed to find the methods to enhance the reliability and adequacy of studies. While Woudenberg (1991) used the Delphi method in order to enhance reliability of the research using expert panels in which he divided the participants into two groups and compared the results[23], Kastein et al. (1993) used intraclass correlation coefficient (ICC) to analyze reliability[10]. This study was necessary to find out more precisely the methods to enhance reliability of research.

6. Appendix
### Priority of each work-site PMO scope

<table>
<thead>
<tr>
<th>Scope</th>
<th>Contents</th>
<th>Rank</th>
<th>Average by item</th>
<th>Average by scope</th>
<th>Scope rank</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Work-site operation management</strong></td>
<td>Organization and change management of project participating work-site TFT</td>
<td>1</td>
<td>6.57</td>
<td>6.11</td>
<td>3</td>
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<tr>
<td></td>
<td>Definition and management of project participating work-site TFT R/R</td>
<td>4</td>
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<tr>
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<td>Establishment and management of the plan to secure personnel necessary for work-site TFT</td>
<td>9</td>
<td>6.26</td>
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<tr>
<td></td>
<td>Establishment of the plan to make adjust to practices and allocate the participating staff into work-site operation after project finishes (NEW)</td>
<td>36</td>
<td>5.08</td>
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<tr>
<td><strong>Demands management</strong></td>
<td>Effective drawing and management of demands from work-site operation</td>
<td>2</td>
<td>6.54</td>
<td>5.92</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Drawing and management of matters to be improved (TO-BE directivity)</td>
<td>6</td>
<td>6.28</td>
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<tr>
<td></td>
<td>Leading of working as a control tower for grouping and filtering of demands collected by multiple users</td>
<td>6</td>
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<tr>
<td></td>
<td>Monitoring and management of whether to reflect demands from work-site operation to the system</td>
<td>13</td>
<td>6.23</td>
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<td></td>
<td>Planning and management of process improvement and innovation</td>
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<td>5.97</td>
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<td>Establishment and support of freezing methods for demands from work-site operation (NEW)</td>
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<tr>
<td></td>
<td>Planning and management of work process and regulation change</td>
<td>25</td>
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<tr>
<td></td>
<td>Planning and management to draw clear vision of project</td>
<td>27</td>
<td>5.73</td>
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<tr>
<td></td>
<td>Understanding of problems during system reflection and finding out of solution to such problems (leading the cooperation with IT)</td>
<td>29</td>
<td>5.69</td>
<td></td>
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<tr>
<td></td>
<td>Consideration of gradual access method to reflect filtered and grouped demands</td>
<td>33</td>
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<td></td>
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<tr>
<td></td>
<td>Leading to manage targeting image of system</td>
<td>35</td>
<td>5.22</td>
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<tr>
<td><strong>Change management</strong></td>
<td>Securing and management of sponsorship from top executives and department heads</td>
<td>2</td>
<td>6.54</td>
<td>6.21</td>
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<tr>
<td></td>
<td>Plan/implementation/evaluation on overall change management</td>
<td>5</td>
<td>6.32</td>
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<td></td>
<td>Establishment and management of the education plan on project</td>
<td>14</td>
<td>6.16</td>
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<td>Establishment and management of the promotion plan on project</td>
<td>25</td>
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<tr>
<td><strong>Communication</strong></td>
<td>Management of communication and cooperative between work-site TFT and IT</td>
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<td>6.28</td>
<td>6.17</td>
<td>2</td>
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<tr>
<td>management</td>
<td>organization/major client</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Support and inducement of rapid decision making by project-related work-site department (NEW)</td>
<td>11</td>
<td>6.24</td>
<td></td>
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<tr>
<td>Intervention and communication among branches, head office and IT department</td>
<td>14</td>
<td>6.16</td>
<td></td>
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<tr>
<td>Report of current status and issues of top executives project progress</td>
<td>16</td>
<td>6.11</td>
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<tr>
<td>Management of relations between work-site operations (branches and head office)</td>
<td>17</td>
<td>6.07</td>
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<tr>
<td>Issue management</td>
<td>Solution and management of business issues related to project</td>
<td>11</td>
<td>6.24</td>
<td>5.99</td>
<td>4</td>
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<tr>
<td></td>
<td>Cooperation with project general PMO and maintenance of support system</td>
<td>19</td>
<td>6.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>v</td>
<td>29</td>
<td>5.69</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance management</td>
<td>Pre/present/post evaluation on project from work-site operation perspective</td>
<td>22</td>
<td>5.88</td>
<td>5.79</td>
<td>7</td>
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<tr>
<td></td>
<td>Definition of qualitative/quantitative project goals from work-site operation perspective</td>
<td>28</td>
<td>5.70</td>
<td></td>
<td></td>
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<tr>
<td>Design/ test/ inspection and delivery/ implementation management</td>
<td>Support for the final delivery test</td>
<td>9</td>
<td>6.26</td>
<td>5.80</td>
<td>6</td>
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<td>Establishment and management of the methods to verify display from work-site operation perspective</td>
<td>17</td>
<td>6.07</td>
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<td>Establishment and management of test strategy from work-site operation perspective</td>
<td>21</td>
<td>5.92</td>
<td></td>
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<tr>
<td></td>
<td>System inspection and delivery support from work-site operation perspective</td>
<td>23</td>
<td>5.85</td>
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<tr>
<td></td>
<td>Inspection of gradual outcomes on a work-site basis</td>
<td>31</td>
<td>5.59</td>
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<tr>
<td></td>
<td>Design support for display and report, etc.</td>
<td>32</td>
<td>5.58</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Implementation support after project finishes</td>
<td>34</td>
<td>5.35</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[Table] Priority of each work-site PMO scope

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A Study on the Types of Organizational Culture and IT Governance Implementation Level

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Abstract. In recent years, many companies interested in IT governance that was a process and culture to maximize the effectiveness of IT investment, many studies were conducted to finding critical success factor of IT governance. But there has been lack of the studies considering cultural factors. This study, therefore, will suggest the framework on the intention to investigate relationship between types of Organization which was developed by Harrison and IT Governance Implementation Level and conduct studies on Korean companies with different organizational culture by using the developed IT governance implementation index model.

Keyword: IT Governance, Culture, Organizational Culture, IT Governance framework

1. Introduction

Many companies have introduced and have had efforts to effectively operate IT as a strategy to enhance their own competitiveness but most of them have yet to obtain the desired results comparing to the investment cost. In doing so, they could perceive the malaise of IT investment cost and became interested in IT governance that was a process and culture to maximize the effectiveness of IT investment [2].

With the attention to IT governance increased, the studies on the framework to introduce IT governance have been conducted: the study on the methods to build integrated ITMS (IT management system) to realize IT governance [18] and the study on the method to embody effective IT governance [48]. In addition, the exploratory studies on the factors to accomplish success of IT governance were conducted mostly for the CIO leadership [49, 50] but there has been lack of the studies considering cultural factors.

Since the cultural factors in management studies, however, contribute in part to the failure of accomplishment of organizational goals, such factors are regarded important. Most current literatures focusing on culture maintained that the major factor to determine the effectiveness of organization was culture,
which suggested that organizational culture has affected the accomplishment of organizational goals to some extent [3, 5]. Culture theory has been adopted to explain social behavioral patterns and outcomes largely from the comprehensive perspective on an organizational basis. The studies was conducted suggesting that culture was significantly related to firm effectiveness [6, 7], corporate performance [8, 9, 10] and corporate strategy [11].

To that end, the paper examined the effects of organization’s cultural factors on the introduction of IT governance and its successful accomplishment.

2. Literature Review

2.1 IT Governance

IT governance has become a major concern of many companies, attracting much more attention from the professional and research institutions such as ITGI and Gartner Group, as well as the academic world, which defined IT governance on various bases (See Table 1). The definitions of IT governance commonly include the elements to control and manage IT governance through value enhancement, risk management, maximization of IT investment effects, leadership, organizational structure, and process by connecting IT to business which can be appropriate for organizational strategy and goals.

<table>
<thead>
<tr>
<th>Institution</th>
<th>Definition of IT governance</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITGI [1,48]</td>
<td>A system consisting of leadership, organizational structure, and process of IT organization, which is a part of corporate governing structure performed under the responsibility of the Board of Directors and the Management</td>
</tr>
<tr>
<td>Gartner Group [59]</td>
<td>A system to set up power and responsibility of decision making where IT can be desirably used</td>
</tr>
<tr>
<td>Cisco [2]</td>
<td>A process and culture to maximize IT investment effect</td>
</tr>
<tr>
<td>ISACA [50]</td>
<td>A relationship and process structure to present and control organizational direction through value enhancement and risk management for the purpose of accomplishing organizational goals</td>
</tr>
</tbody>
</table>

IT has faced the change in its role from a support of business to a core element of corporate strategy. In line with such trend, many firms became perceived the necessity to properly control and manage IT and began regarding IT not as a
simple infrastructure but as a medium to create and also sustain corporate value. With this, the effective use of IT and the boundary of IT governance to control and manage IT have also been emphasized.

The studies on IT governance were mostly about the development of frameworks, among which the frameworks developed by Weill and Ross[12], Haes and Grembergen[13], and ITGI[48] are representative. ITGI has developed a tool named COBIT (Control Objective for Information and related Technology)[1] to help understand IT governance process and support to facilitate its establishment. COBIT classified IT activities into four domains—plan and organization, introduction and construction, operation and support, and observation and evaluation—and has provided managers and business process owners including IT service providers, users and observers with comprehensive guidelines.

ISACA Korea developed the following framework as shown in Table 2 based on COBIT, and evaluates the level of IT Governance implementation and annually measured across the world.

<table>
<thead>
<tr>
<th>Domain Classification</th>
<th>Definition and Objective of Each Domain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategic Alignment</td>
<td>Connection between business and solution: The purposing of investing in IT is to accomplish each company's strategy and objectives with a help of IT</td>
</tr>
<tr>
<td>Value Delivery</td>
<td>Cost optimization and Validating the value of IT: The providing value with IT is to deliver IT service required for an appropriate period with the minimum cost</td>
</tr>
<tr>
<td>Risk Management</td>
<td>Protecting IT assets and Capability of restoring from disaster: Risk exists in every aspect of business. For an effective risk management, it is required for a company to analyze risks and weakness in all aspects and cope with it in a prompt manner</td>
</tr>
<tr>
<td>Resource Management</td>
<td>Optimizing knowledge and infrastructure: For IT resource, there are manpower, infrastructure, technology, knowledge, etc. IT resource can be maximized and its cost shall be optimized with IT resource management</td>
</tr>
<tr>
<td>Evaluating Performance</td>
<td>Project Products, IT Service Monitoring: It is difficult to manage unless there is a way of measuring it either quantitatively or qualitatively. Therefore, Project products and IT service shall be continuously monitored to measure</td>
</tr>
</tbody>
</table>

Table 2 Definition and Objective for each domain to analyze the recognition and implementation level of IT Governance [50]
As more companies adopt IT Governance through a tool that supports consistent framework and its adaptation, this research was conducted on factors that determines the success of IT Governance. It mainly focused on the importance of CIO (Chief Information Officer)'s roles [15]. It also focused on the relation and common interests of both CEO and CIO [16], the capability of delivering CIO's value and strategic application [17], and the importance of board committee [51]. ITGI classified CIO's roles and responsibilities into 5 different domains (strategic alignment, value delivery, risk management, IT resource management, and performance management). Also, there were more researches conducted on IT Governance factors such as Trust between partners [52], Synergy of IT application [53], etc.

There are also relevant researches on the successful application of IT governance in terms of IT Governance Structure, Process and Relational Mechanism [13] and on the efficient and cost effective IT delivery, innovation and business impact of IT Governance [54]. However, there are currently only a few researches in a narrow expertise field as mentioned in Introduction.

In particular, there need to have more research on organizational culture and IT management as well as the research on the effect of organizational culture on the success of IT Governance [45]. There are also researches on the relation between nation and IT (A study on the effect of national culture on the relation between business and IT [55]; A study on the application of ICT (Information and Communication Technologies) in accordance with national culture [56]. However, there has not been much of research done on the relation with organization or a company.

Therefore, this study will be conducted on the effect of difference in type of organizational culture on the successful implementation factors (strategic alignment, value delivery, IT resource management, Risk Management, Performance Management, etc.) of IT Governance.

2.2 Organizational Culture

The term ‘culture’ has various meanings and when combined with another word such as organization, corporate, and etc. its meaning can be confused [19]. To reduce such confusion, many researchers defined culture as: regularity of acts indicating when people interacted [20, 21]; norms to be developed within the interacted group [22]; dominant value to be believed within an organization [23]; philosophy to lead policy guidelines of an organization in relation to
employees or customers [24,25]; procedure and rule within an organization[26]
and feeling or atmosphere communicated by an organization [27]. We
understood organizational culture as a whole system comprehensively
including norms, values, philosophy, and procedure and rules of an
organization based on the preliminary studies.

Robin [28] explained that organizational culture played the following roles in a
company:
① to set up the boundary of an organization; ② to make the members of an
organization feel sense of unity; ③ to make the members of an organization
put priority on and be dedicated to organizational goals rather than their own
benefits; ④ to enhance stability of social system; ⑤ to perform controlling
function to guide attitude and behavior of members; ⑥ to affect reversely the
effectiveness of organization if common values fail to harmonize with values
that can promote the effectiveness of organization.

In addition, Schein [26] explained that organizational culture played the
following roles:
① to enable agreement to core duties, major tasks, and explicit and potential
functions; ② to support agreement to operation goals that are drawn from
individual duties; ③ to facilitate agreement to the medium that helps
accomplish organizational goals; and ④ to enable agreement to the criteria
that evaluate the results.

Finally, Sathe [29] explained that organizational culture had the following
functions:
① to reduce the difficulty in communication within an organization; ② to
support real cooperation to the extent to provide common values and
confidence of an organization; ③ to induce members to perceive the
organizational goal as their personal goal and immerse themselves into it; ④ to
support efficient decision making; ⑤ to propose correct behavioral
direction in course of implementing the organizational policy or decision
making contents; and ⑥ to have difference of effect on members depending
on the strength of organizational culture.

The preliminary studies above suggested that organizational culture supported
smooth agreement to communication between members and organizational
goals, and also supported to put organizational goals and personal goals in the
same category; on the other hand, which could act rather reversely when the
values on which the organization put priority were at odd with the values that
were necessary to accomplish a certain goal. As well, the level of
organizational culture functions could be different depending on the strength of
organizational culture.
The studies on organizational culture mostly tend to materialize the characteristics of a company and review such characteristics on an empirical basis by addressing them to systematic and effectiveness. In particular, Harrison revealed that there was a dominant corporate organizational culture types depending on various environments—complicated and rapidly-changing environment, risky, threatening, and competitive environment, etc. Harrison classified organizational culture type into four as shown in Table 3.

<table>
<thead>
<tr>
<th>Division</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Oriented</td>
<td>A culture to try conquering all competitive powers externally and for members to internally cause conflicts due to continuous competitiveness in order to obtain much more benefits than others</td>
</tr>
<tr>
<td>Role Oriented</td>
<td>A bureaucratic culture to put emphasis on rule and procedure, lawfulness and responsibility, and hierarchy and position</td>
</tr>
<tr>
<td>Task Oriented</td>
<td>A culture where accomplishment of top goals are recognized the best value, which changes the existing authority, old roles, rules and regulations if they impair the accomplishment of tasks</td>
</tr>
<tr>
<td>Person Oriented</td>
<td>An organizational culture that is interested in individual goals and actualization of needs which members have</td>
</tr>
</tbody>
</table>

2.3 Organizational culture and IT

IT researchers, who have recognized the corporate effectiveness and performance, and the magnitude of culture, became interested in how organizational culture affects the introduction and use of IT. The preliminary studies were conducted on the topics such as: the study on the effects of organizational culture on the development and introduction of information system [30, 31, 32]; the study on the difference of IT introduction and distribution depending on the type and characteristics of organizational culture [33, 34, 35, 36, 37]; the study on the managing method difference and usage level of IT depending on different organizational culture to IT [38, 39]; the study on the difference in IT management strategy depending on organizational cultures [40]; and the study on the difference in IT usage and performance depending on organizational cultures [41, 42, 43, 44]. But it has been observed the lack of studies on organizational culture and IT management sectors; in particular, the studies related to the effects of organizational culture on IT governance have not been enough [45].
Therefore, the study examined the effects of different organizational cultures on the factors to successfully perform IT governance—planning and organization, introduction and construction, operation and support, and monitoring and evaluation of IT activities.

3. Exploration of IT Governance Type

3.1 Data Collection and Research Method

This study was conducted based on 125 companies (refer to the table 4) with various organizational cultural types, based on the evaluation index of ISACA. IT Governance implementation level of each organization was evaluated based on total 36 evaluation items in 5 fields (strategic alignment, value delivery, IT resource management, risk management and performance management) for the successful implementation of IT Governance.

Hierarchical cluster analysis was selected as a research methodology. Cluster analysis is a statistical method to deduce cluster groups of similar objects, based on multi-variable characteristics of groups, without clearing defining groups in advance. This can clarify the difference between clusters. In addition, it measures similarity and feasibility for used variables among objects, based on clustering[58]. As a way of justifying the classification of objects into clusters, it is suitable to this study where the objective is to draw the type of organizational culture that has a significant different based on 5 domains for IT governance.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Frequency</th>
<th>Percentage</th>
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<tr>
<td>Annual Turnover</td>
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<td></td>
</tr>
<tr>
<td>under 1trillion</td>
<td>30</td>
<td>24.0%</td>
</tr>
<tr>
<td>1 trillion ~ 2 trillion</td>
<td>14</td>
<td>11.3%</td>
</tr>
<tr>
<td>2 trillion ~ 3 trillion</td>
<td>16</td>
<td>12.9%</td>
</tr>
<tr>
<td>3 trillion ~ 4 trillion</td>
<td>11</td>
<td>8.9%</td>
</tr>
<tr>
<td>4 trillion ~ 5 trillion</td>
<td>5</td>
<td>4.0%</td>
</tr>
<tr>
<td>5 trillion ~ 6 trillion</td>
<td>8</td>
<td>6.5%</td>
</tr>
<tr>
<td>6 trillion ~ 7 trillion</td>
<td>4</td>
<td>3.2%</td>
</tr>
<tr>
<td>7 trillion ~ 8 trillion</td>
<td>2</td>
<td>1.6%</td>
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<tr>
<td>over 8 trillion</td>
<td>35</td>
<td>28.2%</td>
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<tr>
<td>Total</td>
<td>125</td>
<td>100%</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of</th>
<th></th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer goods</td>
<td>4</td>
<td>3.2%</td>
</tr>
<tr>
<td>Construction</td>
<td>8</td>
<td>6.4%</td>
</tr>
<tr>
<td>Industrial Sectors</td>
<td>Securities</td>
<td>Machine</td>
</tr>
<tr>
<td>--------------------------</td>
<td>------------</td>
<td>---------</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.0%</td>
<td>5.6%</td>
</tr>
</tbody>
</table>

### 3.2 Analysis Result

Four significant groups were selected through a method of word, which is frequently used among hierarchical cluster methods of SPSS 18.0 on 125 samples. The following table shows the result of one way layout variation analysis for the post-verification purpose. Based on p-value on F value for the score of each factor, F-value is 170.316 for strategic alignment, with p-value of 0.000. Therefore, based on 0.01 of p-value, it is clear that there is a significant different between groups scores. Accordingly, F value of other domains: value delivery (F=147.136); IT resource management (F=75.181); risk management (F=82.557); performance management (F=52.437). p-value for all these domains show 0.000, such that there is a significant difference on groups cores based on 0.01 level of p-value.
<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strategic Alignment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Combined)</td>
<td>4380.192</td>
<td>3</td>
<td>1460.064</td>
<td>170.316</td>
<td>.000</td>
</tr>
<tr>
<td>Linear Term</td>
<td>2439.133</td>
<td>1</td>
<td>2439.133</td>
<td>284.524</td>
<td>.000</td>
</tr>
<tr>
<td>Unweighted</td>
<td>3228.106</td>
<td>1</td>
<td>3228.106</td>
<td>376.557</td>
<td>.000</td>
</tr>
<tr>
<td>Weighted</td>
<td>1152.086</td>
<td>2</td>
<td>576.043</td>
<td>67.195</td>
<td>.000</td>
</tr>
<tr>
<td>Deviation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within Groups</td>
<td>1037.296</td>
<td>121</td>
<td>8.573</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>5417.488</td>
<td>124</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Value</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between (Combined)</td>
<td>1839.698</td>
<td>3</td>
<td>613.233</td>
<td>147.136</td>
<td>.000</td>
</tr>
<tr>
<td>Linear Term</td>
<td>1022.343</td>
<td>1</td>
<td>1022.343</td>
<td>245.296</td>
<td>.000</td>
</tr>
<tr>
<td>Unweighted</td>
<td>1409.869</td>
<td>1</td>
<td>1409.869</td>
<td>338.278</td>
<td>.000</td>
</tr>
<tr>
<td>Weighted</td>
<td>429.829</td>
<td>2</td>
<td>214.915</td>
<td>51.566</td>
<td>.000</td>
</tr>
<tr>
<td>Deviation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within Groups</td>
<td>504.302</td>
<td>121</td>
<td>4.168</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2344.000</td>
<td>124</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>IT Resource Management</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between (Combined)</td>
<td>1540.692</td>
<td>3</td>
<td>513.564</td>
<td>75.181</td>
<td>.000</td>
</tr>
<tr>
<td>Linear Term</td>
<td>1391.129</td>
<td>1</td>
<td>1391.129</td>
<td>203.648</td>
<td>.000</td>
</tr>
<tr>
<td>Unweighted</td>
<td>1511.256</td>
<td>1</td>
<td>1511.256</td>
<td>221.234</td>
<td>.000</td>
</tr>
<tr>
<td>Weighted</td>
<td>29.437</td>
<td>2</td>
<td>14.718</td>
<td>2.155</td>
<td>.120</td>
</tr>
<tr>
<td>Deviation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within Groups</td>
<td>826.556</td>
<td>121</td>
<td>6.831</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2367.248</td>
<td>124</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Risk Management</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between (Combined)</td>
<td>2007.323</td>
<td>3</td>
<td>669.108</td>
<td>82.557</td>
<td>.000</td>
</tr>
<tr>
<td>Linear Term</td>
<td>1694.042</td>
<td>1</td>
<td>1694.042</td>
<td>209.018</td>
<td>.000</td>
</tr>
<tr>
<td>Unweighted</td>
<td>1815.616</td>
<td>1</td>
<td>1815.616</td>
<td>224.018</td>
<td>.000</td>
</tr>
<tr>
<td>Weighted</td>
<td>191.707</td>
<td>2</td>
<td>95.853</td>
<td>11.827</td>
<td>.000</td>
</tr>
<tr>
<td>Deviation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within Groups</td>
<td>980.677</td>
<td>121</td>
<td>8.105</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2988.000</td>
<td>124</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Performance Management</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between (Combined)</td>
<td>966.529</td>
<td>3</td>
<td>322.176</td>
<td>52.437</td>
<td>.000</td>
</tr>
<tr>
<td>Linear Term</td>
<td>560.435</td>
<td>1</td>
<td>560.435</td>
<td>91.215</td>
<td>.000</td>
</tr>
<tr>
<td>Unweighted</td>
<td>823.160</td>
<td>1</td>
<td>823.160</td>
<td>133.975</td>
<td>.000</td>
</tr>
<tr>
<td>Weighted</td>
<td>143.369</td>
<td>2</td>
<td>71.684</td>
<td>11.667</td>
<td>.000</td>
</tr>
<tr>
<td>Deviation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within Groups</td>
<td>743.439</td>
<td>121</td>
<td>6.144</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1709.968</td>
<td>124</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The following <Table 6> shows the analysis result for score and average of each section of IT Governance implementation for 4 groups (based on hierarchical cluster analysis). Based on the result of table, it is clear that there are characteristics (strength/weakness) for each group section. For Group A, IT Governance implementation level is higher than average in overall. In particular, it has strength in value delivery and has weakness in IT resource management and performance management relatively.

For Group B, almost all parts other than IT resource management is lower than the average while Group C has higher result than the average except for IT resource management. In particular, it has strength in strategic alignment and value delivery. For Group D, its average lower than average in all aspects.

<table>
<thead>
<tr>
<th>Group</th>
<th>Strategic Alignment (70/100%)</th>
<th>Value Delivery (42/100%)</th>
<th>IT Resource Management (49/100%)</th>
<th>Risk Management (49/100%)</th>
<th>Performance Management (42/100%)</th>
<th>Total (252/100%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>50.364 / 71.9%</td>
<td>31.227 / 74.4%</td>
<td>33.727 / 68.8%</td>
<td>35.682 / 72.8%</td>
<td>28.227 / 67.2%</td>
<td>179.227 / 71.1%</td>
</tr>
<tr>
<td>B</td>
<td>39.900 / 57%</td>
<td>25.100 / 59.8%</td>
<td>29.333 / 59.9%</td>
<td>28.833 / 58.8%</td>
<td>25.100 / 59.8%</td>
<td>148.267 / 58.8%</td>
</tr>
<tr>
<td>C</td>
<td>45.929 / 65.6%</td>
<td>28.714 / 68.4%</td>
<td>27.000 / 55.1%</td>
<td>28.500 / 58.2%</td>
<td>26.643 / 63.4%</td>
<td>156.786 / 62.2%</td>
</tr>
<tr>
<td>D</td>
<td>34.915 / 49.9%</td>
<td>21.322 / 50.8%</td>
<td>24.356 / 49.7%</td>
<td>24.593 / 50.2%</td>
<td>21.271 / 50.6%</td>
<td>126.458 / 50.2%</td>
</tr>
<tr>
<td>Average</td>
<td>42.777 / 61.1%</td>
<td>26.591 / 63.3%</td>
<td>28.604 / 58.4%</td>
<td>29.402 / 60.3%</td>
<td>25.310 / 60.3%</td>
<td>152.684 / 60.6%</td>
</tr>
</tbody>
</table>

This research was conducted to determine influencing factors of organizational culture type on the implementation of IT Governance. Hence 4 groups were sampled based on their implementation data of IT Governance in South Korea’s companies. In addition, it showed the strength and weakness in respective domain of company. The result showed that there is a significant difference between groups.

Based on the characteristics of cultural types (as investigated by Harrison [47]), the followings were guessed after analyzing the result and culture type of each group.

Type of power-oriented organizational culture is consisted of an organization with highly centralized power system. Its decision making process is fast to abrupt change. In particular, all the results are reported even up to CEO [57]. Therefore, it will have strength in strategic alignment. In addition, its performance evaluation system is more systematic than other types of
organizational culture. Therefore, it will have strength in performance management. In comparison, characteristics of inducing consistent conflict through competition [47] may have weakness when there is a problem to dissolve in collaboration with more than 2 departments. In particular, it is the case where the emergency situation happens due to a lack of collaboration between departments. It seems that Group A is similar to power-oriented culture type where IT Governance is highly implemented. In particular, it is similar to an aspect of having strength in strategic alignment and value delivery. On the other hand, it is differ from an aspect of having strength in risk management and having weakness in performance relatively.

The type of role-oriented organizational culture is a culture that puts more emphasis on regulation, procedure, hierarchical structure and position[47]. Accordingly, it is expected that this type will systematically manage the regulation and procedure for performance and IT resource management, compared to other culture types. However, it is susceptible to urgent matters, bound to regulation and procedure, which can be a reason for being weak in risk management. Although a consulting procedure of other departments was already established, it is difficult to have candid discussion on the same level between those with different positions due to hierarchical atmosphere in company. This will result to have both strength and weakness in strategic alignment. It seems that role-oriented organizational culture is similar to Group B which resulted in having the lower value than average. Besides, it has strength in IT resource management.

Task-Oriented organizational culture type is a type of culture to implement an upper level objective as the best value[47]. It is strong in strategic alignment field with an objective of company's strategy and goal through IT. Therefore, it is expected to carry out systematic performance management in advance to achieve its goal. However, it puts the company goals ahead of IT resource management and value delivery. Therefore, it is expected to frequently have exceptional circumstances, so that it is not likely to systematically manage in this field. Group C which has strength in strategic alignment and performance management that have similarity with task-oriented cultural type, in that it is weak in IT resource management and risk management.

The type of person oriented organizational culture focuses on individual goals and realization of personal desires[47]. Therefore, this culture does not put much of emphasis on procedure or position, even not putting organizational objective ahead. Therefore, it seems that it is weak in every aspect. However, it is expected to supplement the weakness through smooth discussion between individuals or departments, particularly, in value delivery and risk management sector. D group showed the below average performance. In particular, they
showed a weakness in strategic alignment, implying that its culture focuses more on personal goals rather than organization’s goal. Therefore, it is our understanding that it is similar to human-oriented cultural type, which is somewhat unfavorable to IT Governance.

4. Future Research & Expected Contribution

In order to verify the abovementioned details, more questionnaire and interview will be conducted with 125 companies in reference to questionnaire answers on both a type of organizational culture and the organizational characteristics of ISACA Korea (a strategy of determining IT investment and priority, a method of organizing a committee and consultative group, risk management strategy, etc.). Based on the result, a combination type of culture type and IT Governance will be determined more in detail.

For the purpose of studying on the successful performance of IT governance on an theoretical basis, this study will define the features of advantageous environments for the five sectors related to IT governance through a new perspective of organizational culture and identify advantageous types of organizational culture, suggesting a new direction to the studies related to IT governance which tend to lean too much on the magnitude of CIO role until today. In addition, the study will help companies grasp their unique organizational culture type on a working-level basis and understand their environmental features that are favorable to successfully accomplish the matters that are likely to cause problems when performing IT governance. When companies establish strategies from an organizational culture perspective to complement their vulnerable part, the findings from the study will be used as their reference.

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Innovation
The Effects of Business Environment and Competitive Strategies on the Adoption of Technological Innovations in the Thailand Context

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Abstract. By examining the effects of business environment and competitive strategies on the adoption of technological innovations, this study aims to update Operations Management research. Using data collected from 180 manufacturing firms in Thailand, this research extends previous research on the adoption of technological innovations by using the mediation perspective and the classical industrial organization economics paradigm of structure -> conduct -> performance as a theoretical lens to explain that competitive strategies (differentiation strategy and cost leadership strategy) mediate the effect of business environment perceived by managers (environmental dynamism and environmental competitiveness) on their decision making on adopting design technologies and manufacturing technologies. This study supports the view that the adoption of different types of manufacturing technologies has specific strategic needs. For decision makers, this research provides a richer understanding of context in the adoption of technological innovations. The findings from this study can be translated into specific implications for strategic decision-making and technology justification.

Keywords: Operations Management, Business environment, Competitive strategies, Innovation, Adoption

1 Introduction

The Operations Management (OM) literature has raised the importance of innovation in the organisational context. Khazanchi, Lewis, and Boyer [1] point out: “For managers, innovation is vital, but paradoxical...” Technological innovations, such as advanced manufacturing technologies (AMT), have been playing significant roles increasing the firms’ productivity through the improvement of quality and the reduction of costs and lead times for decades [2, 3]. AMT commonly refers to a group of integrated hardware-based and software-based technologies, such as computer-aided design (CAD), computer-aided manufacturing (CAM), flexible manufacturing system (FMS), automated material handling (AMH), automated storage/retrieval systems (AS/RS), and so on [4-8]. As a number of authors [9-13] have stressed the need to consider AMT using a multi-dimensional perspective, Boyer, Ward, and Leong [5]’s
classification (which have been further adopted by other studies, e.g., Swink and Nair [8]), was commonly adopted to provide a basis for identifying the three dimensions of AMT (i.e., design, manufacturing (processing) and administrative (planning) technologies). This present study focuses on the two dimensions: design and manufacturing technologies. Design technologies include technologies such as CAD, computer-aided engineering (CAE), and computer-aided process planning (CAPP) that focus primarily on product definition, design, and related information processing functions. While, manufacturing technologies encompasses technologies such as CAM, real-time process-control systems, computer numerical control (CNC) machines, sophisticated robots tend to focus on the process-related aspects in manufacturing.

In the field of innovations in organizations, the differences between the generation of innovation and the adoption of innovation have been acknowledged [14]. The generation of innovation is intended to contribute to the organization’s effectiveness and competitiveness by creating a new opportunity or by making use of an existing opportunity in novel ways [15]. The adoption of innovation is intended to contribute to the organization’s effectiveness and competitiveness by changing the adopting organization so that it can adapt to new conditions in its external environment [16]. This study focuses on the adoption of innovation.

The OM literature also discusses a numbers of factors that affect the adoption of AMT. For example, Schroder and Sohal [17] assess the differences between firms in terms of advanced manufacturing technology (AMT) investment planning and implementation based on a firm’s size and ownership in the context of manufacturing companies in Australia and New Zealand. Ariss, Raghunathan, and Kunnathar [18]’s case study indicates reasons which affect the adoption of advanced manufacturing technology in small firms in Ohio and Michigan States include industry, product/market, and management. Swamidass and Winch [19] found that training, operator characteristics, and causes of delay in technology use have impacts on manufacturing technology implementation in the UK and the US. Swamidass [20] poposes a summative model to explain why the use of technology in small firms lags behind larger firms in the US context. According to the model, the level of technology use in small firms can be explained by the key factors including the level of technology use in larger firms, the management style, lack of technical know-how, and lack of funds. Khazanchi et al. [1] explore how organizational values – a foundational building block of culture– impact the implementation of AMT.

However, the relationships between business environment, a firm’s strategies, and the adoption of innovation are not definitive. Previous research has discussed the effects of business environment on the adoption of
innovations [21, 22]. Other researchers explain that firms’ innovation adoptions are influenced by market-related factors [18, 23] and the others [24]. Business environment can be considered as multidimensional [25]. This paper focuses on the two dimensions: environmental dynamism and environmental competitiveness. Environmental dynamism refers to the rate of change and the degree of instability of the environment [25-27], whilst environmental competitiveness is the extent to which external environments are characterized by intense competition [26-28].

Nevertheless, a number of researchers [e.g., 14, 29] argue that a firms’ strategy may influence the adoption of innovations. Ariss, Raghunathan, and Kunnathar [18], for instance, point out that firms should make decisions on adopting new technologies based on strategic needs. Damanpour and Schneider [30] argue that the adoption of innovation results from managerial choice. Ward and Duray [31] propose that business environment impacts on top managers’ strategic decision making processes, especially, those affecting competitive strategies. When outlining the idea of generic competitive strategies, Porter [32] holds that differentiation and cost leadership signify two fundamentally different approaches to achieve competitive advantage. Differentiation strategy aims to build up competitive advantage by offering unique products which are characterized by valuable features, such as quality, innovation, and customer service. In contrast, cost leadership strategy seeks to achieve above-average returns over competitors through low prices by driving all components of activities towards reducing costs [32, 33].

However, according to previous research, the complex relationship between business environment, competitive strategies, and the adoption of technological innovations has not been thoroughly investigated yet [see 30, 34, 35]. Salaheldin [36] points out that previous studies lack of sufficient explanation on linking the adoption of advanced technologies with a firms’ strategy. Spanos and Voudouris [34] mention further that previous empirical research provides evidence showing that firms within the same industry in the same country have different ways in adopting and investing technological innovations.

Therefore, this study investigates the effect of business environment (environmental dynamism and environmental competitiveness) and competitive strategies (differentiation strategy and cost leadership strategy) on the adoption of technological innovations (design and manufacturing technologies) in the context of an emerging economy, Thailand. Studies in emerging economies are needed to examine whether the findings from studies conducted in advanced economies apply equally to emerging economies [37]. Yet only a few studies have focused on understanding operations management issues in emerging economies [38, 39]. Having risen as one of the emerging economies, Thailand has been considered as an important production platform
in South-East Asia and is the base for the regional headquarters of many multinational companies [40-42]. However, the major challenge facing emerging economies, including Thailand, is how their firms can eventually exploit the benefits from using transferred or imported technologies [43]. Hence, the study on how firms make decisions on adopting in these technologies is also important.

The rest of the paper is organized as follows: First, I develop a set of hypotheses concerning the relationships between business environment and competitive strategies, and their effects on the adoption of design and manufacturing technologies. Then the research methodology and analyses of the results are presented. Finally, I discuss the theoretical and practical implications of the findings.

2 Theoretical framework

2.1 The adoption of technological innovations

In the field of innovations in organizations, researchers have generally defined innovation as the development and use of new ideas or behaviors in organizations [14]. A new idea could be a new product, service or method of production (technological innovations) or a new market, organizational structure or administrative system (administrative or organizational innovation) [44]. This paper focuses primarily on technological innovations.

In this paper AMT is considered as technological innovations. Damanpour and Wischnevsky [14] also explain that “Newness,” a property in all definitions of innovation, is a relative term. In past studies of innovations in organizations, an innovation can be considered new to the individual adopter, to most people in the unit of adoption, to the organization as a whole, to most organizations in an organizational population, or to the entire world. If an organization has never implemented AMT, AMT can be therefore considered new to this organization. As suggested by previous studies (e.g., Adler [9]; Boyer et al. [45] Swink and Nair [8]), AMT is considered in three interrelated aspects. First, design technologies that comprise systems such as CAD, CAE, and CAPP. Second, manufacturing (processing) technologies that comprise of systems such as real-time process control systems, CNC machines, and sophisticated robots. Third, administrative (planning) technologies that consist of electronic mail (e-mail), manufacturing resource planning (MRPII), and enterprise resource planning (ERP) systems. This paper focuses on design and manufacturing technologies.

The differences between organizations that mostly generate innovations and those that mostly adopt innovations have been acknowledged. Damanpour and Wischnevsky [14] refer to the former, which are primarily producers or
suppliers of innovation, as innovation-generating organizations, and to the latter, which are preponderantly users of innovations produced by innovation-generating organizations, as innovation-adopting organizations. The degree of newness can be used to distinguish the generation of innovation from its adoption. The generation of innovation results in an outcome—a product, service, or technology that is at least new to an organizational population. A second organization adopts this innovation by acquiring it from or by imitating the organization that has produced it. As such, adoption basically means that the innovation is developed elsewhere, not in the adopting organization [46]. The adoption of innovation results in the assimilation of a product, service, or technology new to the adopting organization. This paper hence focuses on the adoption of innovation.

2.2 Business environment

This paper focuses on the two dimensions of business environment: environmental dynamism and environmental competitiveness [26, 27]. Environmental dynamism refers to the rate of change and the degree of instability of the environment [25-27]. Previous research not only reflects environmental dynamism through the amount of change, but also through the unpredictability of change [25]. Dynamic environments may be characterized by changes in technologies, variations in customer preferences, and fluctuations in product demand or supply of materials. Dynamic environments make current products and services obsolete and require that new ones be developed [26, 47]. Environmental competitiveness is the extent to which external environments are characterized by intense competition [26-28]. It refers to the degree of competition reflected in the number of competitors and the number of areas in which there is competition [48]. Competitive environments have been associated with intensive pressures for higher efficiency and lower prices [28] that lead to tighter margins and less organizational slack [49].

2.3 Competitive strategies

When outlining the idea of generic competitive strategies, Porter [32] holds that differentiation and cost leadership signify two fundamentally different approaches to achieve competitive advantage. Differentiation strategy aims to build up competitive advantage by offering unique products which are characterized by valuable features, such as quality, innovation, and customer service. Differentiation can be based on the product itself, the delivery system, and a broad range of other factors. With these differentiation features, firms provide additional values to customers which will reward them with a premium
price. In contrast, cost leadership strategy seeks to achieve above-average returns over competitors through low prices by driving all components of activities towards reducing costs. To attain such a relative cost advantage, firms will put considerable effort into controlling production costs, increasing their capacity utilization, controlling supply of materials or product distribution, and minimising other costs, including R&D and advertising.

2.4 The relationship between business environment and competitive strategies

The impact of the external environment on a firms’ strategy formulation has been acknowledged. As discussed earlier, environmental dynamism is characterized by changes in technologies, variations in customer preferences, and fluctuations in product demand or supply of materials, that probably makes current products and services obsolete. To minimize this threat of obsolescence, firms need to introduce new products that depart from existing products in the marketplace. Firms that pursue such new products can capitalize on changing circumstances by creating new products and services or meeting the needs of emerging markets [26, 27]. Thus, differentiation strategy may be suitable for firms competing in this type of environment. As mentioned earlier, differentiation strategy aims to build up competitive advantage by offering new, unique products which are characterized by valuable features perceived by customers. These new products create opportunities for above-normal return by targeting premium market segments [50, 51] and creating new niches [52]. Hence, in dynamic environments, it is expected that firms tend to develop new products to increase their market competitiveness. Accordingly, I propose:

Hypothesis 1a: Environmental dynamism is positively associated with differentiation strategy.

In contrast, as discussed earlier, environmental competitiveness refers to the degree of competition reflected in the number of competitors and the number of areas in which there is competition. In competitive environments that have been associated with intensive pressures for higher efficiency and lower prices [28], cost-leadership strategy may be suitable for this type of environment. This strategy usually drives all components of activities toward controlling costs, as well as increasing capacity utilization. Hence, I hypothesize:

Hypothesis 1b: Environmental competitiveness is positively associated with cost leadership strategy.
2.5 The relationship between competitive strategies and the adoption of technological innovations

The effect of competitive strategies on the adoption of technological innovations has been discussed. As discussed earlier, differentiation strategy focuses on building up competitive advantage by offering unique products which are characterized by valuable features. Firms are therefore pressured to design such products to satisfy customer needs. By doing so, firms need to invest in sophisticated product design technologies (such as CAD, CAE and CAPP). These technologies focus primarily on product definition, design, and related information processing functions. CAD, for example, is a computer software and hardware combination used in conjunction with computer graphics to allow engineers and designers to create, draft, manipulate, and change designs on a computer [20]. CAE allows the engineer to examine and test a design from a structural and engineering viewpoint and deals with engineering analysis, modal vibration analysis, stress analysis, force and column loadings [53]. CAPP works with part-families, allows the manufacturing engineer to quickly design the production process for the product, and involves automatic generation of shop production operations and the route to take to manufacture the part [53]. CAPP also helps manufacturers interpret product design data, select machining process and tools, and sequence the operations [54].

When compared with conventional methods for designing new products (e.g., the manual drafting of technical and engineering drawings), benefits of these computer-aided design technologies perceived by product designers are normally considered as a major reason why a number of firms adopt these technologies. Three-dimensional (3D) CAD technology in cooperation with CAE support the plant’s make-to-order production policy and engineering tasks such as analysis, simulation, design, manufacture and planning. Based on Khanchanapong [55]'s case studies, CAD is generally used for the design of objects (products), real or virtual. When compared with the manual drafting of technical and engineering drawings, CAD provides information, such as materials, processes, dimensions and tolerances, according to application-specific conventions, and helps engineers work more quickly, hence reducing the design process time. A product design team conducts in-depth-reviews on product specifications and all details before manufacturing. In addition, CAD technology helps product designers design more sophisticated product design more rapidly and economically. Hence, a number of firms that pursue differentiation strategy are motivated to acquire these technologies, in order to develop their product design capabilities. Accordingly, I propose:

Hypothesis 2a: Differentiation strategy is positively associated with design technologies.
On the contrary, as discussed earlier, cost leadership strategy seeks to offer a product with low prices by driving all components of activities towards reducing costs. Therefore, firms tend to put considerable effort into controlling costs relating to production, material supplies, and product distribution, as well as increasing their capacity utilization. According to the literature [9, 56], cost is often cited as the primary, realised objective of manufacturing technology implementation. Manufacturing technologies encompasses technologies, such as CAM, real-time process-control systems, CNC machines, and sophisticated robots, which focus on the process-related aspects in manufacturing. These technologies are normally used on the shop floor, generate process-related information from the factory floor, and can be linked to product-related technologies for reciprocal communication [20]. CNC machines, which are locally programmable machines with dedicated micro- or mini-computers, provide great flexibility by allowing the machines to be controlled and programmed on the floor, whereas a robot is considered as a programmable, multi-functional manipulator designed to move material, parts, tools or specialized devices through various programmed motions for the performance of a variety of tasks [20]. The basic purpose of the industrial robot is to replace human labour under certain conditions. CAM further incorporates the use of computers to control and monitor several manufacturing elements such as robots, CNC machines, and automated guided vehicle (AGVs) [20]. In addition, real-time process-control systems deal with the continuous monitoring of the system, keeping track of production to ensure that production requirements and due dates are met [57]. Based on his analysis of 20 AMT users, Zairi [58] reported that AMT is primarily adopted ‘to respond to changes in demand at economical costs’ and is introduced to combat costs and to enable users to compete as economically as possible. Pagell and Krause [59] also found a significant positive effect of AMT on cost. Patterson et al. [60]’s survey of 80 UK manufacturing companies indicated that AMT is related to subsequent productivity. Therefore, I hypothesize:

Hypothesis 2b: Cost leadership strategy is positively associated with manufacturing technologies.

2.6 The relationship between business environment and the adoption of technological innovations

The impact of the external environment on the adoption of technological innovations has been acknowledged. Damanpour and Schneider [30] gave theoretical explanations that since organizations conduct activities within an environmental context, they obtain inputs from the environment and respond to its demands and offer their services or products to it. The external environment provides opportunities (information, resources, technology) and constraints
(regulation, restriction on capital or information). The adoption of innovation can be a means of changing the organization in response to environmental demands and constraints by exploiting environmental opportunities. Innovation researchers [e.g., 21, 22, 61] have often posited that the primary stimulus for organizational innovation and change come from the external environment. Environmental characteristics may refer to the market or sector within which the organization operates, or may represent cultural, societal, political or geographical conditions [30, 62, 63]. In business organizations, the structure of the market (e.g., competition and concentration), technological dynamism, appropriability conditions and market growth are considered as the prominent environmental factors influencing technological product and process innovations [64, 65].

As dynamic environment refers to changes in technologies, variations in customer preferences, and fluctuations in product demand or supply of materials, that probably makes current products and services obsolete [26, 47], firms need to introduce new products that depart from existing products in the market, in order to minimize this threat of obsolescence. By doing so, firms may need to adopt design technologies to facilitate a new product design (NPD) team to develop new products. Accordingly, I propose:

Hypothesis 3a: Environmental dynamism is positively associated with design technologies.

In contrast, in competitive environment that is associated with intensive pressures for higher efficiency and lower prices [28], firms may need to adopt manufacturing technologies. Therefore, I hypothesize:

Hypothesis 3b: Environmental competitiveness is positively associated with manufacturing technologies.

The research framework of this study is presented in Figure 1.

[Insert Figure 1 about here]

3 Methods

3.1 Sample and procedure

The context of this study is manufacturing firms in Thailand. The Thai manufacturing industry has developed rapidly over the past decade. The total export value of the Thai manufacturing industry increased dramatically from US$45 billion in 1999 to US$191 billion in 2010. The development of the automobile industry in Thailand is particularly compelling where the export value has jumped about seven times in the past ten years. Following previous
studies [17, 34], I use the manufacturing firms as the unit of analysis for this study. 1,500 manufacturing firms were randomly selected from a database provided by the Department of Industrial Work, Ministry of Industry, Thailand. A questionnaire was randomly selected to each firm with the request that it be completed by a senior manager who has major operations responsibility and is knowledgeable about the firm’s business environment, competitive strategies, and adoption of new technologies.

I received a total of 180 usable responses, constituting a 12% response rate. I checked the data for potential non-response bias by comparing the responses to industry sector and revenue between the early and late respondents. The chi-square tests for both categories indicated no statistically significant differences between the two groups of respondents. In the sample, the greatest proportion of the firms came from the automotive industry (31%), followed by fabricated metal (30%), machinery and equipment (24%), and electronics, computers, and electrical appliances (13%) industries. Just over half of the sample was made up of large sized companies (more than 200 employees) and the small to medium sized firms employed less than 200 employees. The majority of responses to the survey were from top management (i.e., CEO/vice president of manufacturing and plant managers) (49%), followed by manufacturing/operations managers (31.2%), and other positions that are relevant to operations, e.g., product quality managers and production supervisors (18.3%).

3.2 Measures

I used validated scales with acceptable reliability and validity to measure the adoption of design and manufacturing technologies [5, 8]. I selected 3 items to cover design technologies and 3 items to cover manufacturing (processing) technologies. These 6 items were rated on a five-point scale from ‘no investment’ (1) to ‘heavy investment’ (5).

I also used validated scales to measure business environment (environmental dynamism and environmental competitiveness) [26, 27]. I selected 5 items to cover the areas of environmental dynamism and 4 items to cover the area of environmental competitiveness. These 9 items were rated on a five-point scale from ‘strongly disagree’ (1) to ‘strongly agree’ (5).

I used measures for competitive strategies from existing scales [66]. I selected 3 items to cover differentiation strategy and 3 items to cover cost leadership strategy. These 6 items were rated on a five-point scale from ‘strongly disagree’ (1) to ‘strongly agree’ (5). The items used to operationalize the key constructs are presented in Table 1.

[Insert Table 1 about here]
3.3 Control variables

A number of researchers suggest that business environment and competitive strategies, and their effects on the adoption of technological innovations may be influenced by organizational size [7, 53, 67] and manufacturing processes [68-71]. Therefore, organizational size and manufacturing processes are considered as control variables in this study.

Organizational size. Following previous research conducted in the context of Thailand [72], I classified firms with fewer than 50 employees, between 51 and 200 employees, and more than 200 employees as small-sized (coded as 1), medium-sized (coded as 2), and large-sized (coded as 3) enterprises, respectively.

Manufacturing processes. I measured manufacturing processes using a three-point ordinal scale scored as 1 = highly non-repetitive, 2 = batch, and 3 = highly repetitive [71].

4. Results and Discussion

4.1 Scale validity and reliability

I conducted confirmatory factor analysis (CFA) using maximum likelihood estimation in LISREL 8.52. As recommended by Graham [73], I used full-information maximum likelihood (FIML) estimation for handling missing data. The model fit can be evaluated using 5 indices: the ratio of the chi-square to degree of freedom (the $\chi^2$/df ratio), Parsimony Goodness of Fit (PGFI), Comparative Fit Index (CFI), Standardized Root Mean Squared Residual (SRMR), and the Root Mean Square Error of Approximation (RMSEA). I set the criteria for model fit at $\chi^2$/df < 3.00, PGFI > 0.5, CFI > 0.90, SRMR < 0.10, and RMSEA < 0.10 [74-77]. I ran CFA at items level for each of the measures of environmental dynamism, environmental competitiveness, differentiation strategy, cost leadership strategy, design technologies, and manufacturing technologies. This CFA was acceptable ($\chi^2$ (df = 168) = 310.93, $\chi^2$/df = 1.85, PGFI = 0.59, CFI = 0.92, SRMR = 0.074, RMSEA = 0.081) (see Table 1). This suggests acceptable unidimensionality and convergent validity of the measures. The Cronbach’s alpha coefficients demonstrate satisfactory internal consistency reliability for the 6 measures, with all coefficients exceeding 0.7 [78]. The results of the item level CFA and reliabilities are presented in Table 1. Composite scores for the components of environmental dynamism, environmental competitiveness, differentiation strategy, cost leadership strategy, design technologies, and manufacturing technologies are presented in Table 2.
4.2 Discriminant validity

To test for discriminant validity of environmental dynamism, environmental competitiveness, differentiation strategy, cost leadership strategy, design technologies, and manufacturing technologies, I followed the method used by Ahire et al. [79] by pairing each of the constructs and subjecting them to CFA. In the first model, I allowed the correlation between the two constructs to be estimated (unconstrained), while in the second model, I set the correlation between the two constructs to one (constrained). Each model resulted in a $\chi^2$ value and between the two models there is a difference of one degree of freedom. I then tested the statistical significance of this $\chi^2$ difference at $p < 0.01$ (a $\chi^2$ difference surpassing 6.64 is statistically significant with one degree of freedom). With 6 constructs tested, I conducted 3 discriminant tests and all the tests yielded $\chi^2$ differences greater than 6.64, confirming discriminant validity.

4.3 Common method bias

Because I surveyed a single respondent in each firm, common method variance may be a potential threat. I tested the potential existence of common method variance using Harman’s single factor approach. According to this test, if common method variance exists, a single factor will emerge from a factor analysis of all the survey items [80]. Specifically, I tested a one-factor measurement model where I loaded all the items in the measurement model onto a single latent construct and compared the difference in fit with a $\chi^2$ test with the original factor model [81]. The results of these tests show that the one-factor model produced a significantly poorer fit. Although not a definitive test, I conclude from the results of the Harman test that common method variance was not likely to be a significant issue in the data set.

4.4 Structural relationships

The results of structural equation modeling on the effects of business environment (environmental dynamism and environmental competitiveness), competitive strategies (differentiation strategy and cost leadership strategy) on the adoption of technological innovations (design technologies and manufacturing technologies) are presented in Figure 2. The goodness-of-fit indices support an acceptable fit of the structural model ($\chi^2$ (df = 208) =
The relationship between business environment and competitive strategies

The results provide evidence supporting that environmental dynamism is positively associated with differentiation strategy ($H1a$), while environmental competitiveness is positively associated with cost leadership strategy ($H1b$). The standardised coefficients are $\beta = 0.20 \ (p < 0.05)$ and $\beta = 0.49 \ (p < 0.001)$, respectively. These findings are supported by the literature [35]. In dynamic environment that is characterized by changes in technologies, variations in customer preferences, and fluctuations in product demand or supply of materials [26, 47], firms have to minimize threat of product obsolescence by introducing new products that depart from existing products in the market. Therefore, differentiation strategy may be suitable for firms competing in this type of environment. Differentiation strategy provide directions for top management team to focus on launching policies that relate to develop new products which are characterized by valuable features perceived by customers. Based on the firms’ point of view, these new products create new opportunities for by targeting premium market segments [50, 51] and creating new niches [52]. Hence, in dynamic environments, firms tend to develop new products, in order to increase their market competitiveness.

In contrast, cost leadership strategy is more suitable for competitive environment. Competitive environment refers to the degree of competition reflected in the number of competitors and the number of areas in which there is competition [48], and that has been associated with intensive pressures for higher efficiency and lower prices [28]. Cost leadership strategy provides guidelines for achieving above-average returns over competitors through low prices by driving all components of activities towards reducing costs [32]. Firms, therefore, tend to put considerable effort in controlling production costs, increasing their capacity utilization, controlling supply of materials or product distribution, and minimising other costs.

The relationship between competitive strategies and the adoptions of technological innovations

The results provide evidence supporting that differentiation strategy is positively associated with design technologies ($H2a$), while cost leadership strategies
strategy is positively associated with manufacturing technologies \((H2b)\). The standardised coefficients are \(\beta = 0.30\) \((p < 0.01)\) and \(\beta = 0.38\) \((p < 0.001)\), respectively. It seems that design technologies are more suitable for firms pursuing differentiation strategy rather than cost leadership strategy. Differentiation strategy aims to build up competitive advantage by offering unique products which are characterized by valuable features, such as product quality and innovation. Firms are therefore required to launch new products into the market that are unique and satisfy customer needs. In order to do so, firms need to invest in sophisticated product design technologies (such as CAD, CAE and CAPP) [55]. These technologies focus primarily on product definition, design, and related information processing functions, as well as allow engineers and designers to create, draft, manipulate, and change designs on a computer [20]. Specifically, CAPP works with part-families, helps manufacturers interpret product design data, select machining process and tools, and sequence the operations [53, 54].

To attain a relative cost advantage, firms will put considerable effort in controlling the production cost and increasing their capacity utilization, hence focusing on manufacturing technology implementation. According to the literature [9, 56, 58], cost is often cited as the primary, realised objective of manufacturing technology implementation. Zairi [58], for instance, reported that manufacturing technologies is primarily introduced to combat costs and to enable users to compete as economically as possible. Manufacturing technologies (e.g., sophisticated robots, real-time process control systems, and CNC machines) are mainly used to reduce inventory and labour costs [6, 55, 59, 60]. Consistent with other studies [e.g., 55, 82], the findings indicate that implementation of robotics provides the opportunity to reduce labour costs because the number of people employed is replaced by technologies.

The relationship between business environment and the adoption of technological innovations

The SEM results do not provide evidence supporting that environmental dynamism is associated with design technologies \((H3a)\), nor environmental competiveness is associated with manufacturing technologies \((H3b)\). The standardised coefficients are \(\beta = -0.01\) \((p > 0.05)\) and \(\beta = 0.04\) \((p > 0.05)\), respectively. These findings are not in the line with a previous claim about the direct effect of environment on the adoption of technological innovations as presented earlier. Instead, the findings support the mediator role of competitive strategies on the relationship between business environment and the adoption of innovations. Business environment has an impact on top managers’ strategic decision making process, especially, for those affecting competitive strategies:
differentiation and cost leadership [31]. The adoption of innovations is then a result from managerial choice [e.g., 14, 29].

The view that competitive strategies mediate the effect of business environment perceived by managers on their decision making on adopting technological innovations is supported by the mediation perspective [84] and the classical industrial organization economics paradigm of structure -> conduct -> performance [32]. The mediation perspective specifies the existence of a significant intervening mechanism (e.g., competitive strategies) between an antecedent variable (e.g., business environment) and the consequence variable (e.g., the adoption of technological innovations) [84]. The classical industrial organization economics paradigm of structure -> conduct -> performance is used to test the role that firm-level strategic actions have in influencing the relationship between market-structure characteristics and a firm’s performance [32]. In dynamic environment, firms may need to pursue differentiation strategy as a guideline for managing resources, budgeting, and controlling staff behavior and performance, specifically introducing new products that depart from existing products in the market, in order to minimize the threat of product obsolescence. In order to achieve differentiation strategy, firms therefore need to invest in design technologies to facilitate NDP staff to develop new products. In contrast, in competitive environment that is associated with intensive pressures for lower prices [28], firms should pursue cost leadership strategy and implement manufacturing technologies to increase efficiency and lower production costs. The findings also support Nair and Swink [85]’s theoretical explanations that the adoption of different types of manufacturing technologies has specifically strategic purposes.

4.5 Theoretical contributions

From a theoretical perspective, this present study contributes to the OM research as follows. First, by proposing that competitive strategies mediate the effect of business environment on managers’ decision making on adopting technological innovations, the results obtained can add to the previous studies that explain the effect of environment on the adoption of innovations [e.g., 21, 22]. This study also confirms that the mediation perspective [84] and the classical industrial organization economics paradigm of structure -> conduct -> performance [32] originally developed in advanced economies is applicable in an emerging economy, such as Thailand.

Second, whilst most of previous studies conducted in the context of advanced economies investigate factors that affect the adoption of technological innovations [1, 17-20]; this study provides findings from an emerging economy. In comparison with Spanoss and Voudouris [34]’s study that indicates the relationship between market environment and the adoption of
AMT in the Greek context, this present study found that the two dimensions of business environment (environmental dynamism and environmental competitiveness) has indirect effects on the adoption of different types of technologies (design and manufacturing technologies) in the Thailand context. The results obtained can also add to the existing knowledge base. This should encourage others to carry out similar studies in identical environments.

4.6 Managerial Implications

From a managerial perspective, the present study proposes useful implications as follows. First, the results from this study provide a richer understanding of context in the adoption of technological innovations and guide practitioners in narrowing their focus to the congruence between types of business environment that firms are dealing with, types of competitive strategies that firms pursue, and types of technologies (design and manufacturing technologies) firms should adopt (see Figure 2). This means that before managers decide to adopt design and manufacturing technologies, they should understand the environment-strategy relationship as discussed earlier. In short, this study suggests that senior managers should make decisions on adopting new technologies based on strategic needs; hence helping them make decisions more effectively.

Second, a richer understanding of context in the adoption of technological innovations discussed above signals another challenge for managers of manufacturing firms with large investments in design and manufacturing technologies. Swink and Nair [8] suggest that these are important issues because many manufacturing firms have sunk enormous amounts of capital into investments in these technologies over the last three decades. This could also be the case for Thai firms in the future. Thai firms should be concerned with modernizing their technologies more effectively and efficiently.

4.7 Limitations and directions for future research

I identify the following limitations of this study. First, since I use the cross-sectional survey method, causal inferences must be made with caution [85]. I recommend a longitudinal or experimental study to strengthen casual inference. The second limitation relates to data collection using a single source. Although not a definitive test, the Harman’s single-factor test I conducted indicates that common method bias did not appear to be a serious threat to this study. Nevertheless, I recommend that future research should replicate the present findings using data gathered from multiple sources. For example, data on the adoption of innovations (design and manufacturing technologies) could be gathered using objective organizational records, rather than perceptual reports.
from organizational informants. Finally, this study provides unique insights into the effects of business environment and competitive strategies on the adoption of technological innovations in manufacturing firms in Thailand. The findings from this study may be applicable to other emerging economies (such as those in Asia). Hence replicating and extending my work in other emerging economies may provide a basis for external validation of the findings of this study.

5 Conclusion

In conclusion, this study demonstrates the effects of business environment and competitive strategies on the adoption of technological innovations. From the theoretical perspective, this study of 180 manufacturing firms in Thailand makes a valuable contribution to the OM research by using the mediation perspective and the classical industrial organization economics paradigm of structure -> conduct -> performance as a theoretical lens to explain that competitive strategies (differentiation strategy and cost leadership strategy) mediate the effect of business environment (environmental dynamism and environmental competitiveness) perceived by managers on their decision making on adopting technological innovations (design technologies and manufacturing technologies). The results obtained, therefore, can add to previous studies that explain the effect of environment on the adoption of innovations. This study also supports the view that the adoption of different types of technologies (design technologies and manufacturing technologies) has specific strategic needs. Furthermore, whilst most of previous studies in this field were conducted in the context of advanced economies, this study provides findings from an emerging economy, Thailand. The results obtained can add to the existing knowledge base.

From a managerial perspective, the results from this study provide a richer understanding of context in the adoption of technological innovations and guide practitioners in narrowing their focus to the congruence between types of business environment, types of competitive strategies, and types of technologies firms should adopt. This study suggests that managers should make decision on adopting new technologies based on specific strategic needs. This richer understanding also signals another challenge for managers of manufacturing firms with large investments in design and manufacturing technologies. The findings from this study can be translated into specific implications for strategic decision-making and technology justification.
6 References

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Figure 1. The research framework of this study
Table 1. Scale validity and reliability for environmental dynamism, environmental competitiveness, differentiation strategy, cost leadership strategy, design technologies, and manufacturing technologies

<table>
<thead>
<tr>
<th>Construct</th>
<th>Indicators</th>
<th>Loading</th>
<th>Cronbach’s alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental dynamism</td>
<td>ENV1: Environmental changes in our primary market are intense.</td>
<td>0.62</td>
<td>0.77</td>
</tr>
<tr>
<td></td>
<td>ENV2: Our clients regularly ask for new products and services.</td>
<td>0.57</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ENV3: In our primary market, changes are taking place continuously.</td>
<td>0.79</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ENV4: In a year, our primary market changes frequently.</td>
<td>0.73</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ENV5: In primary market, products/services quantities change rapidly and frequently.</td>
<td>0.88</td>
<td></td>
</tr>
<tr>
<td>Environmental competitiveness</td>
<td>ENV6: Competition in our primary market is intense.</td>
<td>0.80</td>
<td>0.81</td>
</tr>
<tr>
<td></td>
<td>ENV7: Our organizational unit has relatively strong competitors.</td>
<td>0.84</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ENV8: Competition in our primary market is extremely high.</td>
<td>0.89</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ENV9: Price competition is a hallmark of our primary market.</td>
<td>0.42</td>
<td></td>
</tr>
<tr>
<td>Differentiation strategy</td>
<td>STR1: Stress new product development.</td>
<td>0.80</td>
<td>0.82</td>
</tr>
<tr>
<td></td>
<td>STR2: Engage in novel and innovative marketing techniques.</td>
<td>0.92</td>
<td></td>
</tr>
<tr>
<td></td>
<td>STR3: Strive to be the first to have new products available.</td>
<td>0.76</td>
<td></td>
</tr>
<tr>
<td>Cost leadership strategy</td>
<td>STR4: Emphasize cost reduction in all facets of business operations.</td>
<td>0.75</td>
<td>0.81</td>
</tr>
<tr>
<td></td>
<td>STR5: Strongly emphasize improvement in employee productivity and operations efficiency.</td>
<td>0.80</td>
<td></td>
</tr>
<tr>
<td></td>
<td>STR6: Have developed lower production costs via process innovation.</td>
<td>0.81</td>
<td></td>
</tr>
<tr>
<td>Design technologies</td>
<td>AMT1: Computer-aided design (CAD)</td>
<td>0.70</td>
<td>0.82</td>
</tr>
<tr>
<td></td>
<td>AMT2: Computer-aided engineering (CAE)</td>
<td>0.73</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AMT3: Computer-aided process planning (CAPP)</td>
<td>0.68</td>
<td></td>
</tr>
<tr>
<td>Construct</td>
<td>Indicators</td>
<td>Loading</td>
<td>Cronbach’s alpha</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>---------</td>
<td>------------------</td>
</tr>
<tr>
<td>Manufacturing technologies</td>
<td>AMT4: Computer-aided manufacturing (CAM)*</td>
<td></td>
<td>0.76</td>
</tr>
<tr>
<td></td>
<td>AMT5: Sophisticated robots</td>
<td>0.73</td>
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<td></td>
<td>AMT6: Real-time process control systems</td>
<td>0.87</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AMT7: Computerized numerical control (CNC) machines</td>
<td>0.53</td>
<td></td>
</tr>
<tr>
<td></td>
<td>AMT8: Automated material handling *</td>
<td></td>
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</tbody>
</table>

\[ \chi^2 = 310.93, \ df = 168, \ p = 0.00, \ RMSEA = 0.081, \ CFI = 0.92, \ SRMR = 0.074, \ PGFI = 0.59, \ \chi^2/df = 1.85 \]

* The item which is dropped from the final measure.
Table 2. Composite scores for the components of environmental dynamism, environmental competitiveness, differentiation strategy, cost leadership strategy, design technologies, and manufacturing technologies

<table>
<thead>
<tr>
<th>Composite variable</th>
<th>Number of items</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental dynamism</td>
<td>5</td>
<td>3.67</td>
<td>0.48</td>
</tr>
<tr>
<td>Environmental competitiveness</td>
<td>4</td>
<td>3.93</td>
<td>0.58</td>
</tr>
<tr>
<td>Differentiation strategy</td>
<td>3</td>
<td>3.91</td>
<td>0.54</td>
</tr>
<tr>
<td>Cost leadership strategy</td>
<td>3</td>
<td>4.12</td>
<td>0.54</td>
</tr>
<tr>
<td>Design technologies</td>
<td>3</td>
<td>2.89</td>
<td>0.95</td>
</tr>
<tr>
<td>Manufacturing technologies</td>
<td>3</td>
<td>2.48</td>
<td>0.91</td>
</tr>
</tbody>
</table>
Figure 2. Path coefficients (N = 180)

Goodness of fit indices: $\chi^2 = 387.32$, df = 208, p = 0.00, RMSEA = 0.082, CFI = 0.91, SRMR = 0.091, PGFI = 0.60, $\chi^2$/df = 1.86

*Standardized coefficients reported
† Significant at $p < 0.10$
* Significant at $p < 0.05$
** Significant at $p < 0.01$
*** Significant at $p < 0.001
<table>
<thead>
<tr>
<th>No.</th>
<th>Hypotheses</th>
<th>Reject or support?</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1a</td>
<td>Environmental dynamism is positively associated with differentiation strategy.</td>
<td>Supported</td>
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<td>H1b</td>
<td>Environmental competitiveness is positively associated with cost leadership strategy.</td>
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<td>H2a</td>
<td>Differentiation strategy is positively associated with design technologies.</td>
<td>Supported</td>
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<td>H2b</td>
<td>Cost leadership strategy is positively associated with manufacturing technologies.</td>
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<td>H3a</td>
<td>Environmental dynamism is positively associated with design technologies.</td>
<td>Rejected</td>
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<td>H3b</td>
<td>Environmental competitiveness is positively associated with manufacturing technologies.</td>
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Diffusion of organizational innovations: an empirical test in Thailand

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Abstract. This paper reports on an empirical study of the relationship between business strategy and operational practices in terms of total quality management, lean manufacturing and supply chain management in a sample of 329 Thai manufacturing firms. We first divide the sample into three strategy clusters of cost leadership, differentiation and focus. We then explore the relationships between strategy and practices. Our results suggest a pattern unique to Thailand and differ from what is expected in the context of developed nations.

1 Introduction

The alignment between corporate strategies and operations strategies has received considerable attention in recent years since the Skinner’s seminal article (1969). For example, Brown et al. (2007) explored links between the process of strategy formulation and subsequent performance in operations within firms and found that world-class plants incorporated both strategic operations content and strategic operations processes, while low-performing plants did not. This suggests that involving manufacturing managers in the strategic planning process helps align manufacturing and business strategies, and this alignment can lead to higher manufacturing performance. Although much of the research in this area has been in the context of developed countries (Vickery et al., 1993; Gupta & Lonial, 1998; Ward & Durray, 2000), there has been interest in examining the notion of the diffusion of these frameworks in emerging countries (Badri et al., 2000; Dangayach & Deshmukh, 2001; Zhao et al., 2006). A key element of successful firms is the alignment between corporate strategy and organizational innovation in the form of strategic action programs. These strategic action programs have been deployed in leading edge firms with the promise of having widespread (more than a local) influence across the entire firm. For example, the quality movement saw the adoption of total quality management (TQM) programs (Anderson et al., 1995; Dow et al., 1999; Cua et al., 2001). Other popular strategic action programs were lean manufacturing (LEAN) and supply chain management (SCM) (Womack et al., 1990; Davis, 1993; Cua et al., 2001; Tan et al., 2002).

Consistent with past operationalization, the three strategic action programs are collectively called organizational innovations because they represent
significant business process transformations across the organization. Their associated benefits attract the attention of other companies not only in the same country as the original innovator but also across national boundaries (Damanpour & Gopalakrishnan, 1998). Organizational innovation can take the form of a new product, a service, a technology, or an administrative practice.

While the influence of organizational innovations on performance is inherently interesting in its diffusion pattern in the context of a developing country, we are also interested in the relationship between organizational innovations and type of corporate strategy. In other words, a firm’s corporate strategy choice of either cost leadership or differentiation or a combination thereof with respect to specific market segments (called focus) has been documented in prior literature (Porter, 1980). We examine the relationship between the choice of corporate strategy at the corporate level and choice of organizational innovation at the operations strategy level. The three competitive strategies include a niche market strategy characterized by targeting specific customer/market groups and two broad market strategies characterized by serving a broad range of customers and market segments via cost leadership or differentiation. Similarly, the three organizational innovations of TQM, LEAN, and SCM share a common theme consistent with sustainable value creation and continuous improvement that are replicable across a variety of units and products within a firm and across the value chain.

To summarize, our study addresses two research objectives: 1) To identify which of the organizational innovations are associated with the three types of competitive strategies; and 2) To answer the question as to whether the diffusion pattern of organizational innovations within the developed countries are also similar to those of developing countries. In some sense, our first objective looks at internal diffusion patterns of organizational innovations by looking at cross-departmental implementation and cross-functional alignment (operations strategy and corporate strategy). In contrast, our second objective looks at external diffusion patterns by examining flow of organizational innovations from developed to developing countries. We use arguments from institutional theory to shed light on our two research objectives.

2 Literature Review

Institutional theory has been used to help explain the spread of administrative innovations primarily through the principle of isomorphism, or the emergence of common organizational practices over time (DiMaggio & Powell, 1983). The principle of isomorphism suggests that organizations become increasingly similar through institutional forces. However, relatively few studies have empirically tested institutional processes to examine the economic consequences of adoption of administrative innovations (Scott,
There is past precedence for using institutional theory in the context of developing economies. For example, Su et al. (2008) examined the SCM strategies of Chinese firms from an institutional theory view and proposed specific improvement strategies based on a composite index score called potential improvement space.

In the developed world, the diffusion of key operational improvement programs such as TQM, SCM, and LEAN has been widespread. While the growth of individual operational improvement programs has seen a lot of attention in the past, the combinatorial role of these programs has also attracted recent research (Kaynak & Hartley, 2008). However, there is a paucity of research that addresses the question of how effective these individual operational improvement programs are on performance in the context of emerging regions such as Asia and Thailand, in particular. As our purpose is not to conduct a meta-analysis of the literature but only to highlight a few studies in both camps, we briefly comment on a few of these studies here to form support for our diffusion hypotheses in a later section.

Few past studies have examined the combinatorial impact of these three operational improvement programs on performance in the context of Thailand. We report on a few in a later section of hypotheses development. As firms face intense pressure on resource acquisition and deployment in emerging economies, there is a renewed interest in research to isolate the combinatorial recipes involving operational improvement programs that affect performance. We address this issue. Also, from a theoretical perspective, we seek to use the Porters (1980) framework which classifies corporate strategies into three types of cost leadership, differentiation, and focus strategies to see if such a clustering classification yields different relationships between operational improvement programs and performance.

Research Hypotheses

Firms formulate and implement various competitive strategies to achieve cost leadership or product differentiation (Bowman & Johnson, 1992; Porter, 1980, 1985; Schlie & Goldhar, 1995). There is support for the generic business strategies of cost, differentiation, and focus in the operations management literature (Frohlich & Robb, 2001; Devaraj et al., 2001). Frohlich and Robb (2001) sought to replicate Miller and Roth’s taxonomy of strategy types and found no evidence of the two dimensions of manufacturing strategy of market scope and differentiation but found other unique manufacturing strategies in the global data set. Devaraj et al (2001) examined the validity of generic manufacturing strategies model of cost, differentiation, and focus amongst manufacturing plants in the United States, Italy, United Kingdom, Japan, and Germany. They found that leading-edge firms in their sample appear to
combine generic manufacturing strategies with the principles governing the product–process matrix effectively. Liao and Cheung (2002) studied the effects of competition strategy in Japanese companies and concluded that competitive strategies directed toward higher added-value and product differentiation exerted more impact on R&D than strategies aimed at cost leadership. They also found that strategies with broad market focus were more important. They concluded that Japanese high-technology firms tend to exploit R&D to differentiate products with high added-value to supply a broad range of markets, instead of focusing on a particular market segment. They argued that a firm has the option to either develop products to satisfy a broad range of commercial and industrial demands or to focus on niche market segments. Laosirihongthong and Dangayach (2005) surveyed Thai and Indian automotive manufacturers to study the relationship between implementation of production strategies and firm performance in newly industrialized countries. The result shows that the focused competitive priorities improved product- and process-related quality and on-time delivery performance. The author concluded that conformance quality and manufacturing efficiency are the most important order-winning criteria in the automotive industry in both countries.

Hence, corporate competitive strategies can be classified as being oriented broadly or narrowly with respect to the market segment. In a broad market focus, firms seek to develop products with higher-added value for a wide range of commercial and industrial uses. Alternatively, in niche market focus, firms can seek to develop products with higher-added value focusing on specific customer groups. Thus, we hypothesize,

**H₁:** The business strategies pursued by manufacturing firms in Thailand can be empirically classified into three clusters in accordance to Porter’s (1980) classification of: 1) cost leadership; 2) differentiation; and 3) focus.

Research on lean practices tends to focus on the relationship between the implementation of lean practices and performance. While most lean practice research focused on a single aspect of lean implementation and its effect on performance (e.g., Hackman & Wageman, 1995; Samson & Terziovski, 1999; McKone *et al.*, 2001), a few studies have explored two aspects of lean implementation and its effect of performance (e.g., Flynn *et al.*, 1995; McKone *et al.*, 2001). However, few studies have explored the simultaneous effects of multiple aspects of lean implementation and its effect on performance, although conceptual research continues to stress the need to empirically exam the simultaneous effect of multiple aspects of lean practices on performance. Shah and Ward (2003) attempted to address the void in this stream of literature by simultaneously examining 22 lean practices grouped into four bundles: JIT, TQM, total preventive maintenance, and human resource management. They
empirically validated the four bundles of lean practices and concluded that lean practices contribute substantially to operational performance. This is consistent with the literature that suggests significant positive relationships between lean practices and operational performance of world-class manufacturers (e.g., Sakakibara et al., 1997; Giffi et al., 1990). Shah and Ward (2007) expanded their earlier study on lean practices and developed a multi-dimensional measure of LEAN that includes 48 practices. These practices were reduced into ten factors that measure supplier development, customer involvement, and internal issues. Specifically, the ten factors are supplier feedback, JIT delivery by suppliers, supplier development, customer involvement, pull, continuous flow, setup time reduction, total preventive maintenance, SPC, and employee involvement. Thus, lean strategies are vital for cost reduction efforts.

\[ H_2: \text{LEAN is more likely to be associated with the business strategy of cost leadership followed by TQM and then SCM.} \]

Research on TQM practices generally separate TQM into soft TQM and hard TQM. Soft TQM issues are human resource related, such as committee and teamwork, where as hard TQM issues are generally process related, such as preventive maintenance and modular designs. It is often argued that soft TQM practices indirectly affect operational performance through its effect on hard TQM by creating an environment for seamless diffusion and implementation of hard TQM practices. Hence, soft TQM practices affect operational performance much in the same way as traditional human resource management practices (Hart & Schlesinger, 1991; Bowen & Lawler, 1992; Kochan et al., 1995). Rahman and Bullock (2005) continued to the research soft TQM practices and argued that it is more appropriate to investigate the direct impact of soft TQM on the diffusion of hard TQM and then assess the subsequent impact of hard TQM on operational performance. Their research showed significant positive relationships between soft TQM and hard TQM elements. Moreover, soft TQM practices also indirectly impact performance via hard TQM elements. Kochan et al. (1995) also argued that TQM can be viewed as a set of technical tools (such as statistical process control and Pareto analysis) or as part of broader changes to human resource practices. They examined six soft TQM elements examined by Dow et al. (1991) and four hard TQM elements used by Power et al. (2001), and studied their effect on performance measures adopted from Samson and Terziiovski (1999).

Tan (2002) identified 25 SCM practices from the literature and examined their relationships with operational performance. These practices address a firm’s supply and materials management issues, operations, information technology and sharing, and customer service issues. A general conclusion from this work was that SCM practices affect operational performance. Using a
set of survey data from the Republic of Ireland, Fynes, Voss, and Búrca (2005) examined the impact of supply chain relationships on manufacturing performance. Relationship factors such as communication, trust, quality, flexibility, cooperation, adaptation, cost, and delivery were examined in the study. They discovered that supply chain relationships affect cost and quality, but not flexibility and delivery performance.

Prajogo and Sohal (2005) attempted to resolve the mixed evidence that appear in the literature concerning the relationship between TQM and differentiation and cost leadership strategies. Using empirical data from a survey of 194 middle/senior managers from Australian firms, they found TQM to be positively and significantly related to differentiation strategy, and TQM partially mediated the relationship between differentiation strategy and three performance measures (product quality, product innovation, and process innovation). Similarly, they report that TQM needs to be complemented by other resources to more effectively realize the strategy in achieving a high level of performance, particularly innovation. This suggests that TQM perhaps is an order qualifier for firms pursuing differentiation and firms need to work closely with external constituents through SCM to really enjoy the performance benefits that are over and above those associated with TQM. Thus, we offer:

\[ H_3: \text{ The organizational innovation of SCM is more likely to be associated with the business strategy of differentiation, followed by TQM and then LEAN.} \]

While few studies have examined the business strategy of focus explicitly, in a recent study, Kim (2006) studied the relationship between corporate competitive capability and supply chain operational capability for performance improvement. The author also studied the effects of supply chain integration on firm performance and concluded that the effect of interaction between corporate competitive capability and supply chain operational capability on performance improvement becomes significant as the development stage of supply chain integration increases. This is suggestive of a higher level of excellence as is often achieved when firms focus exclusively on certain market segments as opposed to mass segments. Accordingly, we suggest that:

\[ H_4: \text{ The organizational innovation of SCM is more likely to be associated with the business strategy of focus, followed by TQM and then LEAN.} \]

Survey Instrument and Respondent Profile

In this study, pre-tested constructs from past empirical studies were adapted to ensure the validity and reliability of the survey instrument (Tata et al., 1999). The business strategy scale was adapted from Liao and Cheung (2002) to
gauge a firm’s conceptual strategy clusters of cost leadership, differentiation, and focus as advocated by Porter (1980). The lean practices scale was adapted from Shah and Ward (2003) and included the vital elements of lean implementations: preventive maintenance, cycle time reduction, inventory reduction, process equipment or technologies, and quick changeover techniques (Womack et al., 1990). The soft TQM scale was adapted from Rahman and Bullock (2005) and captured the key elements of a firm’s commitment and measures taken to enable its workforce to improve quality. Specifically, the soft TQM scale captures the key aspects of policy, internal communication, employee involvement, and training and education (Anderson et al., 1995, Dow et al., 1999; Cua et al., 2001). The SCM scale was adapted from Tan (2002) and included the desires to determine customers’ future expectation and needs, establish good relationships with supply chain members, formal information sharing, communicate strategic needs, create compatible information systems, and the involvement of customers and suppliers. This scale focused on inter-organizational relationship development consistent with the underlying premise of SCM to leverage information sharing (Davis, 1993, Power et al., 2001, Kannan & Tan, 2005). To measure operational performance, criteria used in the TQM, SCM, and LEAN literature were adapted (Cua et al., 2001, Kannan & Tan, 2005, Rahman & Bullock, 2005). The ability to deliver on time, production costs and efficiency compared to industry competitors were used to gauge operational performance. Constructs used in this research were measured using five-point Likert scales ranging from 1 (low) to 5 (high). The constructs and items used in this study are summarized in the appendix.

Survey data was collected from manufacturing firms in Thailand. The Thai manufacturing industry is heterogeneous in terms of sub-sectors, and product and/or process complexity. The literature has showed that TQM, SCM, and LEAN practices have been widely implemented in Thailand.

Data was collected in three stages. Two hundred and seventy questionnaires were handed out in the first stage to participants of training courses organized by the Thai-Japan Technology Promotion Association, the largest professional training organization in Thailand. Participants were mid or senior managers of manufacturing firms including automotive, electronics, foods, and textile companies. A total of 215 questionnaires were completed and returned within a week of completing the course, resulting in a response rate of 79.6 percent. During the second phase, 85 surveys were administrated to industry professionals in the manufacturing industry who were enrolled in the part-time International Executive MBA programs at Thammasat University, a leading Southeast Asian university located in Thailand. Seventy responses were received, leading to a response rate of 82.4 percent. During the last phase, 75 surveys were administered to industry professionals enrolled in the part-time Master of Engineering Program at Thammasat University. Again, participants
during this phase of the survey had several years of work experience in multinational manufacturing firms in Thailand. A total 44 completed surveys were received, yielding a response rate of 58.7 percent. A grand total of 329 surveys were collected, yielding an overall response rate of 76.5 percent.

A large portion of the respondents are from the automotive and electronic industries. More than half of the respondents hired less than 200 employees. More than 60 percent of the respondents had two to ten years of work experience. About 70 percent of the firms were foreigners-owned through direct investment and joint venture, whereas only 20 percent were Thai-owned.

Statistical Analysis

Hierarchical Cluster Analysis and Factor Analysis

Hierarchical cluster analysis was used to examine our assertion that business strategy can be categorized into three distinct clusters consisting of cost leadership, differentiation, and focus strategies (Porter, 1980). The three business strategy items that asked the respondents to indicate the extent to which their firms seek to supply products at lowest costs to a broad range of market segments (cost leadership), seek to differentiate products to supply a broad range of market segments (differentiation strategy), or seek to develop products for a specific customer group only (focus strategy) were used to cluster the cases. The result in Table 1 reveals that there are 42 cases in cluster 1, 178 cases in cluster 2, and 103 cases in cluster 3. A careful examination of the results indicates that cluster 1 is cost leadership, cluster 2 is differentiation, and cluster 3 is focus strategy. This analysis supports the first hypothesis that business strategies pursued by manufacturing firms in Thailand can be empirically categorized into three clusters in accordance to Porter’s (1980) classification of cost leadership, differentiation, and focus strategy.

<table>
<thead>
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<th>Table 1: Ward Method Hierarchical Cluster Analysis</th>
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<td>Frequency</td>
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<tr>
<td>Valid</td>
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<tr>
<td>Cluster 1 (Cost Leadership)</td>
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<tr>
<td>Cluster 2 (Differentiation)</td>
</tr>
<tr>
<td>Cluster 3 (Focus Strategy)</td>
</tr>
<tr>
<td>Total Missing</td>
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<tr>
<td>System</td>
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<td>Total</td>
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Although the survey instrument was adapted from the literature, reliability analysis was conducted by examining the value of Cronbach’s $\alpha$ for each construct (Cronbach, 1951). Results show that in each case, values of $\alpha$ exceeded the suggested threshold value of 0.6 (Nunnally, 1988), thus providing further evidence of scale reliability. Next, factor analysis was used to reduce each set of measured variables into the appropriate construct of interest. Factor loadings of all items within each scale were above 0.70, providing support for the validity of measuring the constructs using the respective sets of measured variables. KMO tests were greater than .50 suggested that the use of factor analysis was appropriate, and that extracted factors were distinct and reliable.

**Multiple Linear Regression of Performance**

Hierarchical multiple linear regression was used to examine the impact of LEAN, TQM, and SCM constructs and their interaction effects on operational performance in each of the three clusters. Multiple regression (Model A) for the cost leadership cluster revealed that the model is statistically significant at $\alpha = 10\%$. The TQM construct was significant at $\alpha = 5\%$, whereas the SCM construct was significant at $\alpha = 10\%$. However, the LEAN construct and none of the interaction terms were statistically significant. The negative coefficient for the SCM construct suggested that SCM implementation is detrimental to operational performance for cost leadership firms. There are various possible explanations for this counter-intuitive result. It could be that cost leadership firms in Thailand operated in the mass-produced market with small profit margin where price was a significant order winner. Cooperative buyer-supplier relationship was not important as firms in this sector maintained a large supplier base to ensure adequate competition among their suppliers.

(Model A) Multiple Linear Regression of Cost Leadership Cluster
Performance  
\[ \text{Cost} = .767^\dagger (\text{TQM}) -.392^\ddagger (\text{SCM}) \]
\[ R^2 = .307, \text{ Adjusted } R^2 = .155; \text{ ANOVA: F-statistic = 2.025, Sig = .082} \]

(Model B) Multiple Linear Regression of Differentiation Cluster
Performance  
\[ \text{Differentiation} = .223^\dagger (\text{TQM}) +.304^\dagger (\text{SCM}) \]
\[ R^2 = .252, \text{ Adjusted } R^2 = .220; \text{ ANOVA: F-statistic = 7.713, Sig = .000} \]

(Model C) Multiple Linear Regression of Focus Strategy Cluster
Performance  
\[ \text{Focus} = -.214^\dagger + .269^\dagger (\text{LEAN})+.231^\dagger (\text{SCM})+.217^\dagger ((\text{LEAN})(\text{SCM})) \]
\[ R^2 = .297, \text{ Adjusted } R^2 = .243; \text{ ANOVA: F-statistic = 5.486, Sig = .000} \]

**Note:** \( ^\dagger \) significant at $\alpha = 5\%$, \( ^\ddagger \) significant at $\alpha = 10\%$
Models B and C above reveal that multiple regression models for the differentiation and focus clusters were statistically significant at $\alpha = 5\%$. In the differentiation cluster, both the TQM and SCM constructs were significant at $\alpha = 5\%$, but LEAN construct and the interaction terms were insignificant. For firms operating in the differentiation cluster in Thailand, both the TQM and SCM constructs enhance operational performance. In the focus strategy cluster, LEAN and SCM constructs enhance performance. The LEAN x SCM interaction term suggests that firms in this cluster achieved additional benefit if LEAN and SCM were implemented concurrently.

**Discussion and Managerial Implications**

In this paper, we addressed the following main research issues: 1) Do manufacturing firms in Thailand follow the pattern of competitive strategies as stated in Porter (1980) of cost leadership, differentiation, or focus?; 2) Are lean strategies as an organizational innovation more effectively associated with overall business strategy of cost, leadership, differentiation, or focus? 3) Are TQM strategies as an organizational innovation more effectively associated with overall business strategy of cost, leadership, differentiation, or focus?, and 4) Are SCM strategies as an organizational innovation associated with overall business strategy of cost, leadership, differentiation, or focus?

In Hypothesis 1, we argued that the manufacturing firms in Thailand can be empirically classified into the three strategic clusters of: 1) cost leadership; 2) differentiation and 3) focus as suggested in Porter (1980). This hypothesis was supported and the theory of corporate strategy largely pursued in developed economies appears to hold true in the case of the developing economy of Thailand as well. The implications of this result is that strategic planning frameworks including the alignment between corporate strategy and operations strategy (as operationalized in this study as organizational innovations) is likely to follow the same pattern in developing economies as in developed economies.

To test the diffusion hypotheses from developed countries to developing countries, we used the organizational innovation perspective and institutional theory to shed light on which organizational innovation: TQM, LEAN, or SCM is important for each strategic cluster. It may be expected from a diffusion of best practices from the developed world to the developing world that the same temporal pattern that emerged concomitantly in developed economies of TQM and LEAN, followed by SCM, would also hold true in the context of Thailand, which is an example of a developing economy. However, just as in the case of firms in developed economies, over and above the temporal pattern was a pattern that can be traced to the type of corporate strategy pursued i.e., cost leadership, differentiation and focus.
Hypothesis 2 stated that for firms pursuing cost leadership, the relative impact of organizational innovations on performance will be in the following rank order from highest to least: LEAN first, then TQM, and then SCM. This hypothesis was not supported. In fact, the rank order in terms of relative influence on performance was TQM, SCM, and LEAN. LEAN was not even significant in the cost leadership cluster, and SCM turned out to have a negative and marginally significant ($p<.10$) influence on performance. This suggests that TQM is the most important trigger of bringing the cost down. Despite the mature body of knowledge with respect to LEAN in the developing economies, diffusion of LEAN to Thailand firms is not apparent. Also, an interesting pattern of results with respect to our sample is the opposing influence of SCM on cost leadership, suggesting that post-TQM efforts to bring in the external constituencies of suppliers and customers are cost-prohibitive. Thus, the diffusion hypothesis with respect to the cost leadership sub-sample is restricted to the organizational innovation of TQM alone.

In Hypothesis 3, we stated that for firms pursuing differentiation, the relative impact of organizational innovations on performance will be in the following rank order from highest to least: SCM first, and then TQM and LEAN at the same level. This hypothesis was supported with LEAN again not having a statistically significant influence on performance for the differentiation cluster. It is interesting to note that the most significant organizational innovation to affect performance in the differentiation sub-sample was SCM (as hypothesized) followed by TQM. This result is indicative of TQM being an order qualifier for firms pursuing differentiation, and it is SCM strategies that have an impact of distinguishing one manufacturing firm from another in the eyes of the customer. It appears that effective lean strategies even for the differentiation sub-sample have elusive performance benefits, indicating the lack of diffusion of this innovation to Thailand firms.

In Hypothesis 4, we argued that for firms pursuing the corporate strategy of focus, the relative impact of organizational innovations on performance will in following rank order from highest to least: SCM first, and then TQM and then LEAN. This hypothesis was only partially supported with LEAN and then SCM having the highest influence on performance in the focus sub-sample. However, TQM was not significantly related to performance after the effects of LEAN and SCM are taken into account. It is interesting to note that LEAN was only significant for firms pursuing a focus strategy, i.e., cost leadership with respect to a distinct market segment or differentiation with respect to a distinct market segment. The diffusion of LEAN to firms in Thailand appears to be effective when these firms focus on a specific market segment as opposed to catering to mass markets. This is an interesting cultural variation of the effectiveness of lean strategies in developing economies such as Thailand.
We also addressed the following secondary research issue: Are there combinatorial effects across organizational innovation types that are associated with overall business strategy of cost, leadership, differentiation, or focus? Our results indicate that the only interaction that was significant was with respect to the focus sub-sample. LEAN and SCM have a combinatorial influence on performance that is strong for firms pursuing the focus strategy. The implication of this result is that when lean strategies diffuse along the supply chain to include suppliers and customers, they have a higher influence on performance for firms pursuing niche market segments. As opposed to several of the interaction terms among organizational innovations that are reported in the literature with respect to firms in the developed economies, our study suggests that the diffusion of combinatorial ‘recipes’ among organizational innovations is not strong with respect to firms in Thailand.

The examination of our research issues on the diffusion of organizational innovations is important in the context of Thailand. As is the case for many emerging economies where resources are scarce, it is vital that managers optimally use resources in alignment with competitive conditions. It is tempting for managers in these economies to ‘blindly copy’ their counterparts in developed economies. However, as the results from our study show, there are idiosyncratic recipes to be considered within each national context. Our study will pave the way for future replication of similar studies leading to a more robust inference as to which organizational innovations really work.

Specifically, our research has the following insights to contribute to possible future replication studies. First, the organizational strategy of LEAN appears to work for those firms that employ a focused business strategy, suggesting that being LEAN is customer-specific and customer-driven. Second, SCM is important for all three strategic clusters, implying that working with external players and integrating internally is vital regardless of the type of business strategy employed. Third, TQM is important for the generic strategies of cost leadership or differentiation but is not significant for the hybrid strategic group of focus. Perhaps in this cluster of focus, TQM is already assumed away to hold true. Fourth, none of the two-way or three-way interactions among organizational innovations were statistically significant on performance for the cost leadership group. This suggests that over and above LEAN, pursuit of other organizational innovations is costly and can be detrimental to the bottom line. Also, none of the two-way or three-way interactions among organizational innovations were statistically significant on performance for the differentiation group, suggesting that confusion that can arise by ‘mixing’ organizational innovations does not really deliver on differentiating the firms from its competitors. Finally, the interaction between LEAN and SCM was strongly related to performance in the focus strategy cluster. This was the only interaction term that was significant in the Thailand sample. This suggests that
in the context of Thailand, firms fare better by focusing on specific customer niche segments and looking at ways in which being LEAN internally can complement being agile with respect to their customer needs and translating those needs to their supply base. In an interesting contrast to our study, Ketokivi and Jokinen (2006), in a sample of firms in the process industry, found that factories that were unfocused were also high performers. They suggest that in certain operating environments and with certain competitive strategies, choosing not to focus the manufacturing task could also be viewed as a viable alternative manufacturing strategy.

It is also interesting to note that the three-way interaction among all three organizational innovation types was not significant on performance in either of the strategic groups. This suggests that the pursuit of all three organizational innovation types simultaneously is detrimental to performance. An alternative explanation could be that managers in Thailand are yet to understand the ‘bigger picture’ that could emerge by transcending across these innovation types to look for common ground. Perhaps the managers were employing ‘cookie cutter’ techniques by attempting the literal behind these organizational innovations instead of understanding the essence of these innovations and tailoring them to their own contexts. Such a revelation can be confirmed through case studies instead of using broad brush survey data.

Conclusions

Our paper used the theoretical base of organizational innovation theory and institutional perspectives theory to examine whether the innovations of TQM, SCM, and LEAN that have seen widespread adoption in developed countries have similar effects in the context of Thailand. The context of Thailand is important as firms in this economy not only cater to domestic needs but also serve as a global source for manufacturers who are keen in developing alternative sources of supply beyond supplies sourced from other countries such as China, Taiwan, and Hong Kong. While most prior studies that have examined relationships among LEAN, TQM, and SCM on performance have been examined in the context of US and European firms, our study examines these relationships in the emerging context of Thailand. Implications of this are that theories that are fairly robust in one or more national contexts tend not to hold in other national contexts (Badri et al., 2000; Zhao et al., 2006).

References available upon request
International Comparison on the Relationship between Quality Management and Innovation Performance

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Abstract. This empirical study conducts an international comparison on the relationship between total quality management (TQM) practices and innovation performance. Eleven TQM practices and two indicators of innovation performance were examined and their relationships were compared across five industrialized countries (Germany, Italy, Japan, Korea, and the United States). The results indicate the positive relationship between TQM practices and Speed of New Product Introduction, but mixed result for the relationship between TQM practices and Product Innovativeness. In addition, the way in which TQM practices affect innovation is significantly different across countries. These findings suggest that TQM-innovation relationship is dependent on the specific indicator of innovation performance and is culture-specific.

1 Introduction

Total quality management (TQM) is widely recognized as a source of competitive advantage to excel in marketplaces. Facing a turbulent and rapidly changing environment, organizations have also considered innovation as a strategic tool to guarantee their long-term survival. The literature has discussed whether TQM fosters or hinders innovation. However, conflicting arguments exist pertaining to the relationship between TQM and innovation [24]. Some researchers have asserted that the principles that TQM embodies are not compatible with the spirit of innovation [17, 31, 32], while some researchers argue that implementing TQM in a proper way can provide a fertile environment for innovation [15, 16, 21, 25, 28]. Despite the ongoing contest of these opposing arguments, only a few studies have empirically examined the relationship between TQM and innovation performance [9, 16, 25, 26, 28, 29]. In these studies, TQM practices are usually combined as a single construct, which is based on a fundamental assumption that these practices are closely interdependent. However, past research has suggested that organizations may not have to subscribe to the entire “TQM ideology” to capture the benefit [5, 7, 23]. This warrants a detailed study examining how individual TQM practices influence innovation performance respectively, which would add depth to the
literature on the TQM-innovation relationship. Another deficiency of the extant empirical studies regarding this issue is that the scope of these studies is usually restricted to a specific region such as the US, Spain, Australia, Canada or Turkey. An international comparison study is needed to test the generalization of the relationship between TQM and innovation.

To fill this void, this study aims to investigate the relationship between individual TQM practice and innovation performance from an international perspective, by answering the following questions:

1. How does each individual TQM practice relate to innovation performance?
2. Is the relationship between TQM practices and innovation performance different across countries?

In this study, hypotheses are tested by regression analysis with data collected from 163 plants from Germany, Italy, Japan, Korea, and the United States.

The remainder of this paper is organized as follows. In the next section, we proceed to the review of relevant literature on the relationship between TQM and innovation, thus formulating the research hypotheses. Section three describes the research methodology. Section four presents the results of hypotheses testing carried out. The main findings and implications stemming from this research are discussed in section five. Section six contains limitations of this study and future research. Finally, the conclusions are summarized in the last section.

2 Literature Review and hypothesis development

2.1 TQM-innovation relationship

While quality is doing things better, innovation is doing things differently [18]. Both are important to the survival of organizations, but the relationship between TQM and innovation is complex and ambiguous. There are both positive and negative arguments about this relationship in the literature. Prajogo and Sohal [24] note that the conflict between the two groups of arguments exists in many facets including the magnitude of change, behavioral traits, ways of thinking, approaches, and principles, embodied in TQM in contrast to innovation. TQM covers a wide spectrum of philosophy and methodologies. The literature on TQM has suggested three core principles of TQM philosophy: customer focus; continuous improvement; and teamwork [6]. Taking this as a referent, the arguments concerning the TQM-innovation relationship are briefly described below.

Customer focus philosophy drives organizations to consistently search for new customer needs and expectations, enabling organizations to offer customers something that they have never experienced or expected. Thus, innovation processes would be fostered by dynamizing sources of innovative
ideas from the market [1, 21]. However, negative arguments are also raised against customer focus. Some scholars argue that customer focus could lead organizations to currently served markets narrow-mindedly rather than creating radical solution of exploring the latent needs of current and future customers, which could build a “tyranny of the served market” [24, 31]. Therefore, an organization’s ability to innovate is likely to be constrained, with the fear of losing existing customers.

The role of continuous improvement in driving innovation is also quite controversial. Continuous improvement can encourage changes and creative thinking in how work is organized and conducted, which is instrumental to innovation [24]. Imai [14] has argued that continuous improvement is needed to sustain the benefits resulting from innovation. However, negative aspects of continuous improvement in relation to innovation have also been highlighted by scholars such as Harari [12]. Continuous improvement focuses on incremental changes and requires standardization or formalization. This would yield rigidity and inhibit innovation by trapping people into focusing on the details of the current quality process rather than new idea.

TQM promotes employee empowerment, involvement and teamwork, and enables employees to participate in decision-making and to suggest ideas for improvement of their products and processes. This especially links to creativity and knowledge management, which could nurture innovative behaviors and lead to beneficial effect on innovations [19, 20]. Also, the implementation of TQM will bring changes to organizations transforming organizational structures to be flexible, which is one of the critical factors for innovation [22]. However, in practice, employee empowerment and involvement are usually constrained to simple execution jobs and lower scales of improvement opportunity. The emphasis of group work on total quality control would also inhibit independent entrepreneurship and individual creativity, yielding a detrimental effect upon radical innovations [24].

There are a few empirical studies that have investigated the relationship between TQM and innovation. The seminal work that deals with this issue is conducted by Flynn [9], which demonstrates that quality foundation and organizational infrastructure can support fast product innovation. McAdam et al. [18] investigate how organizations can progress from TQM to innovation, by comparing continuous improvement to innovation in 15 companies in Ireland. Their findings indicate that organizations which have a history of continuous improvement are more likely to go on and build innovative culture successfully. Prajogo and Sohal [25], based on the experience of Australian firms, found a positive impact of TQM on innovation performance. However, Singh and Smith [30] could not find a firm link between TQM and innovation with a wider sample in the same economic environment (Australia). Prajogo and Sohal [26] divide TQM into two dimensions: mechanistic (customer focus,
and process management) and organic (leadership, and people management) dimensions. Based on a sample of 194 Australian firms, they conclude that the organic dimension positively relates to quality performance, whilst the mechanistic dimension positively relates to innovation performance. Feng et al. [8], by conducting a replicated study in Singapore, confirm such a conclusion. Perdomo-Ortiz et al. [21] demonstrate that TQM is a forerunner of the construction of business innovation capability (BIC), and in particularly, three TQM practices (process management, product design, and human resource management) stand out as paths for building BIC. Kim et al. [15] propose a comprehensive framework to study the causal relationship among TQM practices and five types of innovation. Their results reveal that a set of TQM practices through process management has a positive relationship with all of the five types of innovation. Other empirical studies such as [16, 28, 29], by integrating TQM practices as a single construct, all provide support for the positive TQM-innovation relationship. Therefore, the following hypotheses are formulated:

\[ H1: \text{TQM practices have a positive impact on innovation performance.} \]

While organizational innovation is traditionally divided into product and process innovation, our study is primarily focused on product innovation, and considers two indicators of product innovation – Speed of New Product Introduction, and Product Innovativeness. Consequently, this hypothesis has been split into two:

\[ H1a: \text{TQM practices have a positive impact on Speed of New Product Introduction.} \]

\[ H1b: \text{TQM practices have a positive impact on Product Innovativeness.} \]

2.2 “Culture-free” versus “culture-specific” perspective

There have been two conflicting theoretical perspectives in the research field of comparative management: the “culture-free”, and the “culture-specific” argument. The “culture-free” argument suggests the notion that as nations “... become more industrialized they become more structurally alike” [33]. When managers located in different societies face similar imperatives for change, deep-seated cultural factors would not influence the way managers actually adjust their behavior and the consequent performance they can achieve. On the other hand, “culture-specific” argument [13] posits that cultural differences can play a critical role in affecting the cross-national adoption of managerial practices and the resulting performance. The “cultural specificity” would be explained by political, economic, social, or other factors [2]. Hofstede [13] contends that national culture can be seen as being differentiated along four dimensions: power distance, uncertainty avoidance, individualism/collectivism,
and masculinity. Current operations management research has increasingly linked cultural factors to operations management practices [3].

These two perspectives have considerable implication for researchers on international quality practices. The “culture-free” perspective suggests culture really does not matter, since organizations would adopt TQM in a similar fashion resulting in the increasing similarity between these organizations. The “culture-specific” perspective, however, would suggest that cross-national differences would lead to differential levels in the adoption of TQM practices and the varying impact on performance among organizations across countries. As TQM literature has matured, recent rigorous academic studies have increasingly raised inquiry as to the cross-national validity of TQM practices [11, 27].

Based on our understanding of differences in culture (“culture-specific”, [13]), we argue that the national culture would affect the implementation of TQM practices and the way of TQM implementation influences the achievement of innovation performance. For example, continuous improvement heavily relies on an approach characterized by collectivism, group efforts, and systems approach [14]. Therefore, one could expect that Japanese culture which emphasizes much on collectivism and collaboration will be more favorable to the implementation of continuous improvement, leading to innovation, especially in terms of incremental innovation. Comparatively, since the US culture is highly individualistic and strongly committed to competition, the promoted individual ideas and efforts would directly foster innovation, rather than take a route from continuous improvement to achieve innovation. Therefore, this cultural difference would have an impact on the relationship between TQM practices and innovation. Similar argument can be made between other countries having different national culture. Thus, we offer the following hypothesis:

\[ H2: \text{The relationships between TQM practices and innovation performance are different across countries.} \]

3 Research methodology

3.1 Sample

The sample is comprised of data collected through an international joint research named High Performance Manufacturing (HPM). The aim of this project is to study management practices and their impact on plant performance within global competition. In order to ensure broad variability in practices and performance, the population has been stratified by two factors: plant type and industry. Two plant types were chosen: World-Class reputation and Non-World-Class reputation. The list of world-class manufacturers has been
identified by expert opinions published in trade journals and industry publications. Three industries were chosen: machinery, electronics and transportation, because they were industries in transition, where a great deal of variability in performance and practices was expected to be present [10].

This study uses data gathered from 163 manufacturing plants in 5 countries: Germany, Italy, Japan, Korea, the United States. Within each country, the minimum size of the surveyed plants was 100 employees. Table 1 summarizes the key characteristics of these plants, by industry and country.

Table 1. Demographic of Sample Plants

<table>
<thead>
<tr>
<th>Industry</th>
<th>Germany</th>
<th>Italy</th>
<th>Japan</th>
<th>Korea</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical &amp; Electronic</td>
<td>9</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Machinery</td>
<td>13</td>
<td>10</td>
<td>12</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>Automobile</td>
<td>19</td>
<td>7</td>
<td>13</td>
<td>11</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td>41</td>
<td>27</td>
<td>35</td>
<td>31</td>
<td>29</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Plant characteristics</th>
<th>Germany</th>
<th>Italy</th>
<th>Japan</th>
<th>Korea</th>
<th>United States</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Market Share (%)</td>
<td>30.21</td>
<td>23.38</td>
<td>25.05</td>
<td>31.54</td>
<td>25.50</td>
<td></td>
</tr>
<tr>
<td>Average Sale ($000)</td>
<td>1736230</td>
<td>71209</td>
<td>1118492</td>
<td>2266962</td>
<td>284181</td>
<td></td>
</tr>
<tr>
<td>Average of Number of Employee (salaried person)</td>
<td>161</td>
<td>296</td>
<td>474</td>
<td>2556</td>
<td>153</td>
<td></td>
</tr>
</tbody>
</table>

3.2 Measures

This study adopts the frameworks for quality management by Flynn et al. [10], to measure TQM practices. A set of eleven measurement scales was constructed – Top Management Leadership for Quality (TMLS), Feedback (QSFB), Process Control (PCT), Preventive Maintenance (PVMT), Housekeeping (HSKP), Small Group Problem Solving (SGPS), Task-related Training for Employees (TRTE), Employee Suggestions (ESG), Interfunctional Design Efforts (IFDE), Customer Involvement (CQIV), and Supplier Quality Involvement (SQIV). All of these scales are measured through perceptual questions over seven-points on the Likert scale, where a value of 1 indicates the worst performance and a value of 7 indicates the best performance. Each of these measurement scales has multiple respondents from the same plant. These respondents are from nine positions: direct workers, human resource manager, quality manager, supervisors, process engineer, plant superintendent, inventory
manager, member of product development team, and plant manager. The descriptions of these eleven scales are provided as follows.

1) Top Management Support for Quality (TMLS): This scale measures top management commitment and personal involvement in pursuing continuous improvement.

2) Feedback (QSFB): This scale measures whether the plant provides shop-floor personnel with information regarding their performance (including quality and productivity) in a timely and useful manner.

3) Process Control (PCT): This scale measures whether the plants conduct statistical quality control to reduce variance in processes.

4) Preventive Maintenance (PVMT): This scale measures whether the plants conduct preventive maintenance in order to improve equipment performance.

5) Housekeeping (HSKP): This scale evaluates whether plant management has taken steps to organize and maintain the work place in order to help employees accomplish their jobs faster and instill a sense of pride in their work place.

6) Small Group Problem Solving (SGPS): This scale evaluates how the plant uses teamwork activities on the shop floor for continuous improvement.

7) Task-related Training for Employees (TRTE): This scale evaluates whether employees skill and knowledge are being upgraded in order to maintain a work-force with cutting edge skills and abilities.

8) Employee Suggestions (ESG): This scale is designed to measure employee perception regarding management’s implementation and feedback on employee suggestions.

9) Interfunctional Design Efforts (IFDE): This scale measures the level and amount of input that the manufacturing function has in the new product introduction process. This includes cooperation and input into the process across functional boundaries.

10) Customer Involvement (CQIV): This scale assesses the level of customer contact, customer orientation, and customer responsiveness.

11) Supplier Quality Involvement (SQIV): This scale assesses the amount and type of interaction, which occurs with vendors regarding quality concerns.

We focus on product innovation, and two indicators are used to measure product innovation performance – Speed of New Product Introduction and Product Innovativeness. These two measures were judged by the plant manager on a five-point Likert scale, where a high score indicates that plant management perceives that the plant has been relatively successful pursuing product innovation performance comparing to its competitors.

Then, we assessed the measurement quality of each multi-item measurement scale, and with satisfactory measurement quality results, we averaged the item scores for the measurement scale. All scale responses are averaged into a single plant response per scale; analysis is at the plant level. Aggregating respondents
across respondent category and collecting the same data from different respondents can help to address the issue of common method bias.

3.3 Testing measurement instruments

The validation process for the survey instrument includes three steps: reliability, content validity and construct validity. Reliability is operationalized through the internal consistency method and Cronbach’s alpha is used as the reliability indicator [4]. Cronbach’s alpha value of at least 0.6 is considered acceptable, and items that do not strongly contribute to alpha and whose content is not critical are eliminated. Table 2 shows the alpha value for all scales and most the scales exceed the lower limit by a substantial margin both for country sample and pool sample, indicating that the scales are internally consistent.

Content validity is ensured through an extensive review of literature and empirical studies. Construct validity measures the extent to which the items in a scale all measure the same multivariate construct. It is established through the use of factor analysis, demonstrating that all scales are one-dimensional. Table 2 presents the summary of the eigenvalues for each of the scales. The eigenvalue of the first factor for each scale exceeds the minimum eigenvalue of 1.00 both for country sample and pool sample, and all factor loadings meet the criterion of larger than 0.4, indicating all of items contribute to their respective scales.

4 Hypothesis Testing

Prior to testing the hypotheses H1 and H2, a correlation analysis is conducted for the eleven TQM scales. Table 3 presents the mean and the standard deviation of each variable along with the correlation matrix. It indicates that there is no problem with unusually high standard deviation and/or unusual mean. We then conduct another correlation analysis on the relations between eleven TQM practices and two innovation performance indicators for countries samples and the pooled sample. The results are presented in Table 4.

The correlation result for pool sample indicates that Preventive Maintenance (PVMT), Housekeeping (HSKP), Small Group Problem Solving (SGPS), Task-related Training for Employees (TRTE), Interfunctional Design Efforts (IFDE) significantly correlate with Speed of New Product Introduction, while Top Management Leadership for Quality (TMLS), Housekeeping (HSKP), Small Group Problem Solving (SGPS), Task-related Training for Employees (TRTE) significantly correlate with Product Innovativeness. However, five practices Feedback (QSFB), Process Control (PCT), Employee Suggestions (ESG), Customer Involvement (CQIV), and Supplier Quality Involvement (SQIV)
Table 2. Summary of Measurement Analysis for Country-Wise Samples and Pooled Sample

<table>
<thead>
<tr>
<th>Measurement Scales</th>
<th>Germany</th>
<th>Italy</th>
<th>Japan</th>
<th>Korea</th>
<th>United States</th>
<th>Pooled Sample</th>
<th>Germany</th>
<th>Italy</th>
<th>Japan</th>
<th>Korea</th>
<th>United States</th>
<th>Pooled Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMLS</td>
<td>0.803</td>
<td>0.796</td>
<td>0.769</td>
<td>0.807</td>
<td>0.767</td>
<td>0.784</td>
<td>3.110(52)</td>
<td>3.152(53)</td>
<td>3.094(52)</td>
<td>3.136(52)</td>
<td>2.984(50)</td>
<td>3.026(50)</td>
</tr>
<tr>
<td>QSFB</td>
<td>0.799</td>
<td>0.882</td>
<td>0.777</td>
<td>0.744</td>
<td>0.762</td>
<td>0.796</td>
<td>2.798(56)</td>
<td>3.467(69)</td>
<td>2.712(54)</td>
<td>2.484(50)</td>
<td>2.631(53)</td>
<td>2.792(56)</td>
</tr>
<tr>
<td>PCT</td>
<td>0.798</td>
<td>0.887</td>
<td>0.854</td>
<td>0.795</td>
<td>0.841</td>
<td>0.822</td>
<td>2.778(56)</td>
<td>3.467(69)</td>
<td>3.166(63)</td>
<td>2.807(56)</td>
<td>3.120(62)</td>
<td>2.952(59)</td>
</tr>
<tr>
<td>PVMT</td>
<td>0.632</td>
<td>0.671</td>
<td>0.768</td>
<td>0.709</td>
<td>0.722</td>
<td>0.680</td>
<td>2.103(42)</td>
<td>2.297(46)</td>
<td>2.631(53)</td>
<td>2.370(47)</td>
<td>2.428(49)</td>
<td>2.230(45)</td>
</tr>
<tr>
<td>HSKP</td>
<td>0.853</td>
<td>0.792</td>
<td>0.833</td>
<td>0.656</td>
<td>0.805</td>
<td>0.795</td>
<td>3.192(64)</td>
<td>2.803(56)</td>
<td>3.082(62)</td>
<td>2.231(45)</td>
<td>2.919(58)</td>
<td>2.817(56)</td>
</tr>
<tr>
<td>SGPS</td>
<td>0.859</td>
<td>0.840</td>
<td>0.737</td>
<td>0.745</td>
<td>0.853</td>
<td>0.816</td>
<td>3.529(59)</td>
<td>3.396(57)</td>
<td>2.633(44)</td>
<td>2.663(44)</td>
<td>3.500(58)</td>
<td>3.144(52)</td>
</tr>
<tr>
<td>TRTE</td>
<td>0.802</td>
<td>0.762</td>
<td>0.747</td>
<td>0.802</td>
<td>0.816</td>
<td>0.787</td>
<td>2.550(64)</td>
<td>2.369(59)</td>
<td>2.290(57)</td>
<td>2.525(63)</td>
<td>2.607(65)</td>
<td>2.459(61)</td>
</tr>
<tr>
<td>ESG</td>
<td>0.874</td>
<td>0.857</td>
<td>0.809</td>
<td>0.693</td>
<td>0.851</td>
<td>0.834</td>
<td>3.334(67)</td>
<td>3.224(65)</td>
<td>2.854(57)</td>
<td>2.365(47)</td>
<td>3.165(63)</td>
<td>3.026(61)</td>
</tr>
<tr>
<td>IFDE</td>
<td>0.792</td>
<td>0.753</td>
<td>0.701</td>
<td>0.714</td>
<td>0.785</td>
<td>0.745</td>
<td>2.466(62)</td>
<td>2.312(58)</td>
<td>2.134(53)</td>
<td>2.221(56)</td>
<td>2.442(61)</td>
<td>2.280(57)</td>
</tr>
<tr>
<td>CQIV</td>
<td>0.776</td>
<td>0.844</td>
<td>0.765</td>
<td>0.663</td>
<td>0.836</td>
<td>0.692</td>
<td>2.921(49)</td>
<td>3.211(54)</td>
<td>2.738(46)</td>
<td>2.476(41)</td>
<td>3.248(54)</td>
<td>2.314(46)</td>
</tr>
<tr>
<td>SQIV</td>
<td>0.674</td>
<td>0.773</td>
<td>0.636</td>
<td>0.650</td>
<td>0.690</td>
<td>0.774</td>
<td>2.324(46)</td>
<td>2.800(56)</td>
<td>2.133(43)</td>
<td>2.283(46)</td>
<td>2.324(46)</td>
<td>2.893(48)</td>
</tr>
</tbody>
</table>

Table 3. Correlations and Descriptive Analysis

<table>
<thead>
<tr>
<th>Measurement Scales</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>TMLS</th>
<th>QSFB</th>
<th>PCT</th>
<th>PVMT</th>
<th>HSKP</th>
<th>SGPS</th>
<th>TRTE</th>
<th>ESG</th>
<th>IFDE</th>
<th>CQIV</th>
<th>SQIV</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMLS</td>
<td>5.549</td>
<td>0.624</td>
<td>.422**</td>
<td>.406**</td>
<td>.483**</td>
<td>.407**</td>
<td>.532**</td>
<td>.540**</td>
<td>.422**</td>
<td>.367**</td>
<td>.383**</td>
<td>.378**</td>
<td></td>
</tr>
<tr>
<td>QSFB</td>
<td>4.839</td>
<td>0.857</td>
<td>.422**</td>
<td>.742**</td>
<td>.516**</td>
<td>.462**</td>
<td>.677**</td>
<td>.464**</td>
<td>.612**</td>
<td>.386**</td>
<td>.507**</td>
<td>.636**</td>
<td></td>
</tr>
<tr>
<td>PCT</td>
<td>4.803</td>
<td>0.794</td>
<td>.406**</td>
<td>.742**</td>
<td>.509**</td>
<td>.455**</td>
<td>.598**</td>
<td>.408**</td>
<td>.499**</td>
<td>.275**</td>
<td>.510**</td>
<td>.608**</td>
<td></td>
</tr>
<tr>
<td>PVMT</td>
<td>4.846</td>
<td>0.685</td>
<td>.483**</td>
<td>.516**</td>
<td>.509**</td>
<td>.440**</td>
<td>.591**</td>
<td>.595**</td>
<td>.583**</td>
<td>.507**</td>
<td>.236**</td>
<td>.409**</td>
<td></td>
</tr>
<tr>
<td>HSKP</td>
<td>5.362</td>
<td>0.618</td>
<td>.407**</td>
<td>.462**</td>
<td>.455**</td>
<td>.440**</td>
<td>.643**</td>
<td>.515**</td>
<td>.560**</td>
<td>.365**</td>
<td>.540**</td>
<td>.439**</td>
<td></td>
</tr>
<tr>
<td>SGPS</td>
<td>5.012</td>
<td>0.618</td>
<td>.532**</td>
<td>.677**</td>
<td>.598**</td>
<td>.643**</td>
<td>.643**</td>
<td>.653**</td>
<td>.737**</td>
<td>.588**</td>
<td>.365**</td>
<td>.544**</td>
<td></td>
</tr>
<tr>
<td>TRTE</td>
<td>5.167</td>
<td>0.633</td>
<td>.540**</td>
<td>.464**</td>
<td>.408**</td>
<td>.595**</td>
<td>.515**</td>
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<td>.637**</td>
<td>.567**</td>
<td>.318**</td>
<td>.358**</td>
<td></td>
</tr>
<tr>
<td>ESG</td>
<td>5.107</td>
<td>0.630</td>
<td>.422**</td>
<td>.612**</td>
<td>.499**</td>
<td>.583**</td>
<td>.560**</td>
<td>.737**</td>
<td>.637**</td>
<td>.483**</td>
<td>.423**</td>
<td>.487**</td>
<td></td>
</tr>
<tr>
<td>IFDE</td>
<td>4.703</td>
<td>0.749</td>
<td>.367**</td>
<td>.386**</td>
<td>.275**</td>
<td>.507**</td>
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<td>.483**</td>
<td>.171**</td>
<td>.291**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CQIV</td>
<td>5.224</td>
<td>0.474</td>
<td>.383**</td>
<td>.507**</td>
<td>.510**</td>
<td>.236**</td>
<td>.440**</td>
<td>.571**</td>
<td>.318**</td>
<td>.423**</td>
<td>.171**</td>
<td>.632**</td>
<td></td>
</tr>
<tr>
<td>SQIV</td>
<td>5.003</td>
<td>0.501</td>
<td>.378**</td>
<td>.636**</td>
<td>.608**</td>
<td>.409**</td>
<td>.439**</td>
<td>.544**</td>
<td>.358**</td>
<td>.487**</td>
<td>.291**</td>
<td>.632**</td>
<td></td>
</tr>
</tbody>
</table>

*Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).
### Table 4. Correlation Analysis between TQM Practices and Innovation Performance

<table>
<thead>
<tr>
<th></th>
<th>Speed of new product introduction</th>
<th>Product innovativeness</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pooled Sample</strong></td>
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<td>SQIV</td>
<td>.480*</td>
<td>.321</td>
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</table>
were found not to significantly correlate with either indicator of innovation performance.

Next, we examine the correlation by countries, and the results are summarized as follows:

1) For German plants, only one significant correlation was found between Housekeeping (HSKP) and Product Innovativeness.
2) For Italian plants, only one significant correlation was found between Interfunctional Design Efforts (IFDE) and Speed of New Product Introduction.
3) For Japanese plants, all TQM practices except Supplier Quality Involvement (SQIV) strongly correlate with Speed of New Product Introduction, and eight among eleven TQM practices except Feedback (QSFB), Employee Suggestions (ESG), and Supplier Quality Involvement (SQIV) show a strong correlation with Product Innovativeness.
4) For Korean plants, five TQM practices – Feedback (QSFB), Preventive Maintenance (PVMT), Small Group Problem Solving (SGPS), Interfunctional Design Efforts (IFDE), Supplier Quality Involvement (SQIV) were found significantly correlated with Speed of New Product Introduction, while only one practice Top Management Leadership for Quality (TMLS) was found significantly correlated with Product Innovativeness.
5) For US plants, none of TQM practices were found to significantly relate with either indicator of innovation performance.

In summary, the relationships between TQM practices and innovation performance in terms of Speed of New Product Introduction and Product Innovativeness appear to be weakest for US plants, stronger for European plants (Germany and Italy) by having TQM practice correlated with either innovation performance indicator, and strongest for Asian plants (Japan and Korea) where both innovation performance indicators were found to be correlated with a set of TQM practices. The results suggest the high possibility

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**Table 4. Correlation Analysis between TQM Practices and Innovation Performance (continued)**

<table>
<thead>
<tr>
<th>United States</th>
<th>Speed of new product introduction</th>
<th>Product innovativeness</th>
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</thead>
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*Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).
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<th>Speed of New Product Introduction</th>
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of strong impact of TQM practices on innovation performance indicators for pooled sample and some country samples such as Japan, Korea, Germany, and Italy.

We then proceed to conduct regression analysis on innovation performance for the pooled sample, using four dummy variables representing four countries: GER (Germany), ITA (Italy), KOR (Korea), and US (the United States). The results are presented in the Table 5, and we use a significance level of 10% to analyze the results.

As far as Speed of New Product Introduction is concerned, we found significant differences between Germany and Japan in the impact of Interfunctional Design Efforts (IFDE), and between US and Japan in the impact of Small Group Problem Solving (SGPS). Also, a marginally significant difference between Italy and Japan in the impact of Top management leadership for quality (TMLS) was observed.

As far as Product Innovativeness is concerned, it is observed that significant differences exist between Korea and Japan in the impact of Housekeeping (HSKP), and between Germany and Japan in the impact of Customer Involvement (CQIV).

The results suggest the significant differences of TQM practices in determining innovation performance between five countries. To confirm this statistical evidence, we first conduct regression analysis for the pooled sample, using TQM practices as independent variable and each innovation performance indicator as dependent variable. We then apply the same model to five sub-samples divided by countries: Germany, Italy, Japan, Korea and the United States. Furthermore, to compare these regression models and examine whether the relationship between TQM practices and innovation performance hold across countries, the Chow test is performed by calculating the F-statistic.

\[
F \text{ statistic} = \frac{(RSSR - \sum_i SSR_i) / k}{\frac{\sum_i SSR_i}{n - i \times k}}
\]

where
\[
RSSR \text{ is the sum of squared residuals from a linear regression of the pooled sample,}
\]
\[
SSR_i \text{ is the sum of squared residuals from a linear regression of sub-sample } i,
\]
\[
i \text{ is the number of subgroup,}
\]
\[
k \text{ is number of independent variable, and}
\]
\[
n \text{ is number of total observations.}
\]

The results of regression and the Chow test for each indicator of innovation performance are presented in Table 6 and Table 7. At the 10% level of significance, our findings can be summarized below.

When Speed of New Product Introduction is taken as innovation performance indicator, we found that it was significantly explained by Small Group Problem Solving (SGPS) and Interfunctional Design Efforts (IFDE) for German sample, and by Preventive Maintenance (PVMT), Housekeeping...
### Table 6. Regression Analysis of Speed of New Product Introduction

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<th></th>
<th>Germany</th>
<th>Italy</th>
<th>Japan</th>
<th>Korea</th>
<th>United States</th>
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<th>Chow test</th>
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<td>(.588)</td>
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<td>-.314</td>
<td>(.379)</td>
<td>-.258</td>
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<td>.409</td>
<td>(.148)</td>
<td>.272</td>
<td>(.299)</td>
<td>.068</td>
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<td>(.366)</td>
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<td>(.702)</td>
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<td>(.718)</td>
<td>-.104</td>
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### Table 7. Regression Analysis of Product Innovativeness

<table>
<thead>
<tr>
<th></th>
<th>Germany</th>
<th>Italy</th>
<th>Japan</th>
<th>Korea</th>
<th>United States</th>
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<th>Chow test</th>
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<tr>
<td>R</td>
<td>.642</td>
<td>.473</td>
<td>.711</td>
<td>.753</td>
<td>.665</td>
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<td>R²</td>
<td>.433</td>
<td>.224</td>
<td>.506</td>
<td>.567</td>
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<td>Adjusted R²</td>
<td>.164</td>
<td>-.345</td>
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<td>.169</td>
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<td>F and p</td>
<td>1.661</td>
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<td>-.328</td>
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<td>(.217)</td>
<td>.139</td>
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</table>

473
(HSKP), Employee Suggestions (ESG), and Interfunctional Design Efforts (IFDE) for pooled sample. Most predicting factors exhibit positive sign, suggesting that the hypothesis H1a should be partially accepted and we could state that some of TQM practices have a positive impact on Speed of New Product Introduction.

When Product Innovativeness is taken as innovation performance indicator, we found that it was significantly explained by Housekeeping (HSKP) and Customer Involvement (CQIV) for German sample, by Housekeeping (HSKP) for Korean sample, and by Task-related Training for Employees (TRTE) (marginally significant) and Supplier Quality Involvement (SQIV) for pooled sample. Though Housekeeping (HSKP) has a positive impact, the sign of the predicting factors are mixed for both German sample and pooled sample. Thus, we could not accept the hypothesis H1b.

Hypothesis H2 is tested through the Chow test. The results indicate the significant differences in the determinants of Speed of New Product Introduction (F=4.487, p<0.01) and Product Innovativeness (F=3.899, p<0.01) across countries. Therefore, we accept the hypothesis H2 and state that the relationships between TQM practices and innovation performance are different across countries.

5 Discussion and Implications

The aim of this study is to examine the relationship between individual TQM practices and innovation performance across five industrialized countries. The correlation and regression analyses between each of the eleven TQM practices and a couple of innovation performance indicators are employed. The results provide strong support for the notion of the quality foundation which supports fast product innovation [9]. Although the positive TQM-innovation relationship has been demonstrated in a few previous studies, comparison of such a relationship among countries was lacking. This study found that significant difference in the way of TQM to affect innovation exists across countries, supporting the “culture-specific” perspective.

Hypothesis H1 states that TQM practices have a positive impact on innovation performance. We found that this hypothesis is partially supported: TQM shows a positive impact on of Speed of New Product Introduction, but a mixed impact on Product Innovativeness. Globally speaking, organizations which keep the workstation clean and well organized, improve equipment performance, and encourage the cooperation between functions to facilitate the new product introduction process, would enjoy a benefit of faster product innovation. However, encouragement of employee suggestions would yield a negative impact on speed of new product introduction on a global basis. A careful scrutiny of regression models for country-wise samples reveals that the
The impact of employee suggestions is actually insignificant. This might be due to the fact that employee suggestions which are mainly collected from the workers are more concerned with how to make the developed products to be more effectively and efficiently produced, rather than focus on ideas regarding development of new product. As far as Product Innovativeness concerned, maintaining a work-force with cutting edge skills and abilities through training would have marginally significant benefit, but involving supplier for quality improvement is risky in that it would hinder the innovativeness of product. The plausible explanation for the negative impact of supplier quality involvement is that the innovative idea of new product would leak to the company’s competitors which share the same supplier. Thus, companies are suggested to develop and maintain a long-term strategic relationship with their suppliers to reduce this negative effect. Furthermore, Housekeeping (HSKP) emerges as a predicting factor for Product Innovativeness. However, this effect appears to be contingent on national situation such as Korea and Germany.

In addition, statistical results reveal the significant differences in the impact of TQM practices on innovation performance among five countries. For example, looking at Speed of New Product Introduction, it is observed that Japanese plants are superior to Italian plants in the impact of Top management leadership for quality (TMLS), to German plants in the impact of Interfunctional Design Efforts (IFDE), and to US plants in the impact of Small Group Problem Solving (SGPS). The similar comparison results are also found on the impact of TQM practices on Product Innovativeness. Japanese plants are superior to Korean plants in the impact of Housekeeping (HSKP), and to German plants in the impact of Customer Involvement (CQIV). The Chow test results furthermore confirm the different relationship between TQM and innovation across countries. The differences in determinants of innovation performance across countries indicate that TQM-innovation relationship is largely dependent on the socio-economic situation, technological environment, and national culture.

This study generally support the notion that TQM could have a positive impact on innovation, but this relationship is dependent on specific indicator of innovation performance and subject to the influence of specific national situation. Prajogo and Sohal [25] noted that “TQM was originally intended for realizing quality performance; innovation performance could then be considered as the ‘unintended’ result of the implementation of TQM practices”. This finding is encouraging for managers who are considering to leverage quality foundation established from the past quality effort to facilitate other strategic thrusts. Even though TQM may not be sufficient for innovation, it is at least a necessary condition. Those organizations which fail to keep the TQM capability but rush to market with a new product would not capture the benefit of their innovation effort eventually.
6 Limitations and future research

It is important to view this study in the context of its limitations. First, this study suffers the generic limitations for any empirical study of such nature. Although the respondents varied by scale, this study relies on the perceptions of the respondents to operationalize the survey instrument. This may have introduced bias into the data, which could cause potential concerns regarding generalizability, reliability, and validity. Another limitation is that data was gathered from a small number of manufacturing plants in each country. The expansion of survey population would be helpful for future study. The other problem is the multi-collinearity where the independent variables are correlated each other. This problem has been encountered in many empirical studies on quality management such as [10]. This is because of the existence of interaction between quality practices.

While this study has contributed to the body of knowledge about the relationship between TQM and innovation, we suggest that the following areas could further enhance the understanding about this relationship. First, while this study primarily focuses on the relationship between TQM practices and product innovation, future study can also examine the relationship between TQM practices and process innovation from an international perspective. Second, an examination of the potential effects of contingency factors on the proposed framework could also provide a fruitful field of research endeavor. Contingency factors such as environmental uncertainty, organizational culture, and organization’s strategy can be investigated. Third, it would be very valuable if future international study on TQM-innovation relationship could include nations not in this study.

7 Conclusions

This paper conducts an international comparison study on the relationship between TQM practices and innovation performance. Two indicators of innovation performance – Speed of New Product Introduction, and Product Innovativeness are examined. The results indicate the positive relationship between TQM practices and Speed of New Product Introduction, but mixed result for the relationship between TQM practices and Product Innovativeness. In addition, the way in which TQM practices affect innovation is significantly different across countries. Organizations are encouraged to take advantage of ever-implemented TQM as a solid foundation to achieve higher speed of new product introduction. However, the influence of “cultural specificity” is needed to be considered. Future studies in this area would be very valuable.
8 Acknowledgments

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References

Marketing
When does price matter in green product preference?

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Abstract

This conceptual paper aims to provoke thoughts and responses from both marketers and consumers on ‘Green price issues’. The study will investigate the effect of price differences between green and non-green products on green product preference, and also aims to examine the role of moderators affecting the relationship between price and degree of green product preference. This proposition is a crucial issue to study and is based on careful and rigorous review of the relevant literature. Several empirical studies were conducted by marketing gurus, and practitioners experienced in green marketing issues.

The key challenge for marketers is to gain insight in consumers’ perception of both the emotional and social benefits from “Green price”. Future green marketing research should extend its analysis to the emotional and social benefits associated with green quality and environmentally responsible consumption behavior. This proposition is not based on a specific study, but rather expresses a considerable conceptual model which is rigorously grounded in literature.

The propositions and conclusions of this paper provide the basis for an essentially valuable marketing strategy for marketers and practitioners; those who want to strengthen the competitive advantage in their market place for green products and services. The value of this study is to designate the role of emotional and social attributes as moderators which up until this point have received little attention in respect to an in-depth relationship between price and degree of green product preference. In the future, ‘Green marketing’ will be an inevitable issue for the marketer and researcher.

Keywords: Green product preference, Green price,

Introduction

Green environmental issues and marketing literature regarding the growth of green consumerism have been of interest by many scholars and practitioners during the last decades (Jos Bartels, 2010). Because of the results of world climate change over the recent years, the environmental degradation of our planet is of serious concerns today by countries, companies, and consumers. Furthermore, environmental concerns have provided the corporate pursuit of green marketing strategies (Valerie and Deborah, 2011). In the study by
the American Marketing Association and Fleishman-Hillard on communication professionals, it was found that “forty-three percent expect their companies to increase marketing of sustainability programs and efforts” (Frank, 2009). Paco and Raposo (2010) also stated that if the companies do not react to the ‘green challenge’ with environmental products, they may risk losing some consumers’ credibility, especially those consumers who are more worried about environmental issues. Therefore, the effective improvement of green products is essential in order to achieve successful environmental strategies and to enhance companies and economies towards environmental sustainability (Pujari et al., 2003).

The higher cost and increased complexity in the production process of green products compared to non-green products are factors that create a difference in attitude perception and product preference among consumers, especially in the stage of purchase decision making. As Royne et al. (2011) mentioned, green products are often more costly to manufacture than less eco-friendly goods and simply more expensive for consumers to purchase.

According to many studies on the green product price and consumer behavior, it was found that most consumers are willing to pay a high price for green products or substitute for less environmentally harmful products (Gerpott and Mahmudova, 2010; Gilg, 2005; Cason, 2002; Prem et al., 1993). However, D’Souza et al (2007) argued that the green product quality becomes the factor that some consumers are reluctant to compromise with, even though they are willing to pay more for an eco-friendly product. Therefore, research in consumer’s green product preference becomes even more of a consideration, and this needs further examination in the situation that consumers have to pay a higher price for the green goods rather than the competing non-green goods while the quality or functional attributes of both goods are the same.

This leads to the research question of whether price really have an effect on the degree of green product preference. If it does, at what level? In addition, what are the underlying factors that lead consumers to be less price sensitive of green products or be willing to pay more for green products?

Therefore, the objectives in this study are twofold. First, this paper aims to investigate the effect of price difference between green and non-green products on green product preference. Second, the study aims to examine the role of moderators in affecting the relationship between price and degree of green product preference.
Proposed Model

![Proposed Conceptual Model Diagram](image_url)

**Figure I: The proposed conceptual model of moderating effects of the perceived emotional benefits of green products and social attributes on price and degree product preference.**

This conceptual paper adopts pricing models from Goldsmith and Newell (1997) and Goldsmith et al. (2005) to investigate the impacts of price difference on green product preference context. We also adopt concepts of emotional attribute from Patrick and Vanessa (2008) and primary social attribute from Ek and Söderholm (2008) to examine the underlying factors that impact the relationship between price difference and degree of product preference; therefore, this conceptual model is proposed as shown in Figure I. Emotional attribute and primary social attribute moderate the relationship between price and degree of green product preference.

**Literature Review and Propositions**

1. **Price and consumer product preference**

   According to the recent study commissioned by Green Seal and EnviroMedia Social Marketing conducted during the recent recession, this study found that “four out of five people said they were still buying green products despite the recession and higher costs”
(Progressive Grocer, 2009). Furthermore, Shaharudin (2010) also mentioned that price is not a main factor in food purchases as long as organic food can deliver more nutritional value than the ordinary conventional food in the market. Surprisingly, research from Gerpott and Mahmudova (2010) revealed that at least in Germany, very positive attitudes of the population towards environmental issues do not necessarily translate into a willingness to pay a considerable mark-up for green electricity. In addition, Gilg (2005) stated that consumers become price and quality sensitive when it comes to ‘buying green’. This evidence from the literature leads to the following research question; “Does the price really matter when buying green products?”

1.1 Price

As stated in the literature review, price is comprised of two major factors. First, “price and consumer perceptions” relates to general information in terms of the significance and role of price in consumers’ behavior and decision making. Second, “price difference and consumer perceptions” which were emphasized in this study, especially the concepts of price acceptability, price threshold, reference price, and price sensitivity.

1.1.1 Price and consumer perceptions

According to O'Cass and Lim (2002a), customers evaluate products, services, and brands by using price as the main factor. This factor plays an important role on purchase decision making. Similarly, Monroe (1984) stated that price was considered as a “give” factor that people have to sacrifice in order to “get” the product/service. According to Lichtenstein et al. (1993, p. 234), “The pervasive influence of price is due, in part, to the fact that the price cue is present in all purchase situations and, at a minimum, represents to all consumers the amount of economic outlay that must be sacrificed in order to engage in a given purchase transaction”. Recent studies also illustrate that price, as an extrinsic cue, was even more important than country of origin and brand in purchasing fast-moving consumer products (Ozretic-Dosen et al., 2007).

From previous research it has been noted that price plays two different roles in the purchasing of a product; essentially the positive and negative role (Agarwal and Teas, 2001; Dodds and Monroe, 1985; Erickson and Johansson, 1985; Lichtenstein et al., 1993). Positive role of price represents price as a quality indicator of product/service. Consumers expect that the high price means high product quality and vice versa (Agarwal and Teas, 2004; Dodds,
Monroe, and Grewal, 1991; Hansen, 2005). “Price is thought to impact quality because high quality products generally cost more to produce than low quality products and competitive pressures limit a firm’s opportunities to charge high prices for low-quality products” (Agarwal 2001, p. 2). The relationship between price and quality can occur in a reciprocal direction. For example, consumers who pay for high-priced products, think they will also receive high quality products by paying a higher price (Erickson and Johansson, 1985). However, price factor is not only an indicator to present the quality of products, but also portrays the customers’ satisfaction in paying for those products.

In contrast, the negative role of price refers to a monetary sacrifice in purchasing goods (Agarwal and Teas, 2004). This approach designates mainly those consumers who join the price together with their product costs as well as the constraints or risks. Consumers perceive price as a factor they have to sacrifice or give (e.g., money) in order to possess a product or service in return (Monroe, 1984). When consumers make a decision to buy an item or service, price becomes a factor that limits the consumer’s ability to spend money on other products (Agarwal and Teas, 2004). Therefore, it is important that consumers manage their available budget over alternative items and services in order to maximize the utility (Erickson and Johansson, 1985). As a result, consumers tend to apply both positive and negative roles of price in order to make their purchase transaction. Although consumers perceive price as a symbol of the product/service quality by associating higher price with higher quality (positive role of price) (Dodds et al., 1991), negative factors such as economic interpretation and constraint factors of price also have an influence on the consideration of behavioral intention such as purchase decision making (Erickson and Johansson, 1985). This shows that a higher price tends to have a negative impact on consumers’ purchase (Dodds et al., 1991; Lichtenstein et al., 1993). Consequently, when making the purchasing decision, consumers not only define the utility, benefit, and quality they will gain from the product/service, but also price as a significant constraint which will affect their budget and the chance to purchase other things in the future.

1.1.2 Consumer perceptions towards price difference

Generally, when consumers decide to purchase a product/service, they will compare the price with different available brands in order to get the benefits from their purchase and minimize risks and constraints (budget) in acquiring the product/service. Consumers generally seek a fair or acceptable price range (Homburg et al., 2005; Maxwell, 1995; Ofir
that makes them feel they will receive the maximum benefits of the product/service when they do purchase. In order to study the impact of perceived price difference on consumers’ brand perception–purchase intention relationship, several price concepts can be used.

**Price acceptability, price threshold, and reference price**

Price acceptability means “a judgment of price based on a comparison of the price cue to a range of acceptable prices stored in memory” (Lichtenstein 1988, p. 244). Consumers adopt an acceptable range of prices they are satisfied with in paying for a product/service (Cummings and Ostrom, 1982). Acceptable price for consumers is the price that drops within the range between the consumer’s upper and lower price thresholds (Kalyanaram and Little, 1994; Kalyanaram and Winer, 1995). Consumers know prices below the lower threshold either as a bargain point (Kalyanaram and Little, 1994) or as low in quality; in contrast, they also understand prices above the upper threshold as either a resistance point (Kalyanaram and Little, 1994), expensive, or a poor value for the money (Ofir 2004). On the other hand, minor changes in price within the area between the lower and upper price thresholds may not affect the consumer choice (Kalwani and Yim, 1992; Kalyanaram and Little, 1994; Kalyanaram and Winer, 1995). Moreover, the level of customer acceptable price depends on certain factors; for instance, price-quality inference, price consciousness, product involvement, price knowledge, frequency of purchase, brand loyalty, and purchasing satisfaction (Huber, Herrmann, and Wricke, 2001; Kalyanaram and Little, 1994; Lichtenstein,Bloch, and Black, 1988; Sirvanci, 1993).

According to the findings about consumers’ evaluations on the price of a product or service, the authors mention that the consumer needs to know a reference price as a cue for evaluating the price of a market product/service. The consumers’ reference price consists of two main forms—internal reference and external reference price (Mayhew and Winer, 1992; Mazumdar and Papatla, 2000). Internal reference price refers to the price information derived from the consumers’ memory of their purchasing experiences, while external reference price is defined as the price information created during the consumers’ purchasing process (e.g., consumers survey the prices of brands on the shelf while shopping and they compare their favorite brand price based on this information) (Campo and Yagüe, 2007; Mazumdar and Papatla, 2000). In general, consumers will consider the price of products/services below their reference price as a gain while prices higher than their reference price as a loss (Han et al.,
2001; Kalyanaram and Little, 1994). Also, consumers are more sensitive to perceived loss
than to perceived gain (Kalyanaram and Little, 1994; Kalyanaram and Winer, 1995).
Nevertheless, changes in price or price differences have an influence on consumers’
perception and product/service evaluation when price differences exceed consumers’ upper or
lower price threshold (Han et al., 2001; Sirvanci, 1993).

1.1.3 Price sensitivity

Price sensitivity is described as “an individual difference variable describing how
individual consumers react to price levels and changes in price levels” (Goldsmith and
Newell, 1997). This concept is closely related to the price elasticity concept. The main
difference between price elasticity and price sensitivity is the concept of price elasticity
emphasizes the aggregate or market level as the unit of analysis, whereas the price sensitivity
concept emphasizes the individual level. The study of the price sensitivity approach is mainly
to investigate how individuals or a group of consumers react to the price change (Cummings
and Ostrom, 1982; Munnukka, 2005; Ramirez and Goldsmith, 2005).

There are two major sources of variation in price sensitivity – product variation and
purchaser variation (Sirvanci, 1993). The product variation factor is explained as the
difference in product factors such as the actual prices of the products and the perceived
essentiality of the product. For example, price sensitivity has a positive relationship with
higher priced grocery products and a negative relationship with the perceived product
essentiality (Sirvanci, 1993).

The purchaser variation factor refers to shopping characteristics and demographics of
the purchaser. Thus, the individual factors are investigated in this approach together with the
degree of price sensitivity (Goldsmith et al., 2005; Goldsmith and Newell, 1997; Shimp,
Dunn and Klein, 2004). This means that consumers can be divided into two main groups –
price-sensitive consumer and price-insensitive consumer. The concepts of price-sensitive or
high price–sensitive consumers are attributed to those who react strongly to the price change.
This group of consumers will create a higher demand when the price is reduced and
demonstrate much less demand when the price goes up. In contrast, price-insensitive or low
price–sensitive consumers rarely react when the price changes in either an increasing or a
decreasing direction (Goldsmith and Newell, 1997). However, price-sensitive consumers and
price-insensitive consumers are satisfied to purchase the same product/service at higher
prices and more willing to purchase the product/service when the price increases (Goldsmith et al., 2005; Shimp et al., 2004).

There have been many previous studies investigating various individual difference factors that for different reasons play an important role in transactions by sensitive and insensitive consumers regarding price. For example, it was found that consumers’ price sensitivity has a negative relationship with consumer innovativeness (Goldsmith et al., 2005; Goldsmith and Newell, 1997; Munnukka, 2005), consumer satisfaction (Anderson, 1996), brand loyalty (Choi and Miracle, 2004), product involvement (Ramirez and Goldsmith, 2009), consumer participation (Hsieh and Chang, 2004), brand credibility, and perceived brand quality (Erdem, Swait and Louviere, 2002). Consumers’ price sensitivity also has a positive relationship with uncertainty (Erdem et al., 2002). Demographic and regional factors have an affect on the difference in consumers’ price sensitivity. For example, price sensitivity is described to be higher among consumers in Europe than consumers in the United States (Erdem, Ying and Valenzuela, 2004).

1.2 The impact of price on consumer’s green product preference

A ‘green product’ is defined as a product designed to reduce its environmental impact during the product’s entire life-cycle (Vito et al., 2009). ‘Green or environmentally-friendly products’ are also referred to as products "that will not pollute the earth or deplete natural resources, and can be recycled or conserved” (D&B Reports 1990). Moreover, green products need to focus on substantial achievement in minimizing environmental impact because these kinds of products may also have to incorporate strategies of recycling, recycled content, reduced packaging or toxic material reduction (D’Souza et al, 2007) (Wasik J., 1996). As the European communities (2001b) have underscored, the concept of a ‘new growth paradigm and a higher quality of life, through wealth creation and competitiveness’ has become a significant aspect of green products. Therefore, it can be concluded in this study that ‘green products’ are defined as environment friendly goods which can be recycled and non-pollute.

When the consumer considers purchasing a product and the price and quality of green and non-green products are equal, the consumer will choose the green product due to its additional environmental benefit. We therefore postulate the following first proposition:

P 1: Assuming equal price and quality, purchase intention towards a green product will be higher than purchase intention towards a non-green product.
From literature review, it can be stated that green products have a higher cost compared to non-green products. This is because in order to produce green products to meet the equivalent quality standards of non-green products, a higher cost is needed. Consequently, the higher cost of manufacturing green products leads to a higher price. Moreover, consumers considered ‘price’ as the main factor for their purchasing decision. Therefore, in the second proposition we propose that:

P 2: Assuming equal quality, purchase intention towards green product will be diminished, and purchase intention towards non-green product will be enhanced, as price of green product increases relative to the price of non-green product.

2. Moderating roles of emotional attributes and social attributes

In the past two decades, many studies focus on the relationship between price and quality. The most common such definition of value is the ratio or trade-off between quality and price (e.g., Chain Store Age, 1985; Cravens, Holland, Lamb & Moncrieff, 1988; Monroe, 1990) which is a value-for-money conceptualization. In addition, other authors have also suggested that viewing value as a trade-off between only quality and price is too simplistic (Schechter, 1984, Bolton & Drew, 1991), and other attributes should be accounted for. Researchers have described three factors of variables that seem to be influential in classifying the green consumer. These are environmental and social values, socio-demographic variables and psychological factors. (Andrew Gilg et al., 2005). Furthermore, Jillian and Geoffrey (2001) observed that the components of perceived value seem to be differentially weighted for different consumers. Their scale illustrated that consumers assess products not only in functional terms of expected performance, value for money and versatility, but also in terms of the enjoyment or pleasure derived from the product (emotional value) and the social consequences of what the product communicates to others (social value). However, previous studies have paid limited attention on both the emotional benefits and social benefits in respect to the relationship between price and degree of green product preference. And there has been relatively few empirical research to further develop an in-depth understanding of this concept.

Therefore, this study will examine emotional and social attributes as key factors that moderate the relationship between price and degree of green product preference.
2.1 Emotional attributes

Some scholars who found that emotional attributes played an important role in the purchasing of green products by consumers (Ramo & Mercededes, 2009; Patrick & Vanessa, 2008; Chaudhuri, 2001; 1997). Ramo & Mercededes (2009) stated that the emotional response of consumers with respect to a product can be a key point in a purchase decision. Chaudhuri (2001) also said that emotional factors account for an essential and substantial portion of the variance in perceived risk even after the effects of rational determinants (perceived differences between alternatives) has been taken into account. Furthermore, research of emotion prototypes demonstrated from two super ordinate constructs (positive and negative affect) that five basic emotion levels (joy, love, sadness, anger, fear) are underlying dimensions of positive and negative effects (Shaver et al. 1987). Moreover, empirical research dealing with the individual willingness to pay for green energy claimed people tend to feel better when going green. Thus, in order to feel good about the transaction, they are willing to pay a premium price for green energy brands, and not because of primary concerns about the objective environmental impact of their decision (Patrick & Vanessa, 2008).

Chaudhuri (1997, p 82) defines Consumption emotion as “consumers’ knowledge by acquaintance of products and services during the consumption experience”. So consumption emotion can be accessed in terms of feelings generated in consumers’ during the usage/consumption experience and these feelings can be both positive (joy, love) and negative (fear, disgust) (Holbrook, 1986). Surprisingly, Chaudhuri’s (1997) study revealed that negative emotions accounted for more than half the variance in consumption emotion.

Furthermore, Gutman (1982) had described six concepts in the chain consisting of: concrete attributes, abstract attributes, functional consequences, psychological consequences, instrumental values, and terminal values. Functional consequences are the direct benefits that consumers gain from the products or services they consume, and they are linked to their attributes, and Psychological consequences are those of a more personal, social, or intangible nature (Gutman, 1982).

In terms of green product preference emotional factors can refer to feelings (both positive and negative), senses, knowledge, and cognition which all have an influence on...
product preference of the consumer. The literature has supported the concept that a perceived
high emotional attribute will enhance consumers’ willingness to pay a premium price for
green products in order to satisfy their feeling fulfillment. We then state the third proposition as:

P3: Assuming equal quality of green versus non-green products, perceived high
emotional benefits of green product will diminished the impact of price
difference on degree of green product preference.

2.2 Social attributes

The social factor is another substantial force driving consumers in their degree of
product preference. Gotschi et al. (2010) stated that primary socialization is essential in
creating social norms and shaping behavior. In addition, the scale from Jillian and Geoffrey
(2001) illustrated that consumers assess products not only in terms of functional attribute,
but also emotional value and the social consequences of what the product communicates to
others (social value). Felicity Small (2009) also mentioned that it is crucial for the marketers
to emphasize the social meaning of a product because customers expect to get a specific
desired response, hence they are willing to pay for a product that helps them to beneficially
present their self and social image. According to Ek and Söderholm (2008), consumer
assessments of family members’ and friends’ opinions on green energy sources may augment
this social image and the adoption of green energy because consumers tend to align their own
environmental behaviors with preferences of their close social contacts (positive valuation of
normative conformity). In one study ‘social endorsement of green electricity use’ was
identified as the second most important determinant of willingness to adopt green electricity
(Gerpott and Mahmudova, 2010).

The literature regarding socialization had divided this concept into two categories –
primary socialization and secondary socialization. First, ‘primary socialization’ is defined as
the norms and values experienced at home (Gotschi et al., 2010), and is important in forming
social norms and shaping behavior. In addition, Zigler and Child (1969) defined ‘primary
socialization’ as the process by which an individual’s initial world view is acquired.
Futhermore, Schafer (2002) has noted that one element of primary socialization, the role
models of important people or changes in life (e.g., childbirth, sickness), is included as a
significant determinant in the changing of attitudes and behavior towards organic food. The research from Gotschi et al. (2010) also revealed that high levels of knowledge or experiences in school cannot profoundly change attitudes and behavior as they become formed at home during early childhood. Whereas ‘secondary socialization’ takes place outside the home and this is where children and adults learn how to act in a way which is appropriate for the situations they are in (Lisa, 1989). However, secondary socialization is considered to be less important than primary socialization in shaping behavior (Gotschi et al., 2010).

Therefore, this paper viewed that primary socialization is a considerable attribute to moderate the relationship between price and degree of green product preference. We therefore state the following propositions:

P4a: Assuming equal quality of green product and non-green product, perceived high primary socialization benefit will diminish the impact of price difference on degree of green product preference.

P4b: Assuming equal quality of green product and non green-product, perceived high secondary socialization benefit has no impact on the relationship between price difference and degree of green product preference.

Methodology

The quasi experiment will be conducted through this research by using questionnaire survey. This method is also suitable for a study investigating the roles of price such as price sensitivity because this type of study generally requires the actual purchasing experience from either the test market or a controlled experiment (Goldsmith and Newell, 1997). The participants in this research will be university students because the use of a student sample is also beneficial in establishing the homogeneity of respondents.
Implementations and Contributions

At the present time, many marketing scholars and practitioners are paying more attention to green concerns from the perspective of both consumer and manufacturer. As the literatures regarding product pricing have stated; consumers these days still trade-off between what they have to ‘pay for’ and what they will ‘get’ from conventional products. Conversely, in terms of green products, most studies revealed that consumers are willing to pay a higher price for the product. Even though consumers have a willingness to pay for the green product at a premium price, only a mere amount of evidence in literatures has shown the preference degree of consumers in both green and non-green products when the price had changed. Moreover, only a limited amount of literature has made an in-depth analysis of the moderating factors, particularly the emotional and social attributes affecting the relationship between price difference and degree of green product preference. Therefore, this proposed study can full-fill this knowledge gap.

The model proposed in this conceptual paper has a potential for managerial implications once empirical tests support the hypotheses, it will send a clear message that marketers who wish to retain their customers and strengthen their marketing competitiveness, need to understand deeply the relationship between price and degree of green product preference and the role of moderators, especially emotional and social attributes. For theoretical contribution, the value of this study is to designate the role of moderators, especially emotional and social attributes are the key factors to moderate the relationship between price and degree of green product preference. Future research also needs to discuss more extensively the quality difference of green product issues, in relation to price and degree of green product preference. This notion is supported by the Grail Research (2009) that stated consumers expect companies to have green products that are superior or at least on par with conventional products.
Reference


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A study on the long-Term collaborative sales contract with considering the risk of price fluctuation for rapidly growing component market

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Abstract. High degree of demand change is one of the important characteristics of rapidly expanding key component market on its growth stage of high-tech industry. Collaboration that includes essential information sharing and core operations coordination is indispensable for achieving efficient SCM and maximizing supply chain profits under those uncertain situations. In this research, in order to improve the accuracy of contract price determination, a coordinated contract method with a coordination system which can do cooperative decision-making for the component supplier and the set maker is proposed. With the exact calculation of the potential risks and information sharing during the price negotiation, the determination of the contract price by the component supplier and the set maker can be supported. We analyze the validity of the coordinated contract method with comparing with the other two contract methods.
1 Introduction

Severe demand change, which includes demand variation and fluctuation from intensified competition or temporary imbalance between supply and demand, is one of the important characteristics of rapidly expanding market. The problematic situations are getting worse and worse in case of key component market on its growth stage of high-tech industry such as smart phone and tablet PC. A product maker could not acquire the profit which was planned before while the input price of components becomes high, and facing the fall of the product price at the same time. On the other hand, with the expansion of the existing component suppliers’ production capacity or the extension of new entries to the component market, the price competition will become intense, which leads to the fall of the component price. Therefore, the expected profits cannot be gained by the component suppliers. Furthermore, a component supplier makes big-ticket investment such as preparing a production line or doing equipment improvement. As a result, such investment may be unrecoverable, and the continuation of the company in this market will also become hard.

In such a component market with price uncertain, it becomes impossible for a component supplier and a product maker to acquire profits stably only with a short-term contract. In order to solve this problem, a component supplier and a product maker usually use the approach which is making a long-term sale and purchase agreement which determines the amount of components and the price beforehand. But it is difficult for a component supplier and a product maker to do the exact calculation of the risks and the prediction of information in such a market. To think about the profits of the whole supply chain, or the profits of a negotiating opponent, it is common to give priority to think the profits itself. Finally, they may lose the chance to obtain more profits during this transaction.

In this research, after modeling the uncertainty of the price fluctuation in a component market and evaluating the potential risks, a coordination system which can do cooperative decision-making for both the two players is proposed.
We verify strengths and weaknesses of the proposed coordination contract method by dynamic simulation with market condition of high demand uncertainty.

2 Key component market and the contracts

2.1 The market environment

Several component suppliers and several product makers are doing the sales transaction of the key components in the market, and the product market also consists of several makers and several retailers. In this research, it is considered that the key components dealing between one of the large suppliers in the supplier group, and one of the large makers in the maker group, in the above-mentioned market environment.

2.2 The sales contracts

The following two kinds of sales contracts are discussed in this research.

< Short-term contract >

There is a merit when this kind of contract to be used. Based on high-precision prediction, components can be bought in without waste. But it is difficult to get enough components which be planned before, and it is also considered that the components may be bought in with a high input price. When component transaction is based on this contract, the long-term uncertainty of the component market price cannot be taken into consideration, decision-making by the players only based on the average of price changing which is be expected before. All of the cycle, the Span and the bucket are defined by this research as one month.

<Long-term contract>

The quantity of component and the price to it are determined beforehand. A supplier produces the determined quantity and supplies it to a maker. Generally, it is carried out by a supplier and a maker with the fixed confidential
relationship. In the situation that nobody knows how the component price will change in the future, it is effective in hedging a risk by using this contract. The cycle, the Span and the bucket are defined by this research as six month, six month and one month.

3 The evaluation index

When negotiate a long-term sales contract, to determine a price, it is necessary to compute a risk when receiving a certain price from the opponent during negotiation, and it is also necessary to calculate the expected profit based on the price. With considering of them, the contract price can be determined.

3.1 The definition of the risk for price determination

In this research, the case that the profit obtained from the current component price is not able to surpass the expected profit is defined as a "loss". Moreover, the loss times its occurrence probability is defined as a "loss value". The concept of the loss value and the expected profit in this research are shown below.

First, we discuss the expected profits. Expected profits refer to the profits which a supplier or a maker can acquire the average profit during the contract period in the future. The expected profits of a supplier and a maker in this research are calculated as follows.
1) Before making the component sales contract with a supplier, since a maker have finished making a sales contract with a sales company about the product transaction, he conjectures the aggregate supply of the product ($\hat{Q}_r$) from market research.
2) Since the aggregate supply of products can be considered as the total demand of the components, so the aggregate supply of a product ($\hat{Q}_r$) is equal to the total demand of component ($\hat{Q}_c$).
3) The average price of component price ($\hat{P}_c$) in the future can be predicted as
the cross point of the total demand curve of the component, and the average supply curve of the component.

The expected profits of a supplier and a maker can be calculated as follows from the average price of the component.

<Supplier>
\[ \hat{\pi}_S = Q_C \times \hat{P}_C \]  

<Maker>
\[ \hat{\pi}_B = Q_B \times (\hat{P}_B - \hat{P}_C) \]  

Fig. 1. The average and distribution of a component price which were assumed

Fig. 2. The concept of the loss value in this research

Fig. 2 shows the concept of the Loss value in this research. The expected profits can be computed from the formula 1 and the formula 2. The case where the low amount of profits occurs on the basis of the assumed profits is defined as "loss". The loss times its occurrence probability is defined as a "loss value".
Fig. 3. The loss evasion effect for a maker while the component price gets boosting.

Fig. 4. The loss evasion effect for a maker while the component price gets falling.

Fig. 3 and Fig. 4 shows the image of the loss evasion effect while the component price gets rising and gets falling. If the profits which be calculated by a proposed price during the price negotiation exceed the average assumption profits, it is possible to become very profitable to the case that the component price gets falling, and it will not become a large loss to the case that the component price gets rising. Though the component price may actually be different from the assumed price, the probability of loss is very low.

3.2 Calculation of the loss value and the expected profit

\( \hat{p}_f \): The forecasted average price of component
\( \hat{q}_f \): The maximum production capability of a supplier
\( p_s \): The product price
\( q_s \): The amount of product sales
While \( \hat{p}_f \) exceeds the average price of component by \( i \) JPY

While \( \hat{p}_f \) becomes \( i \) JPY less than the average price of component

\( p(X) \) : Probability that the phenomenon \( X \) will occur

\( p \) : Contract price

\( q \) : Contract quantity

< The calculation of the loss value of a supplier and a maker >

\[
S_{\text{loss}}(p, q) = \sum_{i=1}^{\infty} [\hat{p}_f \times \hat{q}_f - \{ p \times q + p_m \times (\hat{q}_f - q) \}] \times P(p_m) \tag{3}
\]

\[
M_{\text{loss}}(p, q) = \sum_{i=1}^{\infty} [p \times q + p_m \times (q_s - q) - \hat{p}_f \times \hat{q}_s] \times P(p_m) \tag{4}
\]

< The calculation of expected profit >

The expected profit be considered during price negotiation, can be calculated with the cost required for contract enforcement and the proposal price from the players. This research defined the total sales as the expected profit of a supplier, and the total sales minus maker’s purchasing cost as the expected profits of a maker. The expected profit with cost consideration can be computed as follows.

\( Cost_S \) : The production cost of a supplier

\( Cost_M \) : The production cost of a maker

\( p \) : The proposed price

< Expected profit of a supplier >

\[
\hat{\pi}_S(p, q) = \hat{q} \times \hat{p} - Cost_S - S_{\text{loss}}(p, q) \tag{5}
\]

< Expected profit of a maker >

\[
\hat{\pi}_M(p, q) = q_S \times p_S - p \times q - \hat{p} \times (q_S - q) - Cost_M - M_{\text{loss}}(p, q) \tag{6}
\]

4 The process of price negotiation

Following Fig. 5 shows the process of the price negotiation in this research.
A process is roughly divided into three stages, creation of the initial proposal price, evaluation of the proposal, and create a draft amendment.

4.1 Creation of the initial proposal

After determined the component trading quantity in a certain fixed range with a supplier with considering of the estimated demand curve of the product market, a maker sets up the price which fills its maximum expected profit through price prediction of the component, and makes this price as the initial proposal.

4.2 Evaluation of the proposal

< Evaluation about expected profit >

When the expected profit calculated from the opponent's proposal is less than the minimum expected profit planned before, it shifts to creation of a draft amendment directly, and when the expected profit calculated from the opponent's proposal is the same as the expected profit planned or over the...
expected profit planned, it shifts to the evaluation about the loss value of the proposal.

< Evaluation about loss value >

The loss value of the opponent's proposal is to be calculated, if the loss value is less than its standard loss value, negotiation will shift to an end, otherwise, negotiation will shift to the creation of a draft amendment.

4.3 Creation of a draft amendment

< The case that it shifts from the evaluation about the expected profit >

The proposal nearest to the proposal which fills its minimum profits is to be set up, and the opponent is to be notified.

< The case that it shifts from the evaluation about the loss value >

The loss value which be calculated from the last proposal of the opponent is to be adjusted, and the draft amendment which fills the adjusted loss value is to be set up.

The amendment will become a new proposal. Henceforth, the maker and the supplier propose the price by turns, and do the evaluation and correction each time.

5 The coordination system

5.1 The main role of the coordination system

< Sharing of cost information >

In this research, the coordination system sets the place of negotiation for the two players, and the supplier and the maker transmit a part of cost information which cannot be shared together to the coordination system.

After the coordination system received the reference information about cost, it predicts the variable cost and fixed cost of the supplier and the maker, so as to support the negotiation between the two players.

< Set up the negotiation restrictions >
The coordination system with technical knowledge and experience creates the restrictions of negotiation by considering the result of the loss value and the expected profit which be calculated by the collected information. Based on these restrictions, both the two players begin to negotiate.

5.2 The function of the coordination system in this research

About the function of the coordination system, it can be roughly divided to negotiation support function and information management function. The negotiation support function is a function to support both the negotiation players in order to find a better settlement proposal for each other while negotiation is going on.

It mainly includes setting the rule of negotiation, guidance of the standard of evaluation, evaluation for the contents of a proposal, etc. The information management function is consisted of data collection, database updating, etc., it usually runs before negotiation, or after negotiation.

Table 1 shows the main function and sub function of the coordination system.

<table>
<thead>
<tr>
<th>Function</th>
<th>Main Function</th>
<th>Sub Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negotiation Support</td>
<td>Table-Setting</td>
<td>Set the rule of negotiation, Determine a standard of evaluation, Guidance</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Calculation of an initial negotiation feasible region, Notification</td>
</tr>
<tr>
<td>Informing</td>
<td>Build the information on forecast, Notification</td>
<td>Evaluation of the contents of a proposal, Notification</td>
</tr>
<tr>
<td>Persuading</td>
<td>Setup the restrictions for equal distribution</td>
<td>The guide of the correction direction</td>
</tr>
<tr>
<td>Go-or-Not Deciding</td>
<td>Possibility judgment of an additional round</td>
<td>Shift direction to an additional round</td>
</tr>
<tr>
<td>Information Management</td>
<td>Data Management</td>
<td>Data collection and acquisition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Data updating</td>
</tr>
<tr>
<td></td>
<td>Rule Management</td>
<td>Correction of a negotiation rule</td>
</tr>
<tr>
<td></td>
<td>Logic Management</td>
<td>Correction of the logic of prediction and evaluation</td>
</tr>
</tbody>
</table>
6 The experiment

In this section, we will discuss the experiment design and the result of the experiment of this research.

6.1 Experiment plan

In order to show whether the coordination contract method proposed by this research is effective or not, we compare the following three models with restraining a loss according to the uncertainty of the component market price, acquisition of profit, and distribution of profit.

Contract models:
(1) Simple model (price only)
(2) With loss consideration model (loss value and expected profit)
(3) With coordinator model (coordination system)

Simple model is a model which determines the contract price, conceding to the opponent's proposal in the end without taking the loss and the expected profit into consideration. With loss consideration model is a model with calculating and evaluating the expected profit and the loss value during the negotiation. With coordinator model is a model which is based on with loss consideration model, and makes use of the coordination system during the negotiation process.

The comparison items of numerical simulation were set up as distribution of total profit, profit difference between the supplier and the maker, and the distribution of profit.

6.2 Analysis of results

In the following section we analyze the result of simulation based on simulator developed with STELLA.
Fig. 6. Distribution of total profits between simple model and with loss consideration model

Fig. 7. Distribution of total profits of simple model and with coordinator model

Fig. 8. Profit difference of simple model and with loss consideration model
Fig. 9. Profit difference of simple model and with coordinator model

Fig. 6 and Fig. 7 shows the result of the distribution of total profits of the three models. We can find the variability of simple model is the largest. Although it shows that the variability of with loss consideration model is getting smaller, the average value of the total profit is decreasing. Moreover, it has checked that the average profit of with coordinator is the highest, and the variability of the total profit is also suppressed very much.

Fig. 8 and Fig. 9 shows the result of the profit difference of the three models. The simple model and with loss consideration model, in many cases, one of the two players may gain a lot; on the contrary another one may lose a lot. So the average value of profit difference is very large. However, with coordinator model, both players’ profits are distributed equally and the profit difference is the smallest.

Fig. 10. The profit distribution of supplier and maker with price fluctuation
Fig.10 shows the profit distribution in three models with the low price fluctuation (20%), medium price fluctuation (50%) and high price fluctuation (80%). It shows that the effect of a profit distribution becomes weaker only with considering of loss and expected profit as price fluctuation becomes high. Moreover, it has checked that with coordinator model still has got a great effect on profit contribution as price fluctuation becomes high.

7 Conclusions

In the rapidly growing component market with uncertain price fluctuation uncertain, a long term sale and purchase contract method with coordination system was proposed, and its validity was verified. Firstly we did the definition of the loss value and the expected profit, and showed the method of calculation of the loss value and the expected profit for both the supplier and the maker. Calculation of the expected profit which includes the risk and the cost is carried out during the price negotiation between the supplier and the maker. Secondly, the coordination system which can support the negotiation process for the determination of a contract price was proposed. The role of a coordination system and the whole function of the coordination system were designed. With the coordinated contract method, the supplier and the maker can decide a fair contract price for themselves though the price fluctuation of the component is uncertain.

We compared the model of price only, with loss consideration and with coordinator with average of total profits, profit difference between the supplier and the maker, and the distribution of profit between the two players. It showed that the average of total profits acquired by the supplier and the maker with the coordinated contract method was the highest. With the coordinated contract method, the profit distribution of the supplier and the maker was the most fair. Moreover, we checked that the coordinated contract method was still so effective when the price fluctuation became large.
Reference


The Effect of Firms' Competitive Advantage Creations on Beyond Sufficiency-Economy Consumption Behaviors

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Abstract. This study aim to investigate the relationship between firms’ competitive advantage creations on the beyond sufficiency-economy consumption behaviors. The concept of competitive advantage creation is borrowed from the generic strategy by Porter (1985) comprising cost leadership, differentiation, and focus. The beyond sufficiency-economy consumption behaviors, i.e. materialism, conspicuous, and impulsive consumptions, are derived from the emotional or non-substantive behavior theories. The data was collected from 726 respondents and the hypotheses were tested using the Structural Equation Modeling (SEM). It is found that the differentiation and focus strategy positively related to the three type of the beyond sufficiency-economy consumptions behaviors. The cost leadership, on the contrary, was found to have a negative relationship to the behaviors. The results also showed that the three strategies affect, to the highest degree, the conspicuous behaviors.

Key words: generic strategy, sufficiency economy, beyond sufficiency-economy consumption behaviors, Structural Equation Model (SEM), LISREL

1. Introduction

The 1997 economic crisis, after a decade of sustained economic growth, not only damaged the Thai economy but also the trust in the business conduct and the way that Thai people live their lives. A new paradigm of living, consuming, spending, and doing business was craved for. Rushing to the prosperity with no strong foundation at the individual level might scour the economy to its fragility. People started to review the way of the past and search for a new way of life and business pattern.

The national interest has turned to heed the sufficiency economy philosophy that has been proposed over the past 30 years by King Bhumipol Adulyadej of Thailand.¹⁰⁷ The King has pointed to the philosophy on various occasions. Until recently, however, the complete concept and guidelines have never been
crafted. It could be sensed all over the country and at every level from
government to business and people that the sufficiency economy is permeating
and contemplated to a different degree. Advertising regarding the philosophy is
ubiquitous. The sufficiency philosophy movements spread throughout the
country. To a certain degree, people develop a sense of 'por pieng' or
'sufficient'. Sufficiency economy is on the move.

At the same time, the agricultural and government sectors exerted a
tremendous effort to turn around the economy after its 1997 downturn. The
Thai government adopted the populism policy and was inclined to recoup the
economy via consumption. Many government initiatives, e.g. the One-Million-
One-Village, Government Housing Project (Baan-Ur-Ar-Thon) and the Interest
Free Loan [98] were introduced to induce personal consumptions at the rural,
individual level. The programs served the purpose only too well. During 2004-
2006, the saving rate diminished from 15.8% to 6.9%. The Bank of Thailand
reported that during the same period personal loan increased 25% (1,571 –
1960 million baht).[4] The economy did regain the centrifugal force, but at the
expense of personal financial risk.

The business sector also strived to survive. Competition is severe when the
economy goes down and even worse when it picks up. Competitive advantage,
although originated from the three types of Porter's generic strategies [82], i.e.
cost leadership, differentiation, and focus, is created in various forms to
achieve one ultimate purpose; to sell to more customers and make more profit.
These strategies even challenge the diminishing marginal utility concept [34] by
inducing additional purchase at the declining utility and full consumption
point.[47] This is one example of beyond sufficiency-economy consumption
behavior. In many cases, consumers are lured to purchase and possess items
that may not be necessary and become overly acquisitive.[75] Both brand
strategy and celebrity marketing influence consumers to emulate the presenters
by using those expensive advertised items.[2] These strategies, although they
bring a lucrative bottom line to businesses, may adversely affect some
consumer who do not fit those products.

Thai consumers of this decade are standing in the middle of a two-way
street, with sufficiency-economy philosophy leading one way and competitive
advantage creation of businesses the other way. Most of the research on
sufficiency economy emphasizes the application of the philosophy at the
individual or community level. Never before has the role of businesses,
although densely surrounding consumers, been explored in relation to how they
affect consumption behaviors. It is, in fact, business activities that people are
continually exposed to and most affect consumption behaviors. This study,
therefore, aims to investigate the effect of competitive advantage creations of
firms on beyond sufficiency-economy consumption. The findings will lead to
useful implications to warn the business sector of a suitable way of
competition, consumer of conscientious purchase, and government of proper policy.

2. Literature Review

2.1 Sufficiency Economy Philosophy

Sufficiency economy philosophy has been known to Thai people for the past 30 years. The philosophy is unanimously accredited to King Bhumibol Adulyad of Thailand, who has undertaken consistent effort to institute the balance of economic growth and the sustainable development of the country. As Medhi Krongkaew [53], one of the leading supporters of the philosophy, explains that the philosophy “...guides the livelihood and behavior of people at all levels, from the family to the community to the country, on matters concerning national development and administration”. The philosophy suggests the observation of the “middle path”, similar to the practice of the middle path in Buddhism philosophy, where the way of life, consumptions, and spending should not exceed the sufficient level. The main idea is that everything should not be excessive or scarce and hence suitable for each person's economic status. The last part connotes the relativity of the implication of the philosophy.[96] Middle path, or moderation, of each person is not identical and differs according to one's status.

In attempt to crystallize and make the concept succinct, scholars try to define the sufficiency economy. Puntasen[84] defines the sufficiency economy as the practice of moderation, integrity, not greed, and not taking advantage of others. A person should be able to make a sustainable living, prudently spend on necessary items according to one's income, and save money to help others. Tantivejakul[106] classified the sufficiency economy into 2 levels, i.e. individual and community. At the individual level, a person should be able to live an untroubled life, properly estimate one's own ability and economic status have freedom, and not be lured into materialism. At the community level, sufficiency economy is the economy that can produce all products necessary to sustain the community and depend least on imported items.

The philosophy of the sufficiency economy becomes clearer after the framework of the philosophy is developed and generally accepted. The framework consists of 3 principles and 2 conditions.[43] The 3 principles are moderation, reasonableness, and self-immunity. Figure 1 displays the 3-principle and 2-conditions framework of sufficiency economy. The three interlocking elements represent the three principles of the: moderation, reasonableness and self-immunity. These three principles are interconnected and interdependent.
Moderation conveys the idea of people living their lives on the middle path, not at the extremes. People should rely on themselves without overindulgence. This way of living occurs when people have reasonable, accumulated knowledge and experience, along with analytical capability, self-awareness, foresight, compassion and empathy. They must be aware of the consequences of their actions, not only for themselves but also for others. The third principle, self-immunity, refers to the ability of people to protect themselves against any external turbulence and to cope with events that are unpredictable or uncontrollable. It implies a foundation of self-reliance, as well as self-discipline. Apart from these three components, two other conditions are needed to make the principles of sufficiency economy work: knowledge and morality. Knowledge encompasses accumulating information with insight to understand its meaning and the prudence needed to put it to use. Morality refers to integrity, trustworthiness, ethical behavior, honesty, perseverance, and a readiness to work hard.[69]

Figure 1: The sufficiency economy framework

![The Sufficiency Economy Framework](source: Thongpake (2006))

After the 1997 economic crisis, the sufficiency economy principles have gained a significant interest in academic research. The research pertaining to the sufficiency economy can be categorized into 7 groups. The first group of research focuses on the applications of the philosophy.[14, 85, 120] The second
group is the research that explores the congruence of the sufficiency economy with organizations and communities.[95, 99] The third group studies the behaviors, of samples, relating to the principles of the philosophy. This group of research intends to explore various aspects of society, e.g. social, culture, economic, and environment that support or obstruct the way of sufficiency economy.[54, 74, 112] The fourth group explore the application of the philosophy on specific problems, e.g. poverty, saving, debt burden, and income management.[18, 49, 102] The fifth group focuses on attitude towards, opinion about, awareness of, and knowledge about the philosophy of sufficiency economy.[16,101] The sixth group concerns the pedagogical methods of the sufficiency economy.[15, 21, 118, 119] The seventh group is the research that collects, develop databases, and synthesize indicators related to the sufficiency economy.[42, 83, 109, 121]

The diversity and amount of research conducted, in the past 15 years, in relation to the sufficiency economy indicate the anxiety of the country to understand and apply the philosophy. It is believed that the sufficiency economy functions to strengthen the very foundation of the economy and to cushion the severe crash of the economic downturn. In general, it requires self-awareness, self-discipline, self-contentment, virtue, and ethics.

2.2 Competitive Advantage Creation and beyond sufficiency-economy consumption

Porter [82] stresses the importance of competitive strategy choices for firms to survive and thrive in the industry. He suggests 3 basic business strategies, i.e. differentiation, cost leadership, and focus. Choosing a strategy on which to concentrate, firms must take thorough considerations on the current competitive situations, their strengths, weaknesses, goals, and objectives.[25, 51] Many researchers support the combination of these strategies to best serve the firms and situations.[38, 39, 64, 67, 68, 71, 116] The focal point of this strategy is to provide a unique product or service to best fit customer's needs and to gain customer loyalty.[5, 25, 40, 79, 80, 81, 82] As there are additional costs incurred from smaller groups of customers, economies of scale is not achieved. Similarly, from the tailoring process, firms charge a premium price to customers. The differentiation strategy is effectively implemented when the business provides unique or superior value to the customer through product quality, features, or after-sale support. Firms following a differentiation strategy can charge a higher price for their products based on the product characteristics, the delivery system, the quality of service, or the distribution channels. The quality may be real or perceived based on fashion, brand name, or image.[1] The crux of the strategy is to differentiate the firms' product or service from that of competitors in the way that most appeals to the
customers. The differentiation strategy is most effective for sophisticated or knowledgeable consumer interested in a unique or quality product and willing to pay higher prices. The firms must ensure that the message of differentiation reaches the customers and make them aware of the differences and uniqueness of their own products and services when compared to the products and services of competitors. When using the differentiation strategy, the firms tend not to set up the price on cost basis. This does not mean that the firms ignore the cost; only that it is not the main focus. Since customers perceive the product or service as unique, they are loyal to the company and willing to pay the higher price for its products.

Cost leadership strategy focuses on achieving the lowest cost in the industry. There are many areas to achieve cost leadership such as mass production, mass distribution, economies of scale, technology, product design, input cost, capacity utilization of resources, and access to raw materials. Porter purports only one firm in an industry can be the cost leader and if this is the only difference between a firm and competitors, the best strategic choice is the low cost leadership role. Lower costs and cost advantages result from process innovations, learning curve benefits, economics of scale, product designs reduce manufacturing time and costs, and reengineering activities. In addition, the firms using this strategy must have low-cost manufacturing, and a workforce committed to the low-cost strategy. The firms must be willing to discontinue any activities in which they do not have a cost advantage and should consider outsourcing activities to other organizations with a cost advantage. A low-cost or cost leadership strategy is effectively implemented when the business designs, produces, and markets a comparable product more efficiently than its competitors. The firm may have access to raw materials or superior proprietary technology which helps to lower costs.

For an effective cost leadership strategy, a firm must have a large market share in order to compensate the lower price charged to customers. Lower prices, however, lead to higher demand and, therefore, to a larger market share. As a low cost leader, an organization can establish barriers against new market entrants who would need large amounts of capital to enter the market. The leader then is somewhat insulated from industry wide price reductions. The cost leadership strategy does have disadvantages. It creates little customer loyalty and if a firm lowers prices too much, it may lose revenues.

Following the focus strategy, a firm targets a specific group of customers with specific and very unique needs or characters. A firm using focus strategy chooses to focus on a select customer group, product range, geographical area, or service line. The target of the focus strategy is a narrow competitive scope within an industry. Focus aims at growing market share through operating in a niche market or in markets either
not attractive to, or overlooked by, larger competitors. These niches arise from a number of factors including geography, buyer characteristics, and product specifications or requirements. That niche may have been overlooked, or cannot be efficiently served with the current technology of other competitors, or not economically sufficient for other firms. A firm can be successful in following the focus strategy if the target is large enough for the firm but not for others. The firm may employ market penetration or market development strategy in order to create and capture the market. Focus strategies are most effective when consumers have distinct preferences and when the niche has not been pursued by rival firms.[26]

2.3 The beyond sufficiency-economy consumption behaviors

The classical economic theories view consumption behaviors as a function of utility, with no personal and emotional factors involved.[114] Marketing scholars take a different perspective and conclude that consumption behaviors are induced in two patterns, i.e. rationally (economically) and irrationally (emotionally). Sereerat [97] proposes that theories explaining consumption behaviors can be categorized into two groups: Rational or substantive behavior theories and emotional or nonsubstantive behavior theories. The rational or substantive behavior theorists believe that purchasing decision is made on the basis of sufficient information. Consumers are rational and prudent in buying products and services. The two important theories in this category are the economic man theory and the learning theory. The economic man theory suggests that consumers have good knowledge about the products, avoid unnecessary payment and rationally choose the products that best meet their needs. The learning theory focuses on experiential purchases that allow consumers to learn and make better and wiser purchasing decisions.

The emotional or nonsubstantive behavior theories, on the contrary, acknowledge the information asymmetry of the world. They believe that consumers lack complete information of products or services. Consumers, in their view, tend not to evaluate or calculate before buying. In addition, most of the differences among the alternative products are intangible or at least not easily observed. The social action theory, one theory of this kind, explains that a person's buying decisions are influenced by other individuals and depend on their endorsement, especially those sharing some characters. Homophily, therefore, has a significant influence on emulative purchase.[55] This type of purchase is consistent to the social comparison theory [30] which explains that people tend to compare themselves to others in all aspects. It is the emulative or even competitive sentiment that induces purchases. In many cases, people purchase items to make them look like or superior to others. The impulse actions theory explains another irrational purchasing behavior, impulsive
buying. This theory postulates that there are certain kinds of products that are purchased with no plan, calculations, nor predetermination.

Derived from the emotional behavior theories, this study propose three types of consumption behaviors that are beyond sufficient level, i.e. materialism, conspicuous, and impulsive consumptions. Belk [7, 8, 9] is the one of the most referred scholars in the area of materialism consumption. He develops 24 Likert items to measure materialism. His instrument consists of three parts: possessiveness, non-generosity, and envy [7], thus reflecting the definition of materialism. The measurement is widely accepted and in consistence with other related studies.[19, 44, 70] Conspicuous consumption is the pattern of consumptions that attempt to show off superior status. Thorstein Veblen [110] observes the wealthy class, or as he terms 'leisure class', and develops the theory of the leisure class. He describes that because of the accumulated wealth, this class of people have relatively more leisure time and desire to spend money to elevate their taste. Showing off activities of various kinds are initiated for such purpose. Consumption of this kind is not only for the true use of oneself but also for being seen and social status promotion.[31, 100] Researches also show a relationship between conspicuous consumption, emulative purchase, and debt and suggest that marketing promotion of various forms provoke this particular type of consumption.[61] The study of impulsive consumption can be traced back as far as 1950.[76] The research department of DuPont explored the consumption behaviors of consumers during 1948-1965. It found that, for certain types of product and consumers, purchase decision was unplanned. Cobb and Hoyer [22] phrase this type of behavior as immediate purchase. Shelf arrangement [76], shelf space [24], demographic data and lifestyles [52] are important factors influencing impulsive purchase.

3. Hypothesis Development

3.1 The marketing mix and the beyond sufficiency-economy consumption behaviors

Competitive advantage is created to influence target customers through marketing mix, i.e. product, price, place, and promotion or the 4 P's (McCarthy [65]). It is the marketing mix that convinces customers to believe that they are fit to the products or services of the firm. The marketing mix strategy must be in consistent with the competitive strategy that the firm decides to undertake. It is through the marketing mix that the firm's competitive strategy affects customers' buying decision. Disagreement between the competitive strategy and the 4 P's strategy, and among the 4 P's, leads to disarrayed product image and confuse customer's decision.
3.2 Materialism and the competitive advantage creation using the 4 P's

Zinkhan [123] explains that materialism consumption is the behavior that a person is overly addicted to spending. Jiratikorn [46] found that materialism in materialism consumption in young people exhibits in the form of buying craze. In addition, materialism consumptions highly correlates to indebtedness and saving decline.[78,115] Product variety and branding can strongly encourage materialism, thus tempting consumers to purchase the same type of products with different forms and patterns to insatiate their acquisitiveness. Bundle selling and multi-function products are example of product strategies that influence customers to pay, in some case, for some functions or additional product that exceed their needs.

Pricing strategies can also stimulate materialism consumption. Premium pricing becomes a prestige and dignity.[7, 41, 89, 91] Values of products are derived not from its utility buy perceptions of buyers. As long as customers strongly desire a product, seller can charge a premium price and make unreasonably high profit. Penetration pricing, on the other hand, can lead to an unnecessary purchase, especially when sellers post a time-limit for such price. Customers decide to buy, even when they do not currently need the items, only for fearing that they would miss the opportunity to buy such a low price. Both premium and penetration pricing can encourage imprudent spending.

Materialism is also encouraged by channel distribution strategies. Operating time expansion, increase coverage of the channel, innovative distribution channel (e.g. internet and mobile phone) are all channel strategies that make products and services ubiquitous for customers, hence inducing purchase.[20] Location choice and shelf design can also attract customer attentions and purchase.[29, 48]

Marketing communication has advanced to make people feel, unfortunately, not think or reason. It provokes desires more than reasonable needs.[57] Highly materialistic persons are most sensitive to emotional advertisements.[10] This advertisement exhibits luxury, specificity, status quo, to convince the customers that the products specially belong to them. Marvin [63] conclude this type of advertisement most affect young people.

The effect of competitive advantage creation through the marketing mix on the materialistic consumption behaviors leads to the following hypotheses:

H1a: The cost leadership advantage creation using the 4 P's strategies positively relates to materialism.

H2a: The differentiation advantage creation using the 4 P's strategies positively relates to materialism.

H3a: The focus advantage creation using the 4 P's strategies positively relates to materialism.
3.3 **Conspicuous consumption and the competitive advantage creation using the 4 P's**

One of the important functions of products is to implicate the user's identity and status quo.[17, 110] It displays a person's social class, wealth, and reputation. [77] Product is therefore an instrument that is used symbolize personal identity as well as social class adjustment, either for real or deception. It is also employed to gain attention from others.[45] Firms pays more attention to create product identity, and less to functionality, to offer to customers.[60]

Researches on premium products conclude that spending high price make a person feel special and prestigious. It also represents cost and quality of the product.[32] Product owners increasingly use psychological pricing; the pricing that impacts on the emotions rather than reason. Conspicuous consumers have a strong desire to be outstanding and differentiated and are sensitive to high-price products that make them distinct from others.

Regarding channel of distribution, exclusive place or invited-only channel can make customer conspicuous when entering such place. This type of channel tends to be located in public areas so that this type of customers are seen using such products.[35] To be able to use such products in such places, customers, accordingly, have to pay high price.

Marketing communication tools that induce conspicuous consumptions come in the form of limited version type. This form of advertisement raises the scarcity of the product, thus make conspicuous customer to desire to be one of the few who own and use such product.[116] In some instances, the firms may offer financial assistance if customers cannot afford at the moment in order to facilitate the purchase.

The effect of competitive advantage creation through the marketing mix on the conspicuous consumption behaviors leads to the following hypotheses:

- **H1b:** The cost leadership advantage creation using the 4 P's strategies positively relates to conspicuous consumption.
- **H2b:** The differentiation advantage creation using the 4 P's strategies positively relates to conspicuous consumption.
- **H3b:** The focus advantage creation using the 4 P's strategies positively relates to conspicuous consumption.

3.4 **Impulsive consumption and the competitive advantage creation using the 4 P's**

Impulsive consumption is the unplanned or unintended purchase. [11, 23, 56, 125] Researches frequently found that consumers refused newly released
products. As a result, marketers focus on existing version to make consumers familiar and fasten buying decision. This type of strategy is mostly found in low-involvement products used in daily life. Trying to emphasize the necessity of this type of product is also the product strategy for impulsive buyers.

Low-price strategy seems to be the only pricing alternative of for impulsive purchase. Relatively low price requires less time to calculate and use reason in buying, especially for those with low self-restraint.[3, 50] Placing this type of products on the eye-level shelf or at the cashier, at the reachable distance is the most common strategy. Baumeister [6] found negative correlations between impulsive purchase and saving habits. If consumers fail to closely keep tracks with their spending on this type of product, they will easily find themselves financially distressed.

Bellenger [11] found that 66% of impulsive purchase is influenced by marketing promotions, especially for durable goods. Anirban [3] reports that 1-million US coupon on unintended items can encourage sales of more than 7-million US.

The effect of competitive advantage creation through the marketing mix on the conspicuous consumption behaviors leads to the following hypotheses:

H1c: The cost leadership advantage creation using the 4 P's strategies positively relates to impulsive consumption.
H2c: The differentiation advantage creation using the 4 P's strategies positively relates to impulsive consumption.
H3c: The focus advantage creation using the 4 P's strategies positively relates to impulsive consumption.

Figure 2: Research framework
4. Methodology

4.1 Sample and data collection

The population of this study is the general consumer. The size of the population is therefore large and unknown. Several methods can be used to determine the appropriate sample size for the Structural Equation Model (SEM), the data analysis of this study. Hair [36] suggests the rule of thumb of 20 respondents for each variable. The sample size of this study, with 30 variables in question, is 600. In order to ensure the sufficient data, however, 726 samples were collected. Respondents are shoppers in 12 major department and discount stores in Bangkok. The selected branches are proportionately located in downtown and uptown areas. The data collection period was during February-March 2011. Survey questionnaires were administered to the samples shopping at the department and discount stores.

4.2 Variables and Measures

Multi-item scales were employed for measuring the latent constructs. The scales were taken from previous studies. The two constructs of the study included (1) strategies for competitive advantage creation (independent variable), and (2) beyond sufficiency-economy consumption behaviors (dependent variable). The strategies for competitive advantage creation consisted of 3 variables, i.e. cost leadership (COST), differentiation (DIFF), and focus (FOCUS). The item-instruments of these three variables were generated from in-depth interview with marketing managers of 5 major department and discount stores. Results of the interviews were synthesized using content analysis and the base for instrument development. The dependent variable included three types of beyond sufficiency-economy consumption behaviors, i.e. materialism (M), conspicuous (C), and impulsive consumption (V). Materialism consumption questions were adapted from Belk [7] and Richins and Dawson [90] conspicuous consumption questions from Marcoux, Filiatrault, and Emmanuel [60] and impulsive consumption behavior questions from Rook, and Fisher [94].

Reliability for the competitive advantage creation sub-scales, as measured by Cronbach's alpha (\(\alpha\)), was satisfactory: 0.848 for COST, 0.811 for DIFF, 0.875 for FOCUS, and 0.943 for the overall constructs. The Cronbach's \(\alpha\) for the beyond sufficiency-economy consumption behaviors sub-scales was 0.706 for M, 0.909 for C, 0.861 for V, and 0.929 for the overall construct. The 0.7 cutting point of Cronbach's \(\alpha\), as suggested by Nunnally [73] was adopted in the study and the instrument was considered reliable.
Table 1: Descriptive statistics and correlation matrix

| Variables | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 |
| 1. Cost  (COST) | 1.00 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2. Differentiation (DIFF) | 1.60 | 1.00 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3. Focus (FOCUS) | 2.00 | 1.60 | 1.00 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Table 2: Reliability of the instrument

<table>
<thead>
<tr>
<th>Constructs</th>
<th>Cronbach’s α</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Competitive Advantage Creation</strong></td>
<td></td>
</tr>
<tr>
<td>1. Cost leadership (COST)</td>
<td>0.848</td>
</tr>
<tr>
<td>2. Differentiation (DIFF)</td>
<td>0.811</td>
</tr>
<tr>
<td>3. Focus (FOCUS)</td>
<td>0.875</td>
</tr>
<tr>
<td><strong>Overall sub-scale</strong></td>
<td><strong>0.943</strong></td>
</tr>
</tbody>
</table>

| **Beyond Sufficiency-Economy Consumption Behaviors** | |
| 1. Materialism (M) | 0.706 |
| 2. Conspicuous (C) | 0.909 |
| 3. Impulsive (V) | 0.861 |
| **Overall sub-scale** | **0.929** |

Confirmatory factor analyses were used to investigate the measurement properties of the scales of the independent and dependent variables of this study. The resulting indices suggest a good fit for all constructs, i.e.
competitive advantage creation ($\chi^2 = 58.98, df = 28, p = 0.00, \text{RMSEA} = 0.039, \text{GFI} = 0.99, \text{AGFI} = 0.96$), and beyond sufficiency-economy consumption behaviors ($\chi^2 = 314.52, df = 110, p = 0.00, \text{RMSEA} = 0.051, \text{GFI} = 0.95, \text{AGFI} = 0.93$). Showing in Figure 2 are the results of the confirmatory factor analyses of the independent and dependent variables.

### 4.3 Results and Discussion

The model parameters of the structural model were estimated with the maximum likelihood method (covariance matrix). For the hypothesized model, results show a RMSEA value of 0.045 and relative Chi-square ($\chi^2/df$) 2.47, with GFI = 0.93, AGFI = 0.90, RMR = 0.50, suggesting a good fit.[13, 28] The goodness of fit statistics showed that the structural model used in this study fit well with the observations. Figure 3 exhibits the structural model, with parameter estimates, of the relationship between the competitive advantage creation and beyond sufficiency-economy consumption behaviors. It is interesting to note that cost leadership (COST) strategy shows negative effects on the three types of beyond sufficiency-economy consumption behaviors. Hypotheses 1a, 2a, and 3a, are accordingly rejected. The other two competitive strategies, i.e. differentiation (DIFF) and focus (FOCUS), on the contrary, positively affect the dependent variables, hence confirming the remaining hypotheses, i.e. H 2a, H 2b, H 2c, H 3a, H 3b, and H 3c.

![Figure 3: CFA results of the independent and dependent variables](image-url)
In light of the size of effect, one can see that the cost leadership strategy demonstrates higher influence on the three types of beyond sufficiency-economy consumption behaviors, that the other two strategies. The negative coefficient signifies that the more the business employs cost leadership strategy the less attractive its products become. In short, consumers with beyond sufficiency-economy consumption behaviors tend to buy less if the product is considered inexpensive or low-cost. Differentiation and focus strategies appear to have lower, yet positive, effects than cost leadership strategy on the beyond sufficiency-economy consumption behaviors. Observing on the dependent variables, the three types of beyond sufficiency-economy consumption behaviors, one can see that conspicuous consumption is influenced by the independent variables to a higher degree than the other two types of beyond sufficiency-economy consumption behaviors.

Not only do the results clearly demonstrate the effect of competitive strategies in enhancing the firms' competitiveness on the beyond sufficiency-economy consumption behaviors, they also set an alarm to the society. Consumers tend to lose their cost-conscious sense. It is probably the influence of value-added advertisement, which convinces customers to pay more, or the celebrity marketing strategy that make low-cost items unpopular. The market has changed from mass to more specific. Consumers tend to further develop their needs to be more unique and specific. However, one has to keep in mind that this trend incurs additional costs to consumers. This nature of market development exhibits no harm if only it does not go beyond the proper limit of each individual. In addition, among the three types of beyond sufficiency-economy consumption behaviors, conspicuous consumption seems to be the most sensitive to the competitive strategy. Consumers tend to
purchase and use products that make them outstanding, different, and the center of attention.[70] One of the firms most successful competitive strategies is the strategy that makes consumers compete with each other on spending.

4.4 Conclusions

The resulted model plainly suggests that the three generic competitive strategies induce materialism, conspicuous, and impulsive purchase. If there is any reason why the sufficiency economy philosophy fails to prosper and be practiced, part of it is the business competitive strategy. It is not the purpose of this study to blame the firms' competitive strategy. Firms, after all, have to compete to survive. However, as the sector that is closest to people's daily life, businesses should acknowledge the adverse effects of their strategies on consumers' buying decision and take ethical responsibility to control their competitions to the level that is healthy to the society. The government should play active roles in promoting and encouraging the business sector to compete in such directions. It is a task that the business sector and government should jointly undertake to prevent consumers in society from being the victims of the firms' economic success.
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Quantitative Analysis 1
Simple formula for estimating the parameter of zero-truncated Poisson distribution

Krisana Lanumteang

Abstract. The main aim of this study is to investigate new estimators which are easily used to estimate the parameter of zero-truncated Poisson distribution. Proposed estimators are developed by extending the idea of Zelterman’s estimator. A simulation study is carried out to study the performance of new estimators under a variety of zero-truncated Poisson models. Simulation results show that proposed estimators perform well under fairly condition in particular large sample size and large value of the true parameter. An application of capture-recapture method is also provided in order to illustrate the use of newly proposed estimators.

1. Introduction

Poisson distribution is a discrete probability distribution expressing the probability of a given number of events occurring in a fixed interval of time or space. If a random variable \( Y \) is Poisson with parameter \( \lambda > 0 \), the probability density function of \( Y \) is

\[
f(Y; \lambda) = \frac{e^{-\lambda} \lambda^y}{y!}, \quad (1)
\]

The range of \( Y \) is the integers from zero to infinity. However, there is a particular situation that the random variable \( Y \) cannot be 0. For this condition, the probability density function of \( Y \) can be written as

\[
f_t(Y; \lambda) = \frac{e^{-\lambda} \lambda^y}{y!(1-e^{-\lambda})}; \quad y = 1, 2, 3, ...
\]

which is traditionally called the zero-truncated Poisson distribution. The zero-truncated Poisson is widely applied in capture-recapture experiment as a capture probability model to estimate the size of an elusive target population [1]. From the capture-recapture experiment, the frequency counts of identified individuals are the variables of interest. The identifying system generally provides a count \( Y_i > 0 \) of how many times the individual \( i \) has been captured, for \( i = 1, 2, \ldots, n \) and \( Y_i = 0 \) denotes unobserved cases in the system for \( i = n + 1, n + 2, \ldots, N \). Hence, if we let \( p_0 \) be the capture probability for unobserved individuals, then \( N(1 - p_0) \) is the expected number of observed cases which can
be estimated by sample size \( n \). This leads to the simple equation to estimate the population size \( N \), where \( N = Np_0 + N(1-p_0) = Np_0 + n \). Therefore, this equation can be solved for estimating \( N \) to provide the Horvitz-Thomson estimator [2] of the form

\[
\hat{N}_{HTE} = \frac{n}{(1-p_0)}.
\] (3)

However, \( p_0 \) is typically unknown and the estimator in (3) would require an estimator of \( p_0 \). Here, the zero-truncated Poisson distribution might be a good candidate model for this probability. Ultimately, we have to estimate the model parameter \( \lambda \). Then, the estimator in (3) can be easily found as

\[
\hat{N}_{HTE} = \frac{n}{(1-e^{-\hat{\lambda}})}.
\] (4)

The maximum likelihood method is one of the most popular techniques used to derive estimators. The maximum likelihood estimator (MLE) of unknown parameter \( \lambda \) can be obtained by finding a maximum of the likelihood function. For the zero-truncated Poisson distribution, the MLE satisfying the relation

\[
\hat{\lambda} = \bar{y}(1-e^{-\hat{\lambda}}), \text{ where } \bar{y} = \frac{1}{n} \sum_{i=1}^{n} y_i.
\] (5)

Unfortunately, the estimator in (5) is not the closed form; therefore iterative method is typically required for solving \( \hat{\lambda} \) via EM algorithm [3]. This is quite complex and difficult in practice for non-statistician. Alternatively, Zelterman [4] also proposed a family of robust estimators of the parameter \( \phi = e^{-\hat{\lambda}} \) under the zero-truncated Poisson. The estimator of Zelterman can be simply derived as a consequence of the property of zero-truncated Poisson distribution,

\[
\hat{\lambda} = \frac{(y+1)f_y(y+1;\hat{\lambda})}{f_y(y;\hat{\lambda})}.
\]

We can estimate \( f_y(y;\hat{\lambda}) \) and \( f_y(y+1;\hat{\lambda}) \) by their associated observed frequency counts \( f_y \) and \( f_{y+1} \), respectively. Thus, it is deduced that

\[
\hat{\lambda} = \frac{(y+1)f_{y+1}}{f_y}.
\] (6)

In practice, Zelterman argued that the most reliable value of \( y \) to be chosen are one or two observed frequencies. These will be more similar to those individuals that were not observed \( (y = 0) \). Clearly, Zelterman formula is very simple to understand and use. This is perhaps one of the reasons why it has been widely used in many fields in particular social section [5]. However, there are also some critical remarks on using Zelterman’s estimator. Firstly, it uses limited information from observed counts. Using only \( f_1 \) and \( f_2 \) to estimate the
parameter, \( \hat{\lambda}_{Zel} = \frac{2f_y}{f_1} \), might not be suitable, especially for long tail data.

Another issue is that Zelterman’s estimator seems to provide overestimation and also typically gives a larger variance compared with other estimators [6]. Hence, we should be concerned about how to overcome with these critical remarks. This is the motivation for the study of an extension of Zelterman’s estimator. Two new proposed estimators will be examined in the next section.

2. Proposed Estimators

Recall the probability density function of zero-truncated Poisson (2), we do not only have \( \lambda = \frac{(y + 1)f_y(y + 1; \lambda)}{f_y(y; \lambda)} \), but also that \( \lambda = \frac{\sum_{y=1}^m (y + 1)f_y(y + 1; \lambda)}{\sum_{y=1}^m f_y(y; \lambda)} \); \( k = 1, 2, 3, \ldots, m - 1 \) where \( m \) is the maximum of observed \( Y \).

**Proof.** If \( \lambda \) is the parameter of a Poisson probability truncated at zero and above \( m \) we have that:

\[
2 \frac{e^{-\lambda} \lambda^2}{2!} + 3 \frac{e^{-\lambda} \lambda^3}{3!} + \ldots + m \frac{e^{-\lambda} \lambda^m}{m!} = \lambda (2 \frac{e^{-\lambda} \lambda}{(2)!} + 3 \frac{e^{-\lambda} \lambda^2}{(3)2!} + \ldots + m \frac{e^{-\lambda} \lambda^{m-1}}{(m)(m-1)!})
\]

\[
= \lambda (e^{-\lambda} \lambda + \frac{e^{-\lambda} \lambda^2}{2!} + \ldots + \frac{e^{-\lambda} \lambda^{m-1}}{(m-1)!})
\]

\[
\lambda = \frac{\sum_{y=2}^m ye^{-\lambda} \lambda^y}{\sum_{y=1}^{m-1} y!} = \frac{\sum_{y=2}^m ye^{-\lambda} \lambda^y}{\sum_{y=1}^{m-1} y!}
\]

\[
\lambda = \frac{\sum_{y=1}^m yf_y(y; \lambda)}{\sum_{y=1}^{m-1} f_y(y; \lambda)} = \frac{\sum_{y=1}^{m-1} (y + 1)f_y(y + 1; \lambda)}{\sum_{y=1}^{m-1} f_y(y; \lambda)}.
\]
Hence, if $Y$ is truncated at only zero we have that $\lambda = \frac{\sum_{y=0}^{m-1} (y+1)f_y(y+1;\lambda)}{\sum_{y=0}^{m-1} f_y(y;\lambda)}$.

This can be also satisfied $\lambda = \frac{\sum_{y=1}^{k} (y+1)f_y(y+1;\lambda)}{\sum_{y=1}^{k} f_y(y;\lambda)}$; $k = 1, 2, 3, ..., m-1$ for a Poisson probability truncated at zero and above $k$.

Consequently, substituting associated observed frequency count $f_y$ for $f_y(y;\lambda)$ leads to a family of estimation as follows:

$$\hat{\lambda}_1 = \frac{2f_2}{f_1},$$ (7)

$$\hat{\lambda}_2 = \frac{2f_2 + 3f_3}{f_1 + f_2},$$ (8)

$$\hat{\lambda}_3 = \frac{2f_2 + 3f_3 + 4f_4}{f_1 + f_2 + f_3},$$ (9)

$$\vdots$$

$$\hat{\lambda}_{m-1} = \frac{2f_2 + 3f_3 + 4f_4 + \ldots + mf_{m-1}}{f_1 + f_2 + f_3 + \ldots + f_{m-1}}.$$ (10)

It is clearly seen that (7) is the Zelterman’s estimator whereas formula (8) – (10) are an extension of the original Zelterman’s estimator. For capture-recapture experiment, as a small count of $Y$ (particularly one to four observed frequencies) will often behave more similar to those individuals that were not observed ($y = 0$), equation (8) and (9) can be considered as the two alternative estimators of $\lambda$. In general, due to the fact that there is only one mode (the value occurring most frequently) in zero-truncated Poisson distribution, it can be reasonable to consider mode as a central point. Consequently, this contributes to provide two new simply estimator formulas of $\lambda$ as follows:

$$\hat{\lambda}_{New1} = \frac{\sum_{y=0}^{m-1} (y+1)f_{y+1}}{\sum_{y=0}^{m-1} f_y}, \quad \text{and}$$

$$\hat{\lambda}_{New2} = \frac{\sum_{y=0}^{m-1} (y+1)f_{y+1}}{\sum_{y=0}^{m-1} f_y},$$ (11)
where \( mo \) is mode of given random variables \( Y_1, Y_2, Y_3, \ldots, Y_n \) (observed \( Y \) of size \( n \)). The study performance of these proposed estimators will be examined via simulation method in section 4.

3. An Application

According to study of Viwatwongkasem et al. [7], they are interested in estimating the total number of heroin users in Bangkok in the year 2002. This study used the database which recorded all replicated treatment contacts of drug addicts from the 61 health treatment centres in Bangkok metropolis (see Table 1.)

<table>
<thead>
<tr>
<th>( y )</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10+</th>
</tr>
</thead>
<tbody>
<tr>
<td>( f_y )</td>
<td>2,716</td>
<td>1,600</td>
<td>1,278</td>
<td>976</td>
<td>748</td>
<td>570</td>
<td>455</td>
<td>368</td>
<td>281</td>
<td>850</td>
<td></td>
</tr>
</tbody>
</table>

The total of heroin patients (\( n \)) is 9,302. Clearly, this is required to look at zero truncation since zeroes (individuals which are not identified) have not been observed in the identifying systems. The estimated number of heroin users from considered methods is shown in Table 2. Note that the estimated standard error, \( Se(\hat{N}) \), and the confidence interval of \( N \) can be simply investigated by using the percentile bootstrap method which is repeated 1,000 times. The completeness of identifying heroin patients in the system can be estimated by \( \frac{n}{\hat{N}} \times 100\% \). In addition, using the Bangkok population and housing census of 2000 (BKK population = 6,355,144), these estimators reasonably lead to a prevalence of approximately 1.49 – 1.90 per 1,000 residents. Significantly, two newly proposed estimators yield results line between MLE and Zelterman’s estimator and also provide smaller variation of estimating rather than the original Zelterman’s estimator.

<table>
<thead>
<tr>
<th>Estimator</th>
<th>( \hat{\lambda} )</th>
<th>( \hat{N} )</th>
<th>% Completeness</th>
<th>( Se(\hat{N}) )</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>MLE</td>
<td>4.1303</td>
<td>9,454</td>
<td>98.39%</td>
<td>13.40</td>
<td>9,518 – 9,573</td>
</tr>
<tr>
<td>New1</td>
<td>1.6297</td>
<td>11,570</td>
<td>80.40%</td>
<td>111.09</td>
<td>11,496 – 11,917</td>
</tr>
<tr>
<td>New2</td>
<td>1.9553</td>
<td>10,836</td>
<td>85.84%</td>
<td>70.83</td>
<td>10,782 – 11,061</td>
</tr>
<tr>
<td>Zelterman</td>
<td>1.4704</td>
<td>12,078</td>
<td>77.02%</td>
<td>188.45</td>
<td>11,728 – 12,476</td>
</tr>
</tbody>
</table>
4. Simulation Study

4.1 Simulation Scenarios

A simulation experiment is undertaken to study the performance of considered estimators and two competitors, maximum likelihood estimator (MLE) and Zelterman’s estimator. Given random variables of size $n$ have been sampled from the following distributions: zero-truncated Poisson: $\lambda = 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5$ and $5.0$; sample size: $n = 10, 20, 30, 40, 50, 100, 200, 500$ and $1000$.

Each scenario is repeated 10,000 times. To evaluate the performance of estimators, it can be measured by relative bias ($RBias = [E(\hat{\lambda}) - \lambda]/\lambda$), relative variance ($RVar = E[(\hat{\lambda} - E(\hat{\lambda}))^2]/\lambda^2$) and relative mean square error ($RMSE = E[(\hat{\lambda} - \lambda)^2/\lambda^2]$).

4.2 Simulation Results

As a summary result it can be said that two newly proposed estimators can reduce both overestimation and providing large variation of the original Zelterman’s estimator. For a small $n$ and $\lambda$ ($n \leq 30, \lambda \leq 1.0$), $\hat{\lambda}_{New1}$ and $\hat{\lambda}_{New2}$ seem to provide slightly overestimation. However, newly proposed formulas perform a higher accurate results for a large $n$ and $\lambda$ ($n \geq 40, \lambda \geq 3.0$), which $RBias$ of $\hat{\lambda}_{New1}$ and $\hat{\lambda}_{New2}$ are closed to 0. Significantly, the proposed estimators also show a good performance of estimating $\lambda$ as does maximum likelihood estimator (MLE) in particular case that increase in $n$ and $\lambda$. In comparison, $\hat{\lambda}_{New1}$ evidently yields a smaller $RBias$ rather than $\hat{\lambda}_{New2}$. On the other hand, $\hat{\lambda}_{New2}$ gives a lesser $RVar$ than $\hat{\lambda}_{New1}$, see Fig.1 and Fig. 2.

As can be seen from Fig.3, the distribution of both proposed estimators seems to be an approximately normal distribution as well as MLE. Although $\hat{\lambda}_{New1}$ and $\hat{\lambda}_{New2}$ do not provide the smallest variance, they significantly yield less variation than the original form of Zelterman. According to $RMSE$, a small value of $RMSE$ normally indicates that estimator performs an efficiency of estimation. Overall, MLE provides the highest efficient estimation, see Fig 4. Nonetheless, even if proposed estimators seem to be of lack of efficiency for a small $n$ and $\lambda$, they show excellent performance against the other methods for larger $n$ and $\lambda$. 
Panel variable: Sample Size (n)

Fig. 1. Boxplot of estimated lambda ($\hat{\lambda}$) for $\lambda = 2.0$

Panel variable: Sample Size (n)

Fig. 2. Scatter plot of $RBias$ and $\lambda$
Panel variable: Estimator

Fig. 3. Distribution of $\hat{\lambda}$ for $\lambda = 2.0$ and $n = 30$

Panel variable: Sample Size (n)

Fig. 4. Scatter plot of RMSE and $\lambda$
5. Conclusion and Discussion

Two simple estimators of the zero-truncated Poisson parameter are introduced under an extending of Zelterman’s estimator. Simulation results show that both formulas not only show higher performance in term of accuracy rather than the original form, but they also perform better in term of precision. Proposed estimators seem to provide overestimation for a small sample size and a small value of true parameter. However, they show high efficiency of estimation for a big sample size and large value of true parameter as does maximum likelihood estimator. In application of capture-recapture method, both proposed estimators evidently yield results lining between the maximum likelihood and Zelterman estimator, which is known to provide the underestimation and overestimation, respectively. As a variation of both newly estimators seem to be an approximately normal distribution, the approximate normal approach might also be appropriate to apply for constructing the confidence interval of the true parameter. In summary, it is reasonable to state that both proposed estimators might be a good alternative form for estimating the true parameter of zero-truncated Poisson distribution in particular the condition of large sample size and large value of true parameter.

6. References

Investment for Improving the Performance in Multistage Production Systems

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Abstract. The paper presents a modeling framework that assists management to allocate capital resources to improve the yield and the yield variability in a multistage production system. The results indicate that production stages with low yield and/or high yield variability receive more capital resources for improvement. The applicability of the model is demonstrated in a real-life manufacturing firm in the food-packing industry. The solution of the model provides directions of improving the stages of a multistage production system.

1 Introduction

Most products are manufactured in multistage production systems following a production sequence that depends on the nature of the product, the machines available, and the factory layout. Value is added at every production stage until the product is completed. Production sequences in multistage systems can resemble a “tree structure” or a line, in which case we refer to such systems as serial production systems. Such systems are common in many industries, including semiconductor, chemical, and food industries. In multistage systems, yield losses are inevitable due to a number of reasons such as, machine and material failures during the production process, human error, and the production of new products that the organization has no prior experience. Yield losses due to “process imperfections”\textsuperscript{10} result in cost increases due to the scrapping of the entire product, scrapping of components, and any rework required.

The literature on multistage and serial production systems has focused mostly on production planning issues. In this line of work, the multistage production system is characterized by a number of factors, such as the yield of each production stage, the available capacity of every stage, lead times between production runs, and consumer demand. Given that these factors can be treated as deterministic or stochastic, the objective is to minimize various production-related costs in order to satisfy end demand, by deciding the production quantities to be produced at each stage. Various models have been proposed to address the above problem. Some of them introduce uncertainties, such as random yields at each production stage\textsuperscript{1, 11, 15}, random capacity due to
resource unavailability [10], random processing times [7], and random demand [1, 4, 14].

Rework has also been incorporated in the production planning problem of multistage systems, since it significantly contributes to cost increases [5]. Such work has been carried out by Denardo and Tang [3], Wein [16], So and Tang [13], and Grosfeld-Nir and Gerchak [6]. Hadjinicola [8] model a serial production system with rework using Markov chains and compute steady state costs and yields at every production stage.

The above literature on multistage production systems considers the production system's capabilities and uncertainties as exogenous parameters, and attempts to determine an “optimal” mode of operation. However, one of the responsibilities of an operations manager, besides designing and operating the production system, is to further improve the system in order to reduce cost and improve quality [2]. Operational improvements are always a concern in manufacturing firms, especially when yield losses result in a significant increase of the production cost. As such, deciding which production stage(s) should receive more “attention” - and thus more resources - in order to minimize cost from yield losses, becomes particularly important in multistage production systems.

The issue of improving the performance of multistage production systems has not been adequately addressed in the literature. Lee et al. [12] presented a model that computes the amount of investment needed at each production stage in a multistage system, in order to reduce the proportion of defective products and the variability of the yield at each stage. In their solution, the investment made at each stage improves the proportion of defective products in an equal way at every stage, as well as the variability of the yield at each stage. However, this assumption is often unrealistic and restricts the amount of investment given to each stage in a multistage system.

Hadjinicola and Soteriou [9] address this problem and present a model that allocates limited capital resources to the various production stages with the objective to minimize the annual cost incurred from defects. Their framework considers a number of factors for resource allocation such as the mean yield of a stage, the volume of products processed at a stage, and the average cost incurred when a defect is observed. In their formulation, yield is treated as a proportion of total production at each stage. However, in real-life manufacturing environments, yield is characterized by variability. This poses the following question: How does yield variability of the various production stages influence the decision to improve production stage yield and reduce the
cost incurred from defects? In this case, one would argue that production stages with highly variable yields will weigh more heavily on the cost incurred from defects.

In this paper, we present a more general modeling framework to address the above question and assist management in their effort to improve the performance of the production system. We extend the work by Hadjinicola and Soteriou [9] in the following ways: (1) we include the variance of the yield in each production stage in the allocation of resources for yield improvement, (2) we treat the families of products and their production volumes differently and avoid the aggregation of all products in a single family, (3) we examine and compare two scenarios for improving the performance of the production system, a budget constrained case and the unconstrained case, and (4) we show how yield and its respective yield variability can be improved simultaneously.

The organization of the paper is as follows. In Section 2 we present the model for the budget constrained and unconstrained cases. In Section 3 we apply the model in a real-life manufacturing environment. Finally, in Section 4 we provide concluding remarks and directions for future research.

2 Model Formulation and Solution

2.1 Model Features

We consider a manufacturing plant consisting of dissimilar machines, which we refer to as production stages. Products are produced in a pre-specified sequence of production stages, using all or a subset of the stages available in the plant. The model presented in this paper considers the monthly demand for each product, since the decision to invest in improving the manufacturing facility is of strategic importance with long-term consequences.

In a manufacturing setting, frequent measurements of the yield, often daily, allow a manufacturer to compute the mean yield $Y_{ij}$ and the respective standard deviation of the yield $\sigma_{ij}$ of product $i$ at stage $j$. Furthermore, every time a defect appears in a production stage the firm incurs an expected cost. This expected cost results from scrapping components, sometimes scrapping the entire product, and any labor cost due to the rework required. In this paper, we assume that $c_{ij}$, the expected cost incurred from a defect of product $i$ observed at production stage $j$ is variance weighted. As such, we assume that $c_{ij}=c(\sigma_{ij})$. One would expect that as the variability of yield increases, the cost incurred from defects also increases.
We use the function $c_{ij}(\sigma_{ij}) = \beta \sigma_{ij}^\delta$, which satisfies the above assumption. Higher values of the parameters $\beta$ and smaller values for $\delta$ imply the greater the effect of yield variability on the cost incurred from defects. This cost function is often used in the economics literature and has the advantage that after taking the logarithm of both sides, it converts into a linear equation, whose parameters $\beta$ and $\delta$ can be estimated using a simple linear regression model. The inputs to such model are the costs incurred from defects and the yield variability in every production stage. These data, from the practical point of view, are readily available to the operations manager in many manufacturing settings. As such, the cost function used can be easily calibrated using production data.

The modeling framework also uses the following notation in which we refer to both semi-completed and completed products as simply products:

- $n_{ij}$: Monthly number of products $i$ processed at production stage $j$. Production stages in multistage systems often process different numbers of products or components.
- $K$: Number of different products produced by the multistage production system.
- $N$: Number of production stages in the multistage production system.
- $B$: Budget available for improving the yield of the production stages.

Consider an arbitrary product $i$ at production stage $j$ of a multistage production system operating at steady state. The mean yield loss of product $i$ at stage $j$ is equal to $1-Y_{ij}$. The monthly expected number of defects of product $i$ to occur in stage $j$ is given by $(1-Y_{ij})n_{ij}$. Therefore, the monthly variance weighted expected cost incurred from defects of product $i$ at stage $j$ is given by $(1-Y_{ij})n_{ij}c_{ij}(\sigma_{ij})$. Aggregating over all products produced at stage $j$, the cost incurred from defects at stage $j$ is given by:

$$\text{Variance Weighted Defects Cost at Stage } j = \sum_{i=1}^{K} (1-Y_{ij})n_{ij}c_{ij}(\sigma_{ij})$$  \hspace{1cm} (1)

Aggregating over all production stages, the monthly expected cost incurred from defects observed in all production stages is given by:

$$\text{Total Variance Weighted Defects Cost} = \sum_{j=1}^{N} \sum_{i=1}^{K} (1-Y_{ij})n_{ij}c_{ij}(\sigma_{ij})$$  \hspace{1cm} (2)

Of course, not all products undergo operations in all production stages. To accommodate these cases, in the above cost function, we set $n_{ij} = 0$ if product $i$ is not produced in stage $j$.

Investments in the various stages to improve the yield will result in a change of the yield loss for product $i$ at stage $j$ from its initial value of $(1-Y_{ij})$ to $\epsilon_{ij}(1-Y_{ij})$. The decision variable $\epsilon_{ij}$ represents the remaining percentage of the initial yield loss of product $i$ at stage $j$, after improvement in yield has been established. It
follows that $\varepsilon_{ij}$ assumes values between 0 and 1, with small values of $\varepsilon_{ij}$ implying a high yield improvement for product $i$ at production stage $j$. We assume that the investment will not only reduce the yield loss, but it will also reduce the variability of the yield. More specifically, the standard deviation of the yield will change from its initial value $\sigma_{ij}$ to $\zeta(\varepsilon_{ij})\sigma_{ij}$, with $\zeta(\varepsilon_{ij})$ assuming values between 0 and 1. For the sake of simplicity, we use the functional form $\zeta(\varepsilon_{ij})=\rho \varepsilon_{ij}$. Smaller values of $\rho$ imply higher reductions in yield variability, after the investment in the production stage has been implemented.

To capture the phenomenon where higher yield improvement requires higher investment, we define the cost required at stage $j$ for reducing the yield loss for product $i$ from $(1-Y_{ij})$ to $\varepsilon_{ij}(1-Y_{ij})$ to be equal to $m_{ij}-\gamma_{ij}\varepsilon_{ij}$. The parameter $m_{ij}$ represents the investment required at stage $j$ to make the yield loss for product $i$ equal to zero, that is $\varepsilon_{ij}=0$. Furthermore, the parameter $\gamma_{ij}$ represents the investment required at production stage $j$ to reduce the yield loss of product $i$ by one percentage point. A similar non-linear functional form of the cost needed to improve the yield at a production stage has also been used by Hadjinicola and Soteriou [9].

### 2.2 Budget Constrained Model

Given a budget $B$ available for investments that would lead to yield improvement, the program that minimizes the total defects cost, after investments in yield improvement have been established, is given by

$$\min_{\varepsilon_{ij}} \sum_{i=1}^{K} \sum_{j=1}^{N} (1-Y_{ij})\varepsilon_{ij} n_{ij} (\rho \varepsilon_{ij} \sigma_{ij}), \quad (3)$$

subject to

$$B = \sum_{i=1}^{K} \sum_{j=1}^{N} [m_{ij} - \gamma_{ij}\varepsilon_{ij}] \quad (4)$$

$$0 \leq \varepsilon_{ij} \leq 1.$$ 

**Proposition 1** The budget allocation that minimizes the monthly expected cost incurred from defects in all production stages, will result in a change of the yield loss from $(1-Y_{ij})$ to $\varepsilon_{ij}^*(1-Y_{ij})$ and yield variability from $\sigma_{ij}$ to $\rho \varepsilon_{ij}^*\sigma_{ij}$, where

$$\varepsilon_{ij}^* = \frac{\sum_{i=1}^{K} \sum_{j=1}^{N} m_{ij} - B}{\sum_{j=1}^{K} \sum_{j=1}^{N} \gamma_{ij}}\alpha_{ij}, \quad i=1,\ldots,K, \quad j=1,\ldots,N, \quad (5)$$
and

\[ \alpha_{ij} = \left( \frac{\gamma_{ij}}{(1-Y_{ij})n_{ij}\beta\rho^\delta (1+\delta)\sigma^\delta_{ij}} \right)^{1/\delta}. \]  

(6)

### 2.3 Unconstrained Model

Since equations (2) and (3) represent the monthly expected cost incurred from defects observed in all production stages before and after improvement in yield has been established, respectively, subtracting (3) from (2) results in the total savings obtained from improving the yield. In addition, the right hand side of equation (4) represents the investment required for the yield improvement. Therefore, the program that maximizes the net gain from improving the yield is given by:

\[
\min \sum_{i=1}^{K} \sum_{j=1}^{N} (1-Y_{ij})n_{ij}[c_{ij}(\sigma_{ij}) - \epsilon_{ij}c_{ij}(\xi(\epsilon_{ij})\sigma_{ij})] - \sum_{i=1}^{K} \sum_{j=1}^{N} [m_{ij} - \gamma_{ij}\epsilon_{ij}],
\]

(7)

\[0 \leq \epsilon_{ij} \leq 1.\]

**Proposition 2** The solution that maximizes the benefit obtained from the reduction of the yield loss minus the investment to achieve the reduction of the yield loss, will result in a change of the yield loss from \((1-Y_{ij})\) to \(\epsilon^{**}_{ij} (1-Y_{ij})\) and yield variability from \(\sigma_{ij}\) to \(\rho \epsilon^{**}_{ij} \sigma_{ij}\), where

\[ \epsilon^{**}_{ij} = \alpha_{ij}, i = 1, \ldots, K, j = 1, \ldots, N, \]

and \(\alpha_{ij}\) is the same as in Proposition 1.

The proofs and the parametric conditions under which the results of Propositions 1 and 2 are valid can be obtained from the authors.

### 3 Model Application

To demonstrate its applicability, the model presented in this paper is applied to a company in the food packing industry. More specifically, the company packs honey and marmalade in different types and shapes of glass and plastic jars. The production process is relatively simple and consists of three stages. In the first stage, jars are placed on the conveyor belt and are aligned for the filling process. During this stage breakages may occur especially when dealing with glass jars with delicate features. In the second stage, jars are filled using pneumatic machines that release the pre-specified quantity of honey or...
marmalade. Production errors at this stage are typically due to the spilling of liquid food, which results in irrecoverable costs. In addition, rework cost accumulates since some jars need to be cleaned and be placed back in the production process. Finally, during the last stage a label and a safety lid are placed on the jar. Cost incurred from defects at this stage stems from misplaced labels or lids and breakages from the manual placement of the jars in carton boxes.

The company produces a variety of products and groups them in three major families, based on the weight of the filled jars. The production yields of “similar” products are almost equal, and as management stated, the major factors contributing to defects are the size and shape of the jar, rather than the liquid content. Furthermore, grouping enables management to identify the most “problematic” set of products and stages that should attract more attention in improving the system. The primary intent is not to provide the optimal way to improve the production system, since this is heavily depended on parameter estimates, which are often difficult to obtain and sometimes inaccurate, but rather to provide management directions to act in order to improve the production system.

Some parameters used in the model such as production volumes, yields, and yield variability, were readily available by the firm's management. Parameters $\beta$ and $\delta$ were estimated using simple regression with the dependent variable being the cost incurred from defects at each stage for each product, and the independent variable being the respective yield variability. Other parameters were estimated using management's prior experience or information gathered at that time regarding the purchasing of new machinery to improve production, and thus yield, and the use of improved quality materials such as labels, adhesives, and plastic lids.

For example, for the first family of products, using plastic lids from one supplier and then switching to another resulted in a reduction of the average yield loss in the capping stage from 5% to 2%. This implied a value of $\varepsilon_{13} = 0.40$. The use of the new lids during different production runs also resulted in a reduction of yield variability from 0.04 to 0.01. Thus, the yield variability was reduced to 25% of the initial yield variability. This percentage is equal to $\rho \varepsilon_{13}$, which resulted to a proxy for the value of the parameter $\rho$.

The additional monthly cost the firm incurred for using the plastic lids from the new supplier, after taking into consideration the monthly production volume for the first family of products, was estimated to be 660. Given that this amount resulted in a 3% decrease of yield loss, parameter $\gamma_{13}$, which represents the
investment required at production stage 3 to reduce the yield loss of product family 1 by one percentage point, was computed to be approximately 220. For other families of products, the computation of the parameter $\gamma_{i3}$ also used cost information related to lids, adhesives, and labels. For stages 1 and 2, estimation of the parameters $\gamma_{ij}$ used cost information related to the type of glass jars and nozzles used in the filling process, respectively.

Estimation of the parameters $m_{ij}$, the investment required at stage j to make the yield losses for product $i$ equal to zero, was obtained by summing all costs that the firm considered necessary to reduce yield losses to zero, for each product family at each production stage. For example, estimation of $m_{13}=2000$, the investment required at stage 3 to make the yield losses for product family 1 equal to zero, was obtained by adding the monthly cost incurred from using new lids and the cost of purchasing new equipment to complement the labeling machine. These two costs were estimated to be about 660 and 1340, respectively.

The resulting parameters are as follows (rows are separated by semicolon):

$Y_{ij}=[0.96, 0.98, 0.95; 0.95, 0.96, 0.94; 0.97, 0.94, 0.98]$,

$\sigma_{ij}=[0.032, 0.020, 0.020; 0.030, 0.020, 0.020; 0.040, 0.030, 0.030]$,

$n_{ij}=[40000, 39500, 39000; 20000, 19000, 18000; 35000, 33000, 32000]$,

$m_{ij}=[1000, 2000, 2000; 2000, 1000, 2000; 2000, 2000, 2000]$,

$\gamma_{ij}=[300, 120, 200; 170, 100, 170; 220, 200, 100]$,

$B=15500, \rho=0.65, \beta=0.35, \delta=0.13$.

The solution of the constrained model resulted in the following new yields and new yield standard deviations. New $Y_{ij}=[0.9789, 0.9967, 0.9996; 0.9868, 0.9978, 0.9868; 0.9703, 0.9997, 0.9972]$. New $\sigma_{ij}=[0.0110, 0.0022, 0.0001; 0.0052, 0.0007, 0.0029; 0.0257, 0.0001, 0.0027]$.

The solution of the unconstrained model resulted in the following new yields and new yield standard deviations. New $Y_{ij}=[0.9938, 0.9990, 0.9999; 0.9961, 0.9994, 0.9991; 0.9913, 0.9999, 0.9992]$. New $\sigma_{ij}=[0.0032, 0.0006, 0.0000; 0.0015, 0.0002, 0.0008; 0.0075, 0.0000, 0.0008]$.

The computations of the analysis were carried out using MATLAB. As expected, the improved yields in the unconstrained case are greater than those in the constrained case. In addition, the improved standard deviations of the yield in the unconstrained case are less than those in the constrained case. We also note that for the constrained case, all yields and their respective standard deviations are significantly improved, except the case of product 3 in stage 1. This can be attributed to the fact that the investment required at production
stage 1 to reduce the yield loss of product 3 by one percentage point, is the second highest among the rest of the products. Furthermore, the cost to reduce the yield loss of product 3 in stage 1 is also the highest. This model suggests not to allocate significant amounts of capital resources for the improvement of the yield of product 3 at stage 1, as the funds can be diverted to other products and stages that would result in higher reductions in the cost of defects.

The total investment needed to achieve the improvement in the unconstrained case is 15853, compared with 15500 for the constrained case. We also observe that the funds allocated to improve the yield of each product at each stage is always greater in the unconstrained than the constrained case. The funds allocated for yield improvement to stages 1, 2, and 3 under the constrained case are 4579.3, 4973.5, and 5947.2, respectively. The funds allocated for yield improvement to stages 1, 2, and 3 under the unconstrained case are 4876.7, 4992.2, 5984.5, respectively. We also observe that for stages 2 and 3, the funds allocated in the two cases are about the same. For stage 1 the difference in the amount allocated for improvement under the constrained and unconstrained cases deviates by more than 6%. Much of the difference is caused by the investment made in stage 1 for product 3, as explained above.

The initial cost of defects prior to applying the improvement is equal to 2367 per month. The cost of defects after improvement has been established for the constrained and unconstrained cases is equal to 519.02 and 129.67, respectively. Thus, the monthly savings from defects after improvement has been established is equal to 1847.98 and 2237.33 for the constrained and unconstrained cases, respectively. This implied for the company that the period required to recover the investments made for yield improvement is 8.38 and 7.08 months for the constrained and unconstrained cases, respectively. This was perceived by management as a critical piece of information in the decision to improve the production system.

4 Conclusion

The decision to improve the yield and yield variability for every product at each production stage is a multidimensional problem since a number of factors affect such a decision. We present a model that simultaneously provides an optimal allocation of capital resources in order to improve the yield and its respective yield variability. The model considers such factors as yield, yield variability, volume produced at a stage, cost of implementing yield improvements, and the effect of yield variability on the cost of defects. In general, the results show that stages with low yield and high yield variability receive more capital resources for the improvement of these indices.
The model is applied in a real-life manufacturing environment in the food-packing industry. The contribution of the model lies in the fact that it weighs the effect of all these factors in the decision to improve a multistage production system and provides broad directions to management, as to which production stages and products should receive “more attention.” Discussions with management revealed that the model provided some important guidelines for operational improvement of the system. They also highlighted the difficulties in applying this model that stem from obtaining information to estimate the parameters.

Research can be extended in several directions. First, the effect of yield variability on the cost of defects needs further investigation to identify more suitable functions. Second, the effect of production stage sequencing needs to be incorporated in the models since it affects the cost of defects. Third, since the model in this paper used as input only the computed mean and variance from yield data, we need to examine the effect of the distribution of yield on the allocation of resources.

References

Development of Scrap Cost Forecasting Model: A Case Study in Hard Disk Drive Industry

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Abstract. The objective of this research is to develop the optimized scrap cost forecasting model in the Hard Disk Drive assembly process with more accuracy. Due to the current forecasting, the calculation from the Key Performance Indicators (KPIs) of all assembly processes, shows errors of about 30% which means that the production planning is inaccurate. It also cannot precisely specify the cause of scrap since some predicted variables are not relevant to the scrap cost. The reason of this research therefore is to aim to improve the prediction accuracy by more than 10%. At first, the correlation analysis is used to identify the relationship between predicted variable and scrap cost. The forecasting model has been developed and then compared between the technique of regression analysis (RA) and artificial neural network (ANN). The results from scrap cost forecasting of products A, B and C have shown that the ANN model has more accuracy in forecasting than the RA model. The forecasting errors of ANN models are 11.48%, 11.43% and 18.86% for product A, B and C respectively.

1 Introduction

This paper presents the development of scrap cost forecasting model in Hard Disk Drive (HDD) assembly process with good accuracy. Two techniques are used to develop models: regression analysis (RA), and artificial neural network (ANN). Key Performance Indicators (KPIs) of all HDD assembly processes, such as yield of each process, debug disposition, and rework ratio, has been used to formulate the model, given the name of “scrap cost concept”. The diagram in Fig. 1 illustrates the concept of the model.

Up to date for the scrap cost concept, the model has not used the data in the past to forecast scrap cost therefore it is not able to tell which factor will affect the scrap cost. The forecasting results from current models have an error of about 30%. These amounts of error obviously affect the production plan and management and lead to missing the target.

The objective of this work is to study and develop the scrap cost forecasting model that provides more accuracy by using the correlation analysis in order to investigate the correlation between all KPIs and scrap cost. The new
A forecasting model has been developed by using RA technique and then compared to the ANN technique. The most effective model between the two techniques is chosen to forecast the scrap cost.

![Fig. 1. Concept of the current model](image)

### 2 Literature Review

There are many active researches focusing on the development of a forecasting model by using the technique of regression analysis and ANN. These techniques are widely used in the electronics parts industry and HDD industry. Ruankum [1] applies the technique of time-series analysis and ANN to formulate a forecasting model of hard disk drive components demand. Paindee [2] develops a prediction system for forecasting the productivity (called yield) of HDD by using ANN. Chen [3] applies the hybrid fuzzy Linear Regression (FLR) and Back Propagation Network (BPN) to forecast the effective cost per die of a semiconductor product.

These two forecasting techniques also play an important role in the construction industry. Williams [4] studies the relationship between the low bid and completed cost for a competitively bid highway project by using the correlation analysis and regression analysis. Kim et al. [5] develop the cost estimating model based on multiple regression analysis, ANN and case-based reasoning. Wang and Gibson [6] use the regression analysis and ANN to develop models for predicting cost and schedule performance in industrial projects and building construction projects.

The RA and ANN are also widely used in other points of view. For example, Shtub and Versano [7] used them to estimate the cost of steel pipe bending based on the CAD data. Ciurana et al. [8] develop a cost model for vertical high-speed machining (HSM) based on machine characteristics. Verlinder et al. [9] compose cost formulae to estimate cost of sheet metal parts. Bianco et al. [10] use the regression model to forecast the electricity consumption in Italy.
Moreover, the research topic in cost forecasting has been developed continuously by using the different techniques. From the literature reviews [1-10], it can be seen that the ANN technique provides the most accurate results. For this reason, this research chooses the ANN as the tool to develop the scrap cost forecasting model for hard disk drive assembly process and then compares with the regression model. The forecasting model comes from the correlation analysis between scrap cost and KPIs.

3 Methodology

The framework of this research is shown in Fig. 2. Firstly, the correlation analysis is implemented in order to select the KPI’s parameters which correlate to the scrap cost. The scrap cost data and KPIs of all assembly process in the past are used. After the correlated parameters are acquired then the time-series analysis is applied to forecast the correlated parameters in the next period. The forecasting value of the parameters is used as a predicted variable in the scrap cost forecasting model. Two techniques, RA and ANN, are applied to develop the scrap cost model. Finally, the efficiencies of the models are calculated and compared by considering the forecasting errors. A number of different indicators have been introduced such as Mean Absolute Error (MAE), Mean Squared Error (MSE), Root Mean Squared Error (RMSE) and Mean Absolute Percentage Error (MAPE). At the end, the most effective model is used to forecast the scrap cost.

3.1 Correlation Analysis

There are more than sixty KPIs used to calculate the scrap cost in the current model. In this paper, we use A1, A2, A3, … instead of the KPIs of product A, use B1, B2, B3, … instead of the KPIs of product B and use C1, C2, C3, … instead of the KPIs of product C. Some KPIs might not relate to the scrap cost. If we used all KPIs to predict the scrap cost, the results would not be accurate. The Pearson product moment correlation is used to find the relationship between each KPI and scrap cost. The forty sets of weekly data of KPIs and scrap cost are used to calculate the correlation coefficient for product A, B and C. KPIs that have the absolute value of correlation coefficient (|r|) more than the critical values of the correlation coefficient are used as predicted variables in the development of scrap cost forecasting model. The absolute value of correlation coefficient (|r|) for 40 sample size is 0.325 refers to the table of critical values of the correlation coefficient [11] at the degrees of freedom equals to 38 and significant level (α) 0.05.
3.2 Time-Series Analysis

From the correlation analysis, the KPIs parameters that correlate with scrap cost are used as the predicted variables of the scrap cost forecasting model. To predict scrap cost in the future, the researcher must use the predicted variables in the same time period but the values of predicted variables in the future are unknown. Thus we use the time-series analysis to forecast the predicted variable in the future. The techniques of time-series suitable for using are considered from the plots of predicted variable data.

3.3 Regression Model

The scrap cost data and predicted variable from time-series analysis are used in developing the regression model. The multiple regression is selected to develop a forecasting model because this technique is appropriate for many predicted variables and one dependent variable. The forty sets of weekly data are used to
calculate the regression equation. The models have been developed for three products - A, B and C.

### 3.4 Artificial Neural Network Model

This paper uses the Multi-Layer Perception (MLP) to develop the forecasting model. This type of ANN is known as a supervised network because it requires a desired output in order to learn. The MLP learn using an algorithm called backpropagation. Sigmoid is chosen as the activation function. The steps in the modelling are as follows.

#### 3.4.1 Input Data

The goal of ANN is to create a model that correctly maps the input to the output by using historical data for training so that the model can then be used to produce the output when the desired output is unknown.

The input data of ANN are divided into two sets, training set and test set, as shown in table 1. The forty sets of data, weekly scrap cost data and predicted variables from time-series analysis, are used to calculate the scrap cost model in training algorithm of ANN. The other nine sets of predicted variables from time-series analysis data are used to evaluate the scrap cost model in testing algorithm.

<table>
<thead>
<tr>
<th>Table 1. Set of data for ANN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set of data</td>
</tr>
<tr>
<td>Training Set</td>
</tr>
<tr>
<td>Test Set</td>
</tr>
</tbody>
</table>

#### 3.4.2 Structure Design

The ANN structure can be designed in several ways. Since we have N predicted variables as input of ANN and only scrap cost as output, we assigned the structure to have N input, 1 hidden layer, and 1 output as shown in Fig. 3.

The networks are trained by changing the error goal and the numbers of nodes in a hidden layer until the structure gives the results close to the training and testing data. The training cycle is set to stop at 100,000 cycles. The number of nodes used for training is recommended to start at $\sqrt{N + OP}$ and the maximum number of nodes is $OP(N + 1)$ [12]. Note that N is the number of input and OP is the number of output.
3.4.3 Model Validation

After the training process, the structure that has the lowest error is selected to use as optimal structure to forecast the scrap cost.

3.5 Compare the Efficiency of Models

The forecast values from the regression model and the ANN model are used to find the accuracy of the forecasts by calculating the values of MAE, MSE, RMSE and MAPE. The more accurate model is selected to forecast the scrap cost.

4 Application and Case Study

4.1 Correlation Analysis

From correlation analysis, it can be concluded that the numbers of variables that correlating to the scrap cost which have significant level ($\alpha$) 0.05, is 9, 3, and 9 variables for product A, B and C respectively. The correlated variables of product A, B and C are shown in Table 2. It has been found that the scrap cost of each product arises from the different variables. Thus, the forecasting model for each product is developed individually.
Table 2. The variables that correlated to scrap cost

<table>
<thead>
<tr>
<th>Product</th>
<th>Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A1, A2, A3, A4, A5, A6, A7, A8, A9</td>
</tr>
<tr>
<td>B</td>
<td>B1, B2, B3</td>
</tr>
<tr>
<td>C</td>
<td>C1, C2, C3, C4, C5, C6, C7, C8, C9</td>
</tr>
</tbody>
</table>

4.2 Time-Series Analysis

The forty data of predicted variables (A1, A2, …, A9, B1, B2, B3, C1, C2, …, C9) are used to plot on time domain for considering selecting the time-series technique to forecast. The plots of predicted variables data show that all variables have no trend and cycle. Four time-series forecasting techniques are used to predict; moving average (MA), double moving average (DMA), single exponential smoothing (SES) and double exponential smoothing (DES). Tables 3, 4 and 5 show the forecasting error from four time-series techniques of products A, B and C respectively.

Table 3. The time-series forecasting error of product A

<table>
<thead>
<tr>
<th>Time-series technique</th>
<th>Predicted variable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A1</td>
</tr>
<tr>
<td>MA</td>
<td>37.80</td>
</tr>
<tr>
<td>DMA</td>
<td>60.75</td>
</tr>
<tr>
<td>SES</td>
<td>22.58</td>
</tr>
<tr>
<td>DES</td>
<td>81.31</td>
</tr>
</tbody>
</table>

Table 4. The time-series forecasting error of product B

<table>
<thead>
<tr>
<th>Time-series technique</th>
<th>Predicted variable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B1</td>
</tr>
<tr>
<td>MA</td>
<td>26.42</td>
</tr>
<tr>
<td>DMA</td>
<td>33.46</td>
</tr>
<tr>
<td>SES</td>
<td>24.59</td>
</tr>
<tr>
<td>DES</td>
<td>27.21</td>
</tr>
</tbody>
</table>

Table 5. The time-series forecasting error of product C

<table>
<thead>
<tr>
<th>Time-series technique</th>
<th>Predicted variable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C1</td>
</tr>
<tr>
<td>MA</td>
<td>30.13</td>
</tr>
<tr>
<td>DMA</td>
<td>36.73</td>
</tr>
<tr>
<td>SES</td>
<td>24.03</td>
</tr>
<tr>
<td>DES</td>
<td>28.94</td>
</tr>
</tbody>
</table>
The technique that has minimum error is used to forecast each independent variable. From Table 3-5, SES is used to forecast the variable A1, A2, A3, A4, A5, A6, A7, A8, A9, B1, B2, C1, C2, C3, C4, C6, C7, C8, C9. DMA is used to forecast the variable B3, and DES is used to forecast the variable C5.

### 4.3 Regression Model

The time-series forecasting values of predicted variables are used as independent variables in the regression model. The symbols of the variables are shown in Table 6.

<table>
<thead>
<tr>
<th>Product</th>
<th>Independent variables (Predicted variable)</th>
<th>Dependent variable (Scrap cost)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A1, A2, A3, A4, A5, A6, A7, A8, A9</td>
<td>YA</td>
</tr>
<tr>
<td>B</td>
<td>B1, B2, B3</td>
<td>YB</td>
</tr>
<tr>
<td>C</td>
<td>C1, C2, C3, C4, C5, C6, C7, C8, C9</td>
<td>YC</td>
</tr>
</tbody>
</table>

The backward selection method is chosen to find the appropriate independent variable. They then include in the regression equation. The hypothesis test on the regression coefficients, multicollinearity and Durbin-Watson test for autocorrelation are applied to select the appropriate regression equation. The regression equations for product A, B and C are shown in Table 7. The reliability of the regression equation can be determined by the standard error (S) and R-Sq (adj).

<table>
<thead>
<tr>
<th>Product</th>
<th>Regression Equation</th>
<th>S</th>
<th>R-Sq (adj)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>YA = -2.06 + 9.12(A3) + 3.56(A4) + 2.64(A7) + 1.44(A8)</td>
<td>0.08</td>
<td>44.4</td>
</tr>
<tr>
<td>B</td>
<td>YB = -0.096 + 0.831(B3)</td>
<td>0.24</td>
<td>6.4</td>
</tr>
<tr>
<td>C</td>
<td>YC = -0.214 - 1.26(C2) - 17.2(C3) + 6.38(C4) + 1.94(C8) + 0.706(C9)</td>
<td>0.10</td>
<td>45.8</td>
</tr>
</tbody>
</table>

### 4.4 Artificial Neural Network Model

The ANN model formulation starts by training the network. The predicted variables from time-series analysis are used as input data of the network and the weekly scrap cost data are used as output data. The network is trained by forty sets of data and tested with nine sets of data. Training the network is made by changing hidden layer node from starting node to maximum node.
with increasing rate of 1 and changing error goal of each hidden node from 0.1 to 1.0 with increasing rate equal to 0.1. The numbers of nodes in the hidden layer are shown in Table 8.

Table 8. The numbers of node in hidden layer

<table>
<thead>
<tr>
<th>Product</th>
<th>Predicted Variable</th>
<th>Starting node</th>
<th>Maximum number of node</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>9</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>B</td>
<td>3</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>C</td>
<td>9</td>
<td>3</td>
<td>10</td>
</tr>
</tbody>
</table>

The MATLAB program is used to compute the forecasting result of each ANN structure. The lowest error structure is selected to forecast scrap cost, shown as Table 9.

Table 9. Selected structure of ANN

<table>
<thead>
<tr>
<th>Product</th>
<th>Structure of networks</th>
<th>Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>9-9-1 (0.1)*</td>
<td>11.48%</td>
</tr>
<tr>
<td>B</td>
<td>3-4-1 (1.0)</td>
<td>11.43%</td>
</tr>
<tr>
<td>C</td>
<td>9-3-1 (0.1)</td>
<td>18.86%</td>
</tr>
</tbody>
</table>

*number of input – number of hidden layer – number of output (error goal)

4.5 Compare the Efficiency of Models

The comparison of actual scrap cost and forecasting values from regression model and ANN model of product A have been represented in Fig. 4. The gap between actual scrap cost and ANN for nine periods forecasting is narrower than regression. The mean average percentage error (MAPE) of the regression model is 30.46% and MAPE of ANN model is 11.48%. The forecasting results of product B and C are the same as product A. To measure the accuracy of the forecasting model, MAE, MSE, RMSE and MAPE are used to calculate for the forecasting errors. Table 10 shows the error of forecasting. It can be seen that ANN models have lower error than regression models for three products. Table 11 shows the error comparison of the current models and ANN models.
Fig. 4 The comparison of actual scrap cost and forecast value from regression model and ANN model of product A

<table>
<thead>
<tr>
<th>Product</th>
<th>Forecasting Model</th>
<th>MAE</th>
<th>MSE</th>
<th>RMSE</th>
<th>MAPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Regression</td>
<td>0.07</td>
<td>0.006</td>
<td>0.08</td>
<td>30.46</td>
</tr>
<tr>
<td></td>
<td>ANN</td>
<td>0.03</td>
<td>0.001</td>
<td>0.03</td>
<td>11.48</td>
</tr>
<tr>
<td>B</td>
<td>Regression</td>
<td>0.13</td>
<td>0.020</td>
<td>0.14</td>
<td>23.09</td>
</tr>
<tr>
<td></td>
<td>ANN</td>
<td>0.07</td>
<td>0.010</td>
<td>0.10</td>
<td>11.43</td>
</tr>
<tr>
<td>C</td>
<td>Regression</td>
<td>0.06</td>
<td>0.006</td>
<td>0.07</td>
<td>21.99</td>
</tr>
<tr>
<td></td>
<td>ANN</td>
<td>0.05</td>
<td>0.004</td>
<td>0.06</td>
<td>18.86</td>
</tr>
</tbody>
</table>

Table 11. The comparison between the current models and ANN models

<table>
<thead>
<tr>
<th>Product</th>
<th>Current model</th>
<th>ANN model</th>
<th>Different of error</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>28.69%</td>
<td>11.48%</td>
<td>17.21%</td>
</tr>
<tr>
<td>B</td>
<td>27.20%</td>
<td>11.43%</td>
<td>15.77%</td>
</tr>
<tr>
<td>C</td>
<td>50.83%</td>
<td>18.86%</td>
<td>31.97%</td>
</tr>
</tbody>
</table>

5 Conclusion

The objective of this research is to develop the scrap cost forecasting model for the HDD assembly process with improvement of accuracy of at least 10%. The models are developed in two techniques, regression analysis (RA) and artificial neural network (ANN). The backward selection method is applied in order to select the appropriate regression model rather than use the enter selection, forward selection, or stepwise selection method because the backward selection method begins by placing all of the predicted variables in the model and deletes one at a time until reaching a point where the remaining variables all make significant partial contributions to predicting y. For the ANN model, multi-layer perception (MLP) is used to develop the forecasting model.
Training the network is required to find the appropriate structure by changing the hidden layer node and error goal. The lowest error structure is selected to forecast scrap cost.

The results from scrap cost forecasting of products A, B and C have shown that the ANN model is able to forecast with more accuracy than the RA model. The ANN model is recommended to use to forecast the scrap cost in HDD assembly processes. The forecasting errors of ANN models are 11.48%, 11.43% and 18.86% for products A, B and C respectively. The comparison between ANN models and the current models show that ANN can predicted scrap cost with increasing the accuracy from the current models 17.21%, 15.77% and 31.97% for products A, B and C by order.

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References


Quantitative Analysis 2
A Note on Three-Parameter Buy-Back Contract in Newsvendor Setting

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Abstract
In this article, we consider a buy-back contract with three parameters, namely a wholesale price and a buy-back price as well as a returns ratio, in a newsvendor setting. An interaction between a supplier and retailer is modeled as a two-stage game. We provide an analysis of the game and illustrate via a numerical example how it can be used to find the contract parameters.

Keywords: operations research; stochastic model applications; supply chain management; supply contracts

1 Introduction
We consider a buy-back contract (also known as a returns policy), one of the most commonly found supply contracts. In a typical returns policy, a supplier sells a product up-front to a retailer at a wholesale price; after retailer’s demand materializes, a portion of unsold units can be returned to the supplier, and some

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refunds are given to the retailer. In practice, there exists a spectrum of contracts. The most generous term allows the retailer to return all unsold units at a buy-back price equal to the wholesale price. The least generous term does not allow any returns. In a partial returns policy, the supplier allows the retailer to return up to a pre-specified returns ratio of the retailer’s order quantity at the buy-back price which may be strictly less than the wholesale price.

Despite the fact that the returns policy has been implemented for quite some time, a supplier does not have a systematic way to set the three contract parameters, namely the wholesale price, the returns ratio, and the buy-back price. Rather, they are chosen in arbitrary fashion based on the supplier’s experiences. This article proposes a procedure to set the contract parameters in a newsvendor setting with a supplier and a retailer.

An overview of supply contracts in a newsvendor setting can be founded in e.g., [1] and [2]; they describe various types of supply contracts, e.g., a buy-back contract, a revenue sharing contract, a sales rebate contract and a quantity-discount contract. On the buy-back contract, some papers are, for instance, [3], [4], [5], [6]. We briefly review some of them below. [3] considers the three-parameter buy-back contract as in ours. The paper emphasizes on finding a coordinating contract, which maximizes the expected profit of the entire supply chain, i.e., the sum of the both parties’ expected profits. In [3], conditions under which there exists a coordinating contract are derived: Non-coordinating contracts include the most generous contract that allows all unsold units to be returned for the wholesale price and the least generous contract that allows no returns. Rather than focusing on achieving channel coordination, we assume that each of the two parties maximizes its own expected profit; hence, their interaction is formulated as a non-cooperate game between the supplier and the retailer. [4] considers a two-parameter buy-back contract with a buy-back price and a wholesale price;
any left-over can be returned. This two-parameter contract is a special case of ours.

2 Formulation

Consider a supplier with one production opportunity in a newsvendor setting. The product is sold through a retail store (retailer), which faces a random demand, denoted by $D$. Demand will be realized after the supplier has already committed to the store a quantity of $x$ at a per-unit production cost of $c \geq 0$. Once the demand is realized, the number of units sold at the store is $\min(D, x)$ at a unit price of $p \geq c$. Denote the expected sales as $s(x) = E[\min(D, x)]$.

The following sequence of events is assumed. First, the supplier offers a contract to the store. Then, the store decides how many units to order from the supplier. Finally, demand materializes, a transfer payment is made, and a profit of each party is realized. Assume that both parties are risk neutral, so their decisions are based upon their expected profits.

The store pays the supplier a per-unit wholesale price $w \in (c, p)$ in order to receive its order quantity of $x$ from the supplier. After its demand $D$ materializes, the supplier allows the store to return the left-over $(x - D)^+$ up to a fraction of $u \in (0, 1)$ of the store’s order quantity. The notation $(y)^+ = \max(y, 0)$, the positive part of a real number $y$. Thus, the number of units returned to the supplier from the store is

$$R(x; u) = \min((x - D)^+, ux)$$

Let $\nu(x; u) = E[R(x; u)]$, the expected number of returned items. The supplier gives the store a buy-back price $b$ for each unit returned. The expected transfer
payment from the store to the supplier is given as

\[ wx - bw(x; u) \]

Given the vector of contract parameters \((b, u, w)\) offered by the supplier, the expected profit of the store is defined as the expected revenue minus the expected transfer payment:

\[ \psi(x; b, u, w) = ps(x) - wx + bw(x; u) \]

Given the store’s order quantity \(x\), the expected profit of the supplier is the expected transfer payment minus the product cost:

\[ \pi(b, u, w; x) = (w - c)x - bw(x; u) \]

Each party chooses an action to maximize its own expected profit. The decision problem can be formulated as the following two-stage game of the supplier and the store:

\[
\begin{align*}
\max & \quad \pi(b, u, w; \hat{x}) \\
\psi(\hat{x}; b, u, w) & \geq \psi(x; b, u, w) \quad \text{for all } x
\end{align*}
\]

Given the vector of contract parameters \((b, u, w)\), the store chooses an optimal order quantity, denoted by \(\hat{x}\) in (2), which maximizes its expected profit \(\psi(x; b, u, w)\). Next, given the store’s best response \(\hat{x}\), the supplier chooses the vector of contract parameters that maximizes its expected profit \(\pi(b, u, w; \hat{x})\) as in (1).
3 Analysis

Let $F$ denote the probability distribution of demand $D$. Proposition 1 characterizes a solution of the store’s maximization problem in (2), i.e., the store’s best response given that the supplier offers the contract with parameter $(b, u, w)$ in the first stage.

**Proposition 1.** Given a vector of contract parameters $(b, u, w)$ offered by the supplier, the store’s optimal order quantity $\tilde{x}$ that maximizes $\psi(x; b, u, w)$ satisfies the following condition:

$$p\tilde{F}(\tilde{x}) - w + b\nu'(\tilde{x}; u) = 0$$

(3)

where $\nu'(x; u) = d\nu(x; u)/dx$ is given as

$$\nu'(x; u) = u - \left[\tilde{F}(x) - (1 - u)\tilde{F}((1 - u)x)\right]$$

**Proof.** Note that

$$\nu(x) = \int_{0}^{\infty} P\left(\min(ux, (x - D)^+ > t)\right) dt$$

$$= \int_{0}^{ux} P((x - D)^+ > t)dt$$

$$= ux - \int_{0}^{ux} P((x - D)^+ \leq t)dt$$

$$= ux - \int_{0}^{ux} P(D \geq x - t)dt$$

$$= ux - \int_{(1-u)x}^{x} \tilde{F}(y)dy$$

An optimal order quantity that maximizes $\psi(x; b, u, w)$ satisfies the first-order necessary condition: $\psi'(\tilde{x}; b, u, w) = 0$.

It can be easily seen from the store’s optimality condition (3) that it places
a larger order quantity, if the supplier offers a larger buy-back price or a smaller wholesale price.

Assume that $F$ is continuous distribution with a density function $f(x) \geq 0$. Proposition 2 characterizes a solution of the supplier’s problem in the first stage (1), i.e., the supplier’s best response given the store’s best response in the second stage.

**Proposition 2.** Suppose that the buy-back price $b$ and the ratio $u$ are chosen a priori. Then, the supplier’s optimal wholesale price is

$$\tilde{w}(x^0) = p\bar{F}(x^0) + bv'_{k}(x^0; u)$$

where

$$[-pf(x^0) + bv''(x^0)]x^0 + p\bar{F}(x^0) - c = 0$$

and

$$\nu''(x) = f(x) - (1 - u)^2f((1 - u)x)$$

**Proof.** Suppose that the pair $(b, u)$ is chosen a priori. It follows from (3) in Proposition 1 that if the supplier wants to induce the store to order $x$, then the wholesale price it needs to offer is

$$\tilde{w}(x) = p\bar{F}(x) + bv'(x; u)$$

Thus, instead of choosing $w$, the supplier’s decision can be expressed in terms
of \( x \). Given the store’s best response, the supplier’s expected profit is

\[
\hat{\pi}(x) = \pi(b, u, \hat{w}(x); x) = E[\hat{w}(x) - b\nu(x; u) - cx]
\]

Note that

\[
\hat{w}'(x) = -pf(x) + b\nu''(x; u) \tag{7}
\]

The first derivative of the supplier’s expected profit can be easily found:

\[
\hat{\pi}'(x) = \hat{w}'(x)x + \hat{w}(x) - b\nu'(x; u) - c \tag{8}
\]

\[
\hat{\pi}'(x) = [-pf(x) + b\nu''(x)]x + p\hat{F}(x) - c \tag{9}
\]

where we obtain (9) by substituting (6) and (7) into (8). The first-order necessary condition for optimality is \( \hat{\pi}'(x) = 0 \).

Suppose that the buy-back price \( b \) and the ratio \( u \) are given \textit{a priori}. We can use Proposition 2 to solve for an equilibrium solution in the game (1)–(2). Recall \( x^0 \) is a root in (5). In the first stage, the supplier offers an equilibrium wholesale price of \( \hat{w}(x^0) \) as in (6). In the second stage, the retailer places an equilibrium order of \( x^0 \). Given the solution, the supplier’s expected profit is \( \pi^*(b, u) = \pi(b, u, \hat{w}(x^0); x^0) \), and the retailer’s expected profit is \( \psi^*(b, u) = \psi(x^0; b, u, \hat{w}(x^0)) \).

In general, the buy-back price \( b \) and the ratio \( u \) are given not \textit{a priori}. If the supplier has negotiation power and determines the contract parameters, then it chooses the pair \( (b, u) \), which maximizes \( \pi^*(b, u) \). If the set of all possible pairs is small, the maximization problem faced by the supplier can be easily done via enumeration.
4 Numerical Illustration

Consider a monthly magazine publisher, which incurs a per-unit production cost of $c = 60$ THB (Thai Baht) and sells at a retail price of $p = 100$ THB. The retailer’s monthly demand, $D$, is normally distributed with mean $\mu = 12834.50$ and standard deviation $\sigma = 866.95$.

Currently, the publisher allows the store to return up to five percent of the initial order (i.e., $u = 0.05$) at a per-unit buy-back price $b = 70$ THB. It follows from Proposition 2 that the supplier’s optimal wholesale price is $w = 98.77$ THB. Given that the supplier offers this wholesale price, the order quantity placed by the store is $x = 11,161.12$, which can be found from Proposition 1. The expected monthly profits of supplier and retailer are 432,050.86 and 13,314.82 THB, respectively; see Table 1.

An R program for the decision problem is show in Table 2. Note that we use an R built-in function, `uniroot`, to solve for $x^0$ given in (5); see function `RHSOptCond`. The supplier’s wholesale price $\tilde{x}$ is calculated in `rWholesale`. The expected profits of supplier and store are given in `supplierProfit` and `storeProfit`, respectively.

We can easily find different contract parameters, which are better from both parties’ perspective; see the remainder of Table 1. For instance, suppose that the supplier allows the larger ratio $u = 0.10$ but decreases the buy-back price to $b = 70$ THB. Then, the wholesale price is 98.70 THB and the retailer’s order quantity is 11,270.20; the expected profits of supplier and retailer increase to 435,170.56

<table>
<thead>
<tr>
<th>buy-back price</th>
<th>ratio</th>
<th>wholesale price $\bar{w}(x^0)$</th>
<th>order quantity $x^0$</th>
<th>store’s profit $\psi^*(b, u)$</th>
<th>supplier’s profit $\pi^*(b, u)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>75</td>
<td>0.05</td>
<td>98.77</td>
<td>11,161.12</td>
<td>13,314.82</td>
<td>432,050.86</td>
</tr>
<tr>
<td>70</td>
<td>0.10</td>
<td>98.70</td>
<td>11,270.20</td>
<td>14,170.65</td>
<td>435,170.56</td>
</tr>
<tr>
<td>78</td>
<td>0.95</td>
<td>98.66</td>
<td>11,448.27</td>
<td>14,840.37</td>
<td>440,730.08</td>
</tr>
</tbody>
</table>

Table 1: Profits for different contract parameters
```r
main <- function(buyback, ratio){

    price <- 100;  # retailer price
    cost <- 60;    # production cost
    mu <- 12834.5; # mean of demand
    sigma <- 896.33; # stdev of demand
    xmin <- 10000; # lower bound of root in uniroot
    xmax <- 30000; # upper bound of root in uniroot
    x <- uniroot(RHSOptCond, c(xmin, xmax), price, cost, mu, sigma, buyback, ratio)$root;
    wprice <- rWholesale(x, mu, sigma, price, cost, buyback, ratio);
    aProfit <- storeProfit(x, mu, sigma, price, cost, buyback, ratio, wprice);
    sProfit <- supplierProfit(x, mu, sigma, price, cost, buyback, ratio, wprice);
    result <- rbind(prod.quantity=x, wholesale=wprice, store.profit=aProfit, supplier.profit=sProfit);
    print(result);
    return(result);
}

RHSOptCond <- function(x, p, ct, m, s, bb, r){
    v2 <- dnorm(x, m, s) - ((1-r)^2)*dnorm((1-r)*x, m, s);  
    RHS <- ( - p*dnorm(x, m, s) + bb*v2)*x + p*(1-pnorm(x, m, s)) - ct;
    return(RHS);
}

amtReturned <- function(x, m, s, p, ct, bb, r){
    ar <- r*x - (lossFn((1-r)*x,m,s) - lossFn(x, m, s));
    return(ar)
}

storeProfit <- function(x, m, s, p, ct, bb, r, w){
    sale <- m - lossFn(x, m, s);
    sp <- p*sale - w*x + bb*amtReturned(x, m, s, p, ct, bb, r);
    return(sp);
}

supplierProfit <- function(x, m, s, p, ct, bb, r, w){
    sale <- m - lossFn(x, m, s);
    sp <- (w-ct)*x - bb*amtReturned(x, m, s, p, ct, bb, r);
    return(sp);
}

rWholesale <- function(x, m, s, p, ct, bb, r){
    v1 <- r - (1-pnorm(x, m, s)) + (1-r)*(1-pnorm((1-r)*x,m,s));
    ww <- p*(1-pnorm(x, m, s)) + bb*v1;
    return(ww);
}

lossFn <- function(x,mu,sigma){
    # E[(X-
    z <- (x-mu)/sigma
    Lz <- dnorm(z) - z*(1-pnorm(z))
    y <- sigma*Lz
    return(y)
}
}
```

Table 2: R program to find a solution in (1)–(2)
and 14,170.65 THB, respectively. Consider another contract with \( u = 0.95 \) and \( b = 78 \): the expected profits of supplier and retailer increase to 440,730.08 and 14,840.37 THB, respectively. Clearly, the latter \((b, u) = (78, 0.95)\) is preferred to the first \((b, u) = (70, 0.10)\) from either party’s viewpoint.

**References**


A model to locate local blood bank with emergency referral

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Abstract. The location problem is generally formulated as the location allocation problem (LAP). In this study, a variant of the location problem with emergency referral (LPER) is considered. The LPER aims to solve the number and locations for local blood banks (LBBs) assign hospitals to each LBB, as well as determine the location of LBBs with emergency referral. The mathematical model for LPER is proposed, seeking to minimize total costs by locating the LBBs that satisfy emergency referrals. The computational results of the model according to the optimal solution and can be conveniently used for the decision making.

Key word: Location problem, Blood bank, Emergency referral

1 Introduction

The healthcare system has become one of the most important aspects of the developed countries. Due to aging of the societies and continuing improvement of the medical treatment, this trend is likely to continue. Healthcare logistics has been increasingly aware by professionals in the medical, business and engineering fields because it can be used to improve medical services as well as reduce operating costs. Blood is a scarce resource and is essential for medical treatment procedures. Blood logistics is an approach to manage and use blood effectively and efficiently. Determining location of blood banks is strategic decision in the blood logistics. Daskin and Dean [1] described that the location of facilities is critical in any application area for both industry and healthcare. The implications of poor location decision in healthcare extend well beyond cost and customer service considerations. If only a small number of facilities is utilized without the consideration of locations, it may result in increases in mortality and morbidity rates. Thus, facility location takes on an even greater importance when applied to locations determine for healthcare facilities.

In the literature, the research on blood logistics focuses on the complexity of effective and efficient of blood location-allocation. Or and Pierskalla [2] considered a regional blood management problem where hospitals are applied by a regional blood bank in their region and developed a location-allocation
model that minimizes the sum of the transportation costs and the system costs. Brodheim and Prastocos [3] presented a prototype for the regional blood center (RBC) and the hospital blood banks in order to optimize blood availability and utilization for a programmed blood distribution system. Sapountzis [4] developed an integer-programming model to allocate blood from a RBC to hospitals. The objective of the model is to minimize the total expected number of units of expired blood. Jacobs et al. [5] developed an integer-programming model for blood collection and distribution system. This research presented an analysis of alternative locations and service areas of American Red Cross blood facilities. Şahin et al. [6] presented a blood bank location model and developed several location-allocation models to solve the problems of regionalization based on a hierarchical structure, however, the facilities fixed costs of the RBC were not considered. One recent research by Çetin and Sarul [7] derived a mathematical programming model for location of blood banks among hospitals or clinics. The objectives aim to minimize the total fixed cost of LBBs and the total traveled distance between the blood bank and hospitals. After a thorough review, we have found that the area of emergency costs in location problem has yet to be explored, especially in the topic of emergency referral.

The P-median model is one of a basic location model in the class of discrete location models. Daskin and Dean [1] proposed the location model of P facilities to minimize the coverage distance subjected to a requirement that all demands are covered. Daskin [8] provided a traditional formulation of this problem. In subsequent study, Elloumi et al. [9] presented an innovative formulation of the problem that exhibits improved computational characteristics when compared to the tradition formulation. Correa et al. [10] described that an application of the capacitated P-median model to a real-world problem and proposed a genetic algorithm to solve the P-median model.

This paper is organized as follows: section 2 introduces problem definition and assumptions. Section 3 presents the location problem with emergency referral model. Computational results are given in section 4 and the solution is concluded in section 5.

2 Problem definition and assumptions

In this study, we develop a location problem with an emergency referral (LPER) to solve the problem of LBBs, which is extending from the P-median model. The objective of the problem is to minimize three major costs, fixed costs of LBBs, periodic delivery costs, and emergency delivery costs. The main decisions of the problems are to determine (1) locations and the number of LBBs, and (2) hospitals assignment to LBBs.


2.1 Problem definition

In this study, we focus on the area of Nakhon Ratchasima of Thailand, which consists of 36 hospitals. A few hospitals in the region have given up blood collection and made a supply agreement with regional blood center (RBC). Some of these hospitals order blood from RBC periodically. Each order quantity is determined by each hospital based on past experience and knowledge of the professionals. Each hospital sends blood request together with transportation to pick up blood from RBC and then return to the hospital. Generally, RBC is located far from each hospital in the responsible area. This causes a lot of lengthy and inefficient trips, leading to high transportation cost. Moreover, blood may not be available to hospitals in time of needs especially for those patients with emergency attention.

The LPER integrates the decision-making process to determine the optimal number and locations for LBBs as well as an optimal assignment of hospitals to LBBs. The objective of the problem is to minimize the total fixed cost of LBBs, periodic delivery costs, and emergency referral delivery costs associated with LBBs. In particular, given a set of potential LBBs and a set of hospitals locations, we seek to determine a set of candidate LBBs from the whole list of available LBBs to be opened at hospitals in such a way that:

a) Each hospital must be assigned to LBB and can be assigned to no more than one LBB.

b) The maximum number of LBBs is no more than the number of available hospitals.

In the context of this research, a delivery route is a path that starts from a LBB and returns to the same LBB after visiting at least one hospital. Each hospital is allowed to only a single visit in each delivery route.

2.2 Basic assumptions

The basic assumptions of this research are:

2.2.1 Some local hospitals are also functioned as LBBs. The number of LBBs is fixed, not to exceed the number of available hospitals.

2.2.2 The hospitals in a region receive their expected weekly requirements once a week. The blood deliveries are made by vehicles with temperature-controlled containers, starting from the LBB then visiting at least one hospital and returning to the LBB.

2.2.3 In case of emergency referral, a delivery vehicle will be dispatched from LBB immediately to deliver blood to the needed hospital and then return to the LBB without making any further stops at other hospitals.

2.2.4 The information of the number of emergency referral and distance between hospitals is acquired based on actual information.
2.2.5 There is no limit on the maximum tour length. The constraint on the maximum route length is not a physical constraint in the LPER, but is imposed in some cases by labor contracts or other restrictions. This assumption is strictly computational and can be avoided at the expense of a significant additional computational effort.

3 The location problem with emergency referral model

In this section, we present a mathematical model for the location problem with emergency referral. Notations of the model and mathematical model formulation are shown below.

3.1 Notations

The subscripts, sets, parameters, and variables used in the model are as follows:

I) Subscripts:
   - \( i \) = indices of hospitals
   - \( j \) = indices of LBBs

II) Sets:
   - \( I \) = set of all hospitals
   - \( J \) = set of hospitals that are allowed to be LBBs

III) Parameters:
   - \( d_{ij} \) = distance between points \( i \) and \( j \)
   - \( f_j \) = fixed cost for LBB \( j \)
   - \( c \) = cost per kilometer of a delivery vehicle
   - \( p \) = maximum number of LBBs
   - \( r_i \) = number of the emergency referrals for hospital \( i \)

IV) Decision Variables:
   - \( Z_j \) = \begin{cases} 
   1 & \text{if a LBB is established at location } j \\
   0 & \text{otherwise} 
   \end{cases}

   - \( x_{ij} \) = \begin{cases} 
   1 & \text{if hospital } i \text{ is assigned to LBB } j \\
   0 & \text{otherwise} 
   \end{cases}

3.2 Mathematical model formulation

The LPER can be formulated as an integer programming model.
The objective function (1) minimizes the total fixed cost of LBBs, periodic delivery costs, and emergency referral delivery costs. Constraint (2) states that each hospital must be assigned to exactly one LBB. Constraint (3) states that each hospital can be assigned to only one LBB. Constraint (4) states that the number of LBBs is not allowed to exceed \( p \) in this problem. Constraints (5) and (6) are standard integrality constraints. Constraint (6) can be relaxed to a simple non-negativity constraint.

4 Computational results

Computational experiments were performed using various data sets from Regional Blood Center V (RBC-V) of the Thai Red Cross Society, consisting of 36 hospitals. All hospitals are candidate LBBs. The RBC-V also provided us with realistic estimates of the number of emergency referrals and the fixed costs of LBBs determined by different sizes of the hospitals. The proposed mathematical model was solved using LINGO 11.0 on a computer with AMD Sempron (TM) 2.10 GHz and 3.00 GB memory. The program managed to solve the problems optimally.

To be more specific, a data set consisting 36 hospitals \((H_1, H_2, H_3, \ldots, H_{36})\) and 36 referrals was solved as an example in this study. Hospitals are located all over Nakhon Ratchasima province as illustrated in Figure 1. This problem was solved optimally and the result suggests that candidate LBBs should be
located at the hospitals $H_2$, $H_4$, $H_6$, $H_7$, $H_9$, $H_{11}$, $H_{18}$, $H_{21}$, $H_{28}$, $H_{30}$, and $H_{32}$, as shown in Figure 1. For instance, $H_2$ is assigned to serve hospitals $H_1$, and $H_3$. $H_{32}$ is assigned to serve hospitals $H_{33}$, $H_{34}$ and $H_{35}$. The maximum distance between the LBB and the hospital ($H_{18} – H_{26}$) is 59 kilometer. The minimum distance between the LBB and the hospital ($H_{18} – H_{17}$) is 1 kilometer. The objective function value is 17,012 baht per week, which is 11,542 baht per week for the fixed cost of LBBs, 2,680 baht per week for the periodic delivery costs, and 2,790 baht per week for the emergency referral delivery costs.

![Fig. 1. The optimal solution for the location problem with emergency referral](image)

5 Conclusion

In this paper, we propose a mathematical model for the location problem with emergency referral, which is an integer programming model. The objective is to minimize the total cost of LBBs fixed cost, periodic delivery cost, and emergency referral delivery cost. The model is modified from the $P$-
median problem, in which objective function is extended and the number of LBBs is limited. The mathematical model proposed is able to solve the number of LBBs optimally and can be conveniently used to locate the blood bank facilities. The proposed model may be conducted for not only LBB but also other appropriate location issues in healthcare and other areas, such as location of hospitals and ambulance stations with emergency cases, or warehouse location with emergency demand. As another further study, we will modify this model to help analyze the impact of emergencies on the facilities locations and its related cost issue.

6 Acknowledgements

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References

Intensify Avatars’ Immersion
In The Virtual Worlds through a Novel Friend Prediction Model

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Abstract. Virtual worlds are becoming effective interactive platforms no matter in education, social sciences, and humanities. Computing the similarity between users have been the solutions for friend prediction in social networks. However, user communities in the virtual worlds tend to have less real world linkages than those in the social networks. To overcome the problem that arise from individuality in the virtual worlds, this study proposes a novel model to integrate similarity and contact activities for friend predictions. The preliminary experiment was performed with a trained SVM classifier and verified to be an effective model.

Keywords: virtual world (VW), friend prediction, Support Vector Machine (SVM), dynamic contact, social network (SN).

1. Introduction

A virtual world (VW) is an electronic environment that visually mimics complex physical spaces, where people, represented by animated characters or avatars, can interact with each other via virtual objects. The trend of playing online games with friends encourages the even flourishing VWs market. Ubiquitous computing has also brought up the fashion of that many families forgo watching TV drama to virtual worlds Bainbridge [1].

There are more and more VWs plant on social network (SN) platforms. Successful friendship prediction may increase sales for the SN companies. With the explosive power of SNs, such as facebook, the study of friend prediction in SNs is emerging. However, the study of friend prediction in VWs remains few.

Friend prediction in VWs induces users to perform more contact activities. Social interactions in VWs might shape purchase behaviors. Stable relationship was positively associated with social presence and enhances user immersion in the VWs. User flow increases user intentions to purchase and in consequence increases the sales from advertisements for the VWs providers [2].

User contacts in VWs are very different from user interactions in SNs. First, players in a VW start to be strangers to other players. An avatar represents himself/herself in the VW rather than an identity which links to some real
groups in the SNs. On the contrary, users in the SNs tend to have their friends in real life. In the VW, players are not identified by their physical attributes, such as job, education or location.

Secondly, in a VW, players have more diverse actions than those in the SNs. Players may join bidding, play games with others. Due to a variety of complex actions in the VW, there are more interesting homophily attributes of dynamic behaviors for researchers to explore. Existing friend predictions in SNs focus on the analysis of static homophily attributes, such as time and location [3]. In the VW, avatars can swift to any location, so the spatial dynamics become less important for virtual interactions as they are in the real world [2]. The models with static attributes fit for SNs may not fit for VWs. Proposing an effective friends prediction method with behavior homophily attributes will enhance the degree of user adhesiveness in VWs.

Thirdly, participants in the VWs are less information oriented and socialization oriented, they are game oriented and role-play oriented [4]. The friendships in the VWs need not be built from a direct interaction. Some players usually join the same quests or stay in the same community without communication. This kind of contacts may deepen the impression of group players. Stability of the virtual place increases the likelihood of regular encounters with “familiar strangers” thus establishing participants’ connections and build up the friendships [5]. Therefore, the way users make friends in the VWs is different from those in the SNs. In this paper we set user ‘contacts’ rather than ‘interactions’ to broaden participants’ connection in the VWs.

Classification and cluster methodologies have been fruitfully applied on the merchandise prediction to increase the related sales. There is a trend toward friend prediction in SNs. In recent years, more and more research focuses on friend prediction, however, for weblog platforms, such as Livejournal, Amazon and Twitter. Golder et al. structurally classified friend predictions in SNs into 4 categories: reciprocity, shared interests, shared audience and filtered people [6]. Kwon et al. [7] and Hsu et al.[8] use the idea of shared interests to combine with social context and friends of friends respectively. The shared interests are static attributes and present effective results. However, little research has focused on friend predictions in VWs. This research investigates friend predictions in the VWs. With the special attributes encompassed in the VWs, this paper has the following three contributions,

1. There have been studies focused on friendship predictions in SNs where the activities are more simplex, such as read articles or reply message [3][8][9]. Our research proposed a methodology for a complex environment in the virtual world, in which users have heterogeneous contacts with other users.

2. This paper combines personal static attributes and user-to-user dynamic contacts to predict friends. Most of the existing friend recommendation
researches focus on the analysis of static homophily attributes, such as
time, location [3] or graph-based algorithm [10]. We focus on behavior
attributes in the VWs, such as the quests participants do and how they
consume in the VWs. Those complex contacts in the VW may be
described by a set of dynamic features and weights in the proposed model.

3. There has been fruitful research resulting on friend predictions in SNs.
Most of those papers predict friends by similar attributes. In the presented
model, we demonstrate the friend prediction models fit for the SNs, may
not perform effective in the VWs. Our experiment, based on primary
survey data collected from 7,889 users of Roomi (www.roomi.com.tw)
, supports our theoretical model and suggests that both the static attributes
and the VW contacts affect the friendship building in VWs.

In the following sections, we introduce related theory and empirical results.
Section 2 reviews the related works on SN and the related theory we apply,
including SVM, information gain, and the principal of homophily. Section 3
elaborates the methodology we propose. Section 4 demonstrates the experiment
steps and result. Section 5 closes with some conclusions and observations.

2. Theoretic Background

The essential features of social-networking web sites are that they provide a
platform in which members can easily create profiles with information about
themselves and define their trusted circle of friends [11]. Virtual world is a
three-dimension space where everyone can play as an avatar to perform a
variety of contacts to each other and play games with others. In the VWs,
people can perform social activities as in the SNs; however the characteristics
are very different between the two platforms. There are more and more
research results regarding friend predictions in SNs, but little research has been
conducted into friend predictions in the VWs.

In this section, we firstly refer how existing friend prediction methods do in
SNs, and elaborate the recent research on VWs to demonstrate the lack of
friend prediction methodology in VWs, and finally describe existing
classification research in fields of prediction to evolve the interdisciplinary for
the VWs. In the proposed model, information gain measure is applied to
compose the decisive attributes. This measure will also be briefly described in
the last part of this section.

2.1 Friend Prediction In Social Networks

The principle of homophily is the idea that contact between similar people
occurs at a higher rate than among dissimilar people. Potential new ties are
heavily dependent on our existing set of ties, e.g. friends of friends – and on the organizations of which we are part, such as schools, workplaces and community groups[12]. Golder et al. [6] stated that increase internal density will help the organization to build community at the lowest expense. Three of four prediction principals suggest friends based on common interests and tracking activities.

There have been studies utilize user interests and friend social graph to predict friends. Kwon and Kim [7] proposed the friend prediction method with a friendship score. The friendship score was computed by physical context and social context in the SN. The physical context was the similarity of user profiles, such as user location and time, and the social context was the friend relation in the friendship graph. Hsu et al. analyzed the friendships in LiveJournal [8]. It predicted friends by decreasing count of mutual interests and graph features, such as in/out ward degree of the nodes and number of mutual friends. Silva et al. [10] used the data obtained from the Oro-Aro SN in Brasil. It utilized the graph topology of the SNS (social network services) to filter second degree friends of friend of a given node.

Interpersonal communications constitute an important communication media especially for social groups that are hardly reachable by mass media advertising [13]. Therefore, applying social graph, user profile and user interests to predict friendship demonstrates a major portion in the existing SNs research.

2.2 Research On Virtual Worlds

As the ubiquitous computing emerging, the VWs also spread its territory like wildfire. Kzero Worldwide stated that the total registered account in VWs has reached 1,400 millions, which means the registered members expanded more than double fold within two years. And the revenue will rise from $3.9bn in 2011 to $6bn by the end of 2012[14].

Messinger et al. [11] provides a literature review of existing VW research. Bainbridge [1] puts emphasis on the research potential of online VWs. Animesh [2] states the 3D representation of space in VWs brings users closer to the physical world. It helps the researchers may refer the existing research results in physical world. It focuses primarily on three types of virtual experience telepresence, social presence and flow, and how those dynamics affect intention to purchase virtual goods. The study proves flow, user immerse in the VWs, is positively relate to intention to purchase virtual goods.

Utz states that similarity in interests and attitudes are the basis of virtual relationships [4]. It focuses on interests scope on whether users spent time on game playing or role playing and the attitude toward the VWs. This paper gives
a streak of light on what dynamics influence friend relation in the VWs, however, how to enhance the friendship density among users in the VWs remain unstated.

2.3 Classification Applied in Fields of Prediction

A wide range of classification methods have been used for fields of early detection. Prediction tasks are basically binary classification problems. It means observations are assigned into one of the positive and negative groups after data analysis. Among all the classification methods, support vector machine (SVM) has been applied successfully in human resource [15], financial risk prediction [16-18] and trust relationship prediction[9].

As the customer behavior prediction have become extremely common in recent years, trust relationship prediction is becoming a hot issue in the SNs. Ma et al. [9] predicted trust relationship between two users by user interaction features in an online user generated review application. The interaction features were based on combinations of rating score and rating numbers.

Due to the flourishing results in fields of prediction, our proposed model also applied SVM to predict friendship in VWs. SVM is a machine learning classification method for linear or non-linear data. It uses a non-linear mapping technique to transform the original training data into a higher dimension; therefore, data from two classes can always be separated by a hyperplane. It builds a model according to the training data and assigns new examples into one category or the other. The machine finds the global optimal hyperplane by support vectors and margins. Once the maximum marginal hyperplane is derived from training data, the trained model can be used for prediction as well as classification[19]

Information gain is based on pioneering work by Claude Shannon on information theory[20], which studied the value or “information content” of messages. It is the difference between the original information requirement (i.e., based on just the proportion of classes) and the new requirement (i.e., obtained after partitioning on one attribute). We use information gain measure to select the decisive attributes set that affect friend predictions.

3. Friend Prediction Framework

In contrast to the interactions in the SNs, users may have direct contacts, such as talk, gift giving and diary tracking, with those who are not yet his/her friends in the online VWs. In this research, we remain the friendship definition in SNs. The friendship is a relation that two persons have bi-directed link between them or they are mutually recognized to be friends.
In the proposed model, the friendships in the VW are built due to two aspects: personal static attributes and dynamic contacts with others. Users’ personal favors and behaviors, such as amount of consumption and the time s/he spent in various games, belong to static attributes; the interactive actions, such as gift giving, visit and transaction, belong to dynamic contacts.

The research framework is depicted as Figure 1. The methodology is followed by three phases. The first phase is to calculate the user-to-user similarity; the second phase is to accumulate user-to-user dynamic features; in the third phase, a trained SVM classifier will classify users into friends and non-friends for each user.

3.1 Calculate Similarity Based On Attributes

The first phase of the framework is to calculate attribute similarity between user pairs. There are two main procedures in this phase. The first step is to decide the important attributes those affect users’ friend making decision. The method we proposed is information gain[20]. After constructing the attributes set, the second step is to compute similarity between user pairs. The similarity degree will later be merged with dynamic category integrals into SVM classifier for friend prediction.

Compose decisive attributes by information gain

Before calculating the user to user similarity, the first step is to build user-to-user's attribute relation: Each attribute has different value scale. This step is to normalize the scale into 0 to k. There will be k+1 data intervals. User $U$’s actual value of his/her attribute $i$, $U_{ai}$, is transferred to dummy number, $U_{di}$.
where \( U_{di} \) belongs to \( \{0,1,2,\ldots,k\} \). The second step is to calculate the information gain of each attribute relation. The attributes of sample users and users’ friends/non-friends are calculated with information gain. The attributes with top \( n \) information gain are decisive attributes in this research.

**Compute similarity of user-user attributes**

After determining the top \( n \) impact attributes, the following step is to calculate the similarity between user and other users. \( U_{ai} \) and \( V_{ai} \) are respective value of attribute \( i \) for user \( U \) and user \( V \). Whether the data value of attribute \( i \) is quantitative or non-quantitative varies the method of similarity computation of user \( U \) and user \( V \).

Step 1: If value of attribute \( i \) is non-quantitative data, only when the values of user \( U \)'s and user \( V \)'s attribute \( i \) are the same, the similarity of user \( U \) and user \( V \) can be 1, otherwise 0.

Step 2: While attribute is quantitative data, all data values above 90% the data range are counted as 1; The data value below 90% are normalized from 0 to 1 and derived each user \( U \)'s and user \( V \)'s attribute \( i \)'s values \( U_{di} \) and \( V_{di} \).

Step 3: The similarity of quantitative attributes is related to the distance of \( U_{di} \) and \( V_{di} \). If user \( u \) and user \( v \) are more similar than user \( u \) and user \( w \) in \( i \) attribute, then the distance between \( U_{di} \) and \( V_{di} \) is shorter than \( U_{di} \) and \( V_{di} \). The distance can be represented as 1-\(| U_{di} - V_{di} | \). Therefore, the similarity is the opposite of the distance between \( U_{di} \) and \( V_{di} \).

Step 4: A harmonized level is applied to adjust the similarity level. Comparing to two users both do not play game \( i \) (\( U_{di} = V_{di} = 0 \)) and two users both like the game \( i \) very much and get each of his/her attribute \( i \) with \( U_{di} = V_{di} = 1 \). The 2 pair of similarity are in different meanings even both equations are \( U_{di} = V_{di} \). If \( U_{di} = V_{di} = 1 \), it means the user \( U \) and user \( V \) both pay extra efforts to reach the highest value; however, \( U_{di} = p_{ib} = 0 \) just means the user \( U \) and user \( V \) don’t play the game. To harmonize the level of similarity, the weighted mean distance is applied:

\[
S(U_{di} - V_{di}) = \alpha \times (1 - |U_{di} - V_{di}|) + (1 - \alpha) \times \left\{ \frac{(2U_{di} \times V_{di})}{(U_{di} + V_{di})} \right\}
\]

where \( 0 \leq \alpha \leq 1 \). \( \alpha \) is the weight of distance, for example \( \alpha = 0.7 \); \( (1 - \alpha) \) is to harmonize the value of attribute. If \( U_{di} = V_{di} = 0 \), \( S(U_{di} - V_{di}) = \alpha \) and \( (2U_{di} V_{di}) / (U_{di} + V_{di}) = 0 \); if \( U_{di} = V_{di} = 1 \), then \( S(U_{di} - V_{di}) = 1 \).

**3.2 Aggregate Contact Weighting**

In the VWs, users can experience the world through a rich variety of activities, including building or buying things, engaging in quests, doing sports,
or living with other. Those contacts have different levels of closeness. Before figuring out the closeness of user $U$ and user $V$, each contact activity is weighted with different score.

The model traces user to user’s all contact activities and frequency during a specific interval, and sums up each contact weight and frequency to gain the close degree between the two users. Close degree is to represent the closeness of the two users, higher the score, closer the two users; vice versa. However, each contact has its own closeness meaning. For example, behavior that user A cohabits with user B has different close degree from behavior that user A reads user C’s articles. Therefore, close degree of each contact can be described by accumulated dynamic features.

**Clarify contact activities with dynamic features**

All the friendship pairs can be constructed with a serial of contact behaviors. The contacts between user U and user V is represented as $(U-V) : \langle m_1, m_2... \rangle$, where $m$ represents kinds of contact activities. The closeness of the user pair is the accumulated weights and frequencies of all the contacts.

A diversity of contact activities can be classified into five categories of contact activities: Communication based, social-activity based, transaction based, quest based, relationship base. Contact categorization helps us observe kinds of friend making models for different users. Most of the users tend to execute communication based activities before building friendships; some tend to make friends with buyers or sellers; and some focus on game-playing will make friends those play collaborated games with. Table 1 classifies the most common contact activities into five contact categories.

<table>
<thead>
<tr>
<th>Contact Categories</th>
<th>Example of Contact Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication based ($C_c$)</td>
<td>read diary, leave message, read article, reply message, read editor’s log</td>
</tr>
<tr>
<td>Social-activity based ($C_s$)</td>
<td>give a gift, feast, tell a secret, visit, leave footprints</td>
</tr>
<tr>
<td>Transaction based ($C_t$)</td>
<td>economic exchanges, join bidding</td>
</tr>
<tr>
<td>Quest based ($C_q$)</td>
<td>go fishing together, play collaborated games</td>
</tr>
<tr>
<td>Relationship based ($C_r$)</td>
<td>work for economic income, join a family</td>
</tr>
</tbody>
</table>

Dynamic features are a contact activity’s sub-characteristics. Each dynamic feature $f$ is given different weight according to its respective property. The weight of each contact activity ($m_k$) is composed by all its dynamic features. The following defines each of the dynamic feature and its weighting.

1. **Direction ($f_{kd}$):** Whether the contact is directed or bi-directed has different degree of closeness. If two individuals mutually attend to one another, then the bond is reinforced in each direction and both people will find the
tie rewarding [21]. Therefore, a directed action is given 1 point and a bi-directed contact is rewarded extra weighting with 3 points.

2. Synchronization \((f_{kd})\): If the contact activity has to be executed synchronized, the feature weight of this contact activity is set to be 1. On-line cowork and video talk belong to synchronized actions. The activities those belong to asynchronized actions, such as read articles or reply messages, the feature weight is set to 0.

3. Intension \((f_{kp})\): Intension means whether the user performs the contact with specific purpose or extra cost (money or time). According to [22], relationships in which individuals give something of value, lead to stronger effective ties. The contacts those made with intension are given one point feature weight.

4. Continuity \((f_{kc})\): Users join the same quest or talk for hours, it is a kind of one time job but last a long time. This kind of activities has different close degree from noncontinuous actions, such as reading articles or joining bids. The feature weight of these kinds of activities is set to 1.

<table>
<thead>
<tr>
<th>Features</th>
<th>Symbol</th>
<th>Dynamics feature : Feature Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direction</td>
<td>(f_{kd})</td>
<td>Directed: (1); Bi-directed: (3)</td>
</tr>
<tr>
<td>Synchronization</td>
<td>(f_{ks})</td>
<td>Synchronized: (1); Unsynchronized: (0)</td>
</tr>
<tr>
<td>Intention</td>
<td>(f_{kp})</td>
<td>With purpose: (1); Non-purpose: (0)</td>
</tr>
<tr>
<td>Continuity</td>
<td>(f_{kc})</td>
<td>Continuous: (1); Noncontinuous: (0)</td>
</tr>
</tbody>
</table>

Table 2 summaries the weights of contact features. One contact activity can be represented by aggregating its four dynamic features to represent the closeness of the activity. The closeness weight of contact activity \(k\) is denoted as \(m_k\) and is represented as,

\[
m_k = f_{kd} + f_{ks} + f_{kp} + f_{kc}, \ \text{where} \ f_{kd}\in\{1,3\}, \ f_{ks}\in\{1,0\}, \ f_{kp}\in\{1,0\}, \ f_{kc}\in\{1,0\} \quad (2)
\]

Based on the above formulation, we derive the contact weight \((m_k)\) of activities by category and demonstrates in Table 3.

<table>
<thead>
<tr>
<th>Contact Categories</th>
<th>Dynamic Features</th>
<th>Category Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication based ((C_c))</td>
<td>(f_{kd}=1, f_{ks}=0, f_{kp}=0, f_{kc}=0)</td>
<td>1</td>
</tr>
<tr>
<td>Social-activity based ((C_s))</td>
<td>(f_{kd}=1, f_{ks}=0, f_{kp}=1, f_{kc}=0)</td>
<td>2</td>
</tr>
<tr>
<td>Transaction based ((C_t))</td>
<td>(f_{kd}=3, f_{ks}=0, f_{kp}=0, f_{kc}=0)</td>
<td>3</td>
</tr>
<tr>
<td>Quest based ((C_q))</td>
<td>(f_{kd}=3, f_{ks}=1, f_{kp}=0, f_{kc}=0)</td>
<td>4</td>
</tr>
<tr>
<td>Relationship based ((C_r))</td>
<td>(f_{kd}=3, f_{ks}=1, f_{kp}=0, f_{kc}=1)</td>
<td>5</td>
</tr>
</tbody>
</table>

Not only the weight of contact represents the closeness, density of the
contacts also matters their closeness. People are usually prone to trust others that they are familiar with through repeated contacts [23]. For example, repeatedly buying goods from a specific seller, the buyer and the seller could become friends because of the trust through repeated procurement.

Some of the contacts with continuous feature are one-time effort but last a long duration. The density of those contact activities should be reviewed by the duration. Therefore, the measurement of density depends on whether the contact activity is continuous or noncontinuous.

The contact density is set to be 0 to 1. All users’ noncontinuous contact activity is counted respectively, the frequency of that activity over 90% of all the users’ is counted as 1; the data value below 90% are normalized from 0 to 1. As for continuous contact activities, the duration of the same contact is compared with all users. The duration of that contact over 90% of all the users’ is also counted as 1; the duration below 90% is normalized from 0 to 1.

The contact score describes the weighting and the density of one type of contact activity between user \(U\) and user \(V\) during a specific time. It is represented as,

\[
CI_{k(u-v)} = m_{k(u-v)} \times d_{k(u-v)}
\]  

Where \(0 \leq d_{k(u-v)} \leq 1\), \(m_{k(u-v)} \in \{1, 2, 3, 4, 5\}\). \(CI_{k(u-v)}\) is contact score that user \(U\) performs contact activity \(k\) to user \(V\) in a certain interval; \(m_{k(u-v)}\) specifies the weight of contact activity \(k\) user \(U\) executes toward user \(V\); \(d_{k(u-v)}\) is the contact density or frequency user \(U\) performs toward user \(V\).

We may aggregate the closeness degree of a contact category between user \(U\) and user \(V\) as,

\[
C_x(U-V) = \sum_{k=1}^{n} (m_{k(u-v)} \times d_{k(u-v)})
\]  

\(x\) is \(\{c, s, t, q, r\}\) and \(C_x\) is the summarized category closeness of one user pair user \(U\) to user \(V\). \(n\) is the number of contact activities in the contact category \(C_x\).

**Accumulate contact weight and frequency in specific interval**

After defining the contact weight, the next step is to define a reliable interval to accumulate the activity frequency and contact weight. According to the principal of homophily, people rapidly become more similar shortly before their first communication and continue to become more similar for a long time afterward. To reduce further contacts bias similarity that occurs after friendships are built, the experiment observes the most recent one-month activities of friendship pairs in the test bed.
3.3 Classify friend/non-friend with SVM classifier

After finishing the static attributes and dynamic attributes calculation phases, it comes out similarity degree and close degree of each user pair. The last phase in this research framework is to classify users into friend and non-friend groups. In this phase, a SVM classifier is generated according to the similarity degrees and closeness scores of categories.

In the first two phases, there will be $n$ similarity degrees of decisive attributes $S(U_{di}-V_{di})$ and closeness scores of five categories ($C_x$) for every one user pair. After rolling $n$ similarity degrees and five closeness scores of all user pairs in training data, a trained SVM classifier is ready to predict the friendship as friends and non-friends for users.

4. Experiment Setup

In the proposed model, the experiment was extracted from an online virtual platform, www.roomi.com.tw, which is a popular VW in Taiwan and Thailand. There are over 0.7 million registered users. 38% of the users are in the age of senior high to university (year of 15 to 23). In this platform, user may live, shop, play games, role-play and do social activities through his/her own avatar.

4.1 Data Collection

In the Roomi, an avatar has a variety of way to live in his/her VW. Every activity s/he acts generates numbers of dynamic attributes. The number of fishes s/he owns, the time spent in the farm, photographs s/he owns, the number s/he joins bidding, money s/he spent on clothes and monsters s/he kills are part of one avatar’s attributes. The first step is to compose the decisive attributes set among all the attributes.

The target population was the users those registered in Roomi more than six months and has been active within three months. The experiment data was from Roomi rather than questionnaires to explore the real behaviors of users.

The value of each static attribute is normalized into 0 to 10. Every user’s attribute value ($U_{ai}$) is transferred into normalized value ($U_{di}$). After processing all the attribute relations of each user pairs with information gain method, the 11 decisive attributes were gained.

The extracted data for model verification were those friendships built in Jan, 2012 and the one-month contact activities of the pairs before building relationships. There were 15,304 active users created 137,536 pairs of friendships in January 2012. The first step was to random select 300 seed users
in the experiment. Each user $U_i$ respectively has $\gamma$ friend pairs built in Jan, 2012, where $i=\{1, 2, \ldots, 300\}$. In the second step, recruited 20 non-friendship pairs and all his/her $\gamma$ friendship pairs for each seed users. The average friendship pair of the seed users is 16 pairs.

After including each seed user’s friend/non-friend pairs, the total users included in this experiment is 7,889 persons and the total relationship pairs are 13,863 pairs, excluded meaningless data, such as non-contact relationships and users those have at least three attribute values equal to zero. The retrieved data were separated into 9,945 pairs of training data and 3,918 pairs of test data.

4.2 Evaluation Results

Table 4 compares the method we proposed and the method only considering users similarity. It demonstrates SVM classifier trained with contact categories performs better in true positive and true negative.

Table 4. the result of considering similarity only and similarity with contact categories

<table>
<thead>
<tr>
<th>SVM classifier</th>
<th>FF(1)</th>
<th>FN(2)</th>
<th>NF(3)</th>
<th>NN(4)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Similarity</td>
<td>1,038</td>
<td>488</td>
<td>409</td>
<td>1,983</td>
<td>3,918</td>
</tr>
<tr>
<td>Similarity + Contact Categories</td>
<td>1,183</td>
<td>331</td>
<td>222</td>
<td>2,182</td>
<td>3,918</td>
</tr>
</tbody>
</table>

1. FF means the pair counts the SVM classifier predicts as friend among all the friendship pairs.
2. FN means the pair counts the SVM classifier misplaced as non-friend in the friendship pairs.
3. NF is the pair counts the SVM classifier misplaced as friend among the non-friendship pairs.
4. NN is pair count the SVM classifier predicts as non-friend among the non-friendship pairs.

Table 5 was generated from Table 4 to present the percentage of recall, precision and accuracy. It shows SVM classifier considering contact activities can predict true friends more than 10% higher than only considering avatars’ similarity and the accuracy to predict the correct pairs is 9% higher than the other. It demonstrates that the SVM classifier considering avatars’ contact activities has higher hit rate no matter in precision, accuracy, or recall than the other. It is likely that the user behaviors in the VWs are very different from those in the SNs. The users in the later tend to contact with users they have been friends in the real life. The results suggest the proposed model is more suitable for judging real friends for avatars in the VWs and corresponds to the claim that avatars tend to contact with others before making friends.

Table 5. precision and recall for verifying the model

<table>
<thead>
<tr>
<th>SVM classifier</th>
<th>Recall</th>
<th>Precision</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Similarity</td>
<td>68.02%</td>
<td>71.73%</td>
<td>77.11%</td>
</tr>
<tr>
<td>Similarity + Contact categories</td>
<td>78.14%</td>
<td>84.20%</td>
<td>85.89%</td>
</tr>
</tbody>
</table>
5. Conclusion and Future Research

Avatars in the VWs are not like the users in the SNs, such as facebook. Users in the facebook tend to connect with their social groups in the real life. Most of the VWs are isolated from the real society and avatars don’t know others unless through a series of contacts. Through the contact activities, they know others more and decide to make friends with.

In this research, we take into account the characteristics of VWs and hybrid the contact activities with similarity to provide an effective classifier. The experiment result demonstrates the SVM classifier has better judgment in recall, accuracy and accuracy by considering contact activities. This model may be combined with existing friend recommendation methods to provide better recommend result.

In the proposed model, friends are predicted according to his/her previous behaviors in the VWs. We may further study whether different users have different friendship building model, how different types of users immerse themselves in the VWs.

The effect of friend prediction is different from that of commodity recommendation in further applications. Friend Prediction is a starting point to various new possibilities rather than an end point to target search. Through friend prediction to increase the network density, the power of people and network take us to the new direction of future.

We may further study the relation between their communication behaviors and they way they live in the VWs, the relation between the network density and the avatar categories. Categorizing types of avatars is also a starting point to new research possibilities rather than an end point to final research.

6. Reference


Using of Tobit-Piecewise Regression Model

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Abstract. Tobit-piecewise (TP) regression model was first introduced by Mekbunditkul[1] to cope with regression outliers. The estimation of its joined point has been not developed. This paper introduced this interesting issue where the joined point was estimated by two statistical techniques, namely nonlinear least square (NLS) based using Levenberg-Marquardt (LM) method and maximum likelihood (ML) based using Quandt’s method. Five difference regression models, namely (1) least square, (2) Tobit, (3) piecewise, (4) TP where its joined point estimated by LM, and (5) TP where its joined point estimated by Quandt, were applied and compared in case of data containing outliers both of x-, y- and xy-directions. Household-income and household-expenditure data on socio-economic surveys (SES) in Thailand for the year 2009 were analyzed. In this particular case, it was shown that the TP regression when its joined point estimated by LM method is better than the other four regressions.

Keywords: Tobit-piecewise regression, LSE, MLE, Outliers

I. Introduction

A statistical analysis used for analyzing and indicating the relationship between a dependent/response and independent/predictor variables is called regression analysis. It presents a change on one of the variables in correspondence with a change in the other. In addition, the regression model can estimate or predict the value of response variable when knowing the value of predictor variables. A linear or straightline relationship can be written as \( Y = X\theta + \varepsilon \), where \( Y \) is an \( n \times 1 \) vector of dependent/response variable, \( X \) is an \( n \times (k+1) \) matrix of independent/predictor variables, \( \theta \) is a \( (k+1) \times 1 \) vector of unknown parameters, \( \varepsilon \) is an \( n \times 1 \) vector of errors where its elements, \( \varepsilon_i \)'s, is independently and identically distributed as normal (NID) with zero mean and constant variance. It is also assumed that matrix \( X \) is of full rank, i.e., \( \text{rank}(X) = p = k+1 \) and less than the sample size \( n \). If \( \varepsilon \) are \( \text{NID}(0, \sigma^2 I_n) \), then the least square (LS) estimator of \( \theta \) is the same as the maximum likelihood (ML) estimator and \( \hat{\theta} = (X'X)^{-1}(X'Y) \). In addition, by Gauss-Markov Theorem, LS method yields the best linear unbiased estimator (BLUE) of \( \theta \).
Whenever the assumptions are violated, e.g. non-normality, heteroscedasticity (variances of the errors are not constant), and non-linearity, the LS estimator would not be preferable. Another important problem is that the observed data contain outliers. These outliers may have a large effect on the estimated value. Heteroscedasticity problem in regression analysis might be caused by outliers in $y$–direction and/or $x$–direction (Rousseeuw and Leroy[1]). Hence, a better way to estimate the parameters $\theta_1$ in the regression model are needed.

Mekbunditkul[2]’s earlier research construct the Tobit-piecewise (TP) regression model and its findings is as follow: First, Tobit regression is a tool used to investigate the linear relationship when the dependent variable in a regression model is limited. This concept is taken into account for this study in the sense that putting limited value at some desired variable can reduce effect value of outliers in $y$- and $xy$-directions. However, the existence of other types of outliers has not been considered. Second, piecewise (PW) regression is a regression analysis properly applied when structural change in regression occurs. Hence, in this regression analysis, outliers in $x$- and $xy$-directions are taken into account. However, PW is rather not suitable for data consisting of outliers in $y$-directions. Another approach, TP regression, employs a fitting criterion to unusual data that is not as same as LS. This study applied Tobit and PW regression to TP regression model and it was found that: TP regression can reduce the effect of outliers and it can deal with structural change in data more effectively than just PW regression or, Tobit regression alone, and LS method as well. Nevertheless, there was not any study regarding to an estimation of joined point in TP regression. Therefore, in this research, the matter was studied.

The outliers in this study are considered in the sense of regression outliers. They are observations that are distinct from the linear relationship representing most of the data and they may have effect not only on the slope of a regression line but also any other estimators such as the sample mean, variance, covariance and correlation, and all of the LS estimators of the model parameters. They can be very sharply influenced by outliers and often provide not preferable fits to the bulk of the data. Deleting the outliers from the analyzed data, though some usually do, may not appropriate since outliers are not always non-members of the target population.

II. A Joined Point Estimation in Tobit-piecewise(TP)

Regression Model

The TP regression model which was first introduced by Mekbunditkul, the joined point was assumed to be fixed. It is quite simple to fix the joined point in TP regression model if it is known in advance where it is. Thus Thipbharos[4]’s research deals with the more difficult case where the joined point has to be estimated from the data. Two estimation methods are introduced to investigate the joined point in TP regression model in this research as described below.
II.1 The Maximum Likelihood (ML) Method

For simplicity, a single regressor is assumed. Based on simple Tobit\cite{5} and simple PW (Quandt\cite{6}, Hudson\cite{7}, Goldfeld, Kelejian and Quandt\cite{8}, Suits, Mason and Chan \cite{9}), the dependent variable becomes

\[
Y_i = \begin{cases} 
  L_i & ; \quad Y_i^* \leq L_i \\
  Y_i^* & ; \quad L_i < Y_i^* < U_i \\
  U_i & ; \quad Y_i^* \geq U_i,
\end{cases}
\]

where \( Y_i^* = \alpha_1 + \beta_1 x_i + \beta_2 x_i^* + \epsilon_i \) is the link function, \( x_i \) is the regressor and, \( x_i^* = (x_i - \nu)D_i \), \( \nu \) is an unknown joined point of two regression lines, and \( \epsilon_i \)'s are \( \text{NID}(0, \sigma_i^2) \). Note \( \sigma_i^2 = \begin{cases} \sigma_a^2 & \text{if } x_i \leq \nu \\
\sigma_b^2 & \text{if } x_i > \nu \end{cases} \). The locally lower and upper limits are \( L_i = \begin{cases} L_a & ; \quad x_i \leq \nu \end{cases} \) and \( U_i = \begin{cases} U_a & ; \quad x_i \leq \nu \\
U_b & ; \quad x_i > \nu \end{cases} \). The probability density function (p.d.f.) of \( Y \) is determined by

\[
f_Y(y_i) = \Phi \left( \frac{L_i - \alpha_1 - \beta_1 x_i - \beta_2 x_i^*}{\sigma_i} \right) \quad \text{if} \quad y_i = L_i, \\
= \frac{1}{\sigma_i} \phi \left( \frac{y_i - \alpha_1 - \beta_1 x_i - \beta_2 x_i^*}{\sigma_i} \right) \quad \text{if} \quad L_i < y_i < U_i, \quad \text{and} \quad f_Y(y_i) = 1 - \Phi \left( \frac{U_i - \alpha_1 - \beta_1 x_i - \beta_2 x_i^*}{\sigma_i} \right) \quad \text{if} \quad y_i = U_i.
\]

The TP estimator of \( \theta \) achieved by the ML method was presented in Mekbunditkul\cite{2}. Now, we consider the log-likelihood function of \( \nu \) given \( \hat{\alpha}_1, \hat{\beta}_1, \hat{\beta}_2, Y \) in order to estimate the value of a joined point as followed,

\[
\ln L(\nu; \hat{\alpha}_1, \hat{\beta}_1, \hat{\beta}_2, Y) = \sum_{i \in I_L} \ln \Phi \left( \frac{L_i - \hat{\alpha}_1 - \hat{\beta}_1 x_i - \hat{\beta}_2 x_i^*}{\hat{\sigma}_i} \right) \\
+ \sum_{i \in I_Y} \ln \left( \frac{1}{\hat{\sigma}_i} \phi \left( \frac{y_i - \hat{\alpha}_1 - \hat{\beta}_1 x_i - \hat{\beta}_2 x_i^*}{\hat{\sigma}_i} \right) \right) \\
+ \sum_{i \in I_U} \ln \left( 1 - \Phi \left( \frac{U_i - \hat{\alpha}_1 - \hat{\beta}_1 x_i - \hat{\beta}_2 x_i^*}{\hat{\sigma}_i} \right) \right),
\]

(2)
where \( I_L = \{i \mid Y_i = L_4, i = 1, ..., n_1 \} \), \( I_Y = \{i \mid L_4 < Y_i < U_i, i = 1, ..., n_2 \} \), \( I_U = \{i \mid Y_i = U_1, i = 1, ..., n_3 \} \). Note that \( n = \sum_{j=1}^{3} n_j \).

Accordingly, the score statistic for \( \nu \) is always positive and it proves to be traditionally inappropriate to find the value of \( \nu \) which maximizes \( \ln L(\nu; \hat{\alpha}_1, \hat{\beta}_1, \hat{\beta}_2, Y) \) by differentiating this term with respect to \( \nu \) and setting the derivation equal to zero. Quandt [6] suggested a procedure to calculate the value of a switching point (a special case of joined point) by selecting \( t \) which maximizes likelihood function, where \( t \) is the time period. Nevertheless, the assumption of Quandt is without one joined point. By then, the estimate of a switching point was just introduced in PW regression model. Subsequently, Hudson[7] suggested a parameter estimation based on the LS method and the joined point is assumed. Thus, we can apply the procedure of Quandt by assuming the joined point to find the value of \( \nu \) in TP regression model. This procedure can be expressed as followed:

First, order the observation according to the value of \( x_i \) and split the data into two groups, i.e. left and right hand groups.

Second, determine the initial value of \( \nu \) within the range of observed values of \( X \) and put \( \nu \) in the model (1).

Third, estimate remaining parameters in the model (1) by \( \hat{\theta}_{TP} \) as shown in the equation (2.14) or (2.15) of Thipparos[4].

Forth, substitute \( \hat{\alpha}_1, \hat{\beta}_1, \hat{\beta}_2 \) back to the log-likelihood function (2) and calculate those values, after that move the point of \( \nu \) between the two groups by one unit at a time to the right and one unit at a time to the left.

Fifth, calculate the log-likelihood function for each value of \( \nu \) and then choose the value of \( \nu \) which maximizes the log-likelihood function. Then, the ML estimators \( \hat{\alpha}_1, \hat{\beta}_1, \hat{\beta}_2 \) are obtained.

This method, nevertheless, can be complicatedly generalized to the case that multiple linear regressions are taken into consideration.

### II.2 The Nonlinear Least Square (NLS) Method

The Tobit-piecewise regression model can be considered as one of nonlinear regression models. Thus in the case that the data should truly be fitted by nonlinear regression models rather than linear models, some NLS solving-based have been recommended. A nonlinear regression model (Seber and Wild[10]) can be written as

\[
Y_i = f(x_i; \theta^*) + \epsilon_i, \quad (3)
\]
where $i=1, 2, \ldots, n$, $f(x_i; \theta^*)$ is a known regression function as defined in the equation (1), $x_i$ is a $k \times 1$ vector, $\theta^*$ is a vector of $k$ unknown parameters and $E(\varepsilon_i) = 0$. The true value $\theta^*$ of $\theta$ is known and belong to $\Theta$, a subset of $p$-dimension Euclidian space $\mathbb{R}^p$. From these statements, we can state that the $i^{th}$ element, $Y_i^*$, of $Y^*$ as shown in the model (1) can be considered as the model (3). The LS estimate of $\theta^*$, denoted by $\hat{\theta}$, minimizes the error sum of squares. Thus, we can state the definition of nonlinear least square (NLS) estimator by the following definition.

**Definition 1.** The nonlinear least square (NLS) estimator for the nonlinear regression model (3) is defined by

$$
\hat{\theta}^{\text{NLS}} = \arg \min_{\theta^*} \sum_{i=1}^{n} \left( Y_i - f(x_i; \theta^*) \right)^2.
$$

Unlike the linear LS estimator, the analytical solution in solving for a general function $f(x_i; \theta^*)$ cannot be expressed explicitly. The Taylor’s series expansion has been suggested to approximate the nonlinear objective function provided that the first two derivatives of $f(x_i; \theta^*)$ exist. Let

$$
S(\theta) = \sum_{i=1}^{n} \left( Y_i - f(x_i; \theta) \right)^2.
$$

Whenever each $f(x_i; \theta)$ is differentiable with respect to $\theta$, $\hat{\theta}$ is obtained (Seber and Wild[10])

$$
\left. \frac{\partial S(\theta)}{\partial \theta_r} \right|_{\theta=\hat{\theta}} = 0, \quad r = 1, 2, \ldots, p,
$$

The $f(X; \theta)$ is defined as $f(X; \theta) = \left( f(x_1; \theta), f(x_2; \theta), \ldots, f(x_n; \theta) \right)'$ and $F(x_i; \theta) = \frac{\partial f(x_i; \theta)}{\partial \theta'} = \left[ \left( \frac{\partial f_i(x_i; \theta)}{\partial \theta_r} \right) \right]$, where $F(x_i; \theta)$ represents the first derivative. Rewrite the equation (4) as $S(\theta) = \|Y - f(x_i; \theta)\|^2$.

The equation (5) induces to the following equation

$$
\sum_{i=1}^{n} \left( Y_i - f(x_i; \theta) \right) \left. \frac{\partial f(x_i; \theta)}{\partial \theta_r} \right|_{\theta=\hat{\theta}} = 0, \quad r = 1, 2, \ldots, p,
$$

601
or
\[
\theta = \hat{\beta}^T \left( y - f(X; \hat{\theta}) \right)
\]

This is called the normal equation for the nonlinear model. The numerical method, Levenberg-Marquardt (LM) method[3], was utilized to find the value of \( \hat{\theta} \) because most nonlinear estimators of nonlinear model can not be solved explicitly.

**III. Numerical Analyses**

Household income (average monthly total income per household) and household expenditure (average monthly total expenditure per household) data on socio-economic surveys (SES) in Thailand for the year 2009 were analyzed to particularly investigate the performance of five different regressions, (1) LS, (2) Tobit, (3) PW, (4) TP where its joined point estimated by LM, and (5) TP where its joined point estimated by Quandt. In this paper, researcher presented the result only of TP regression where its joined point estimated by LM method because it yields the better results, both of simulation and numerical results, than by Quandt method.

For TP, where its joined point is estimated by two methods, i.e. ML-based method corresponding to Quandt’s method and nonlinear LS-based method of LM. For PW, its joined point is only estimated by LM method. The data on SES used in this application are household-expenditure and household-income. Suitable relationship between response variables (household expenditure) and explanatory variable (household income) were investigated by all five different regression models.

There are the evidence that both household-income and household-expenditure data consist of outliers. Therefore, the LS regression might not be preferable. Instead of using the LS, other 3 methods were considered, namely Tobit, PW, and TP. The results of this study are shown in the form of regression line of each of the four different methods and the average sum of square (ASSR) of them. Moreover RE is denoted as a ratio of the ASSR obtained by each of TP, PW and Tobit regressions to the LS regression.

Findings of the analysis by the four different regressions on household-income and household-expenditure data of socio-economic surveys in Thailand in the year 2009 are presented as below:

1) For Bangkok and metropolis regions, we obtain four regression lines as the followings:

- **LSE**: \( \hat{Y} = 23,408.39 + 0.173X \)
- **Tobit**: \( \hat{Y} = 22,072.24 + 0.187X \)
- **PW**: \( \hat{Y} = 9,885.90 + 0.539X - 0.528X^* \)
- **TP**: \( \hat{Y} = 8,115.94 + 0.604X - 0.563X^* \),
where $Y$ represents expenditure data, $X$ is income data and $X^*= (X-118,213)D$, $D=1$ if $X \geq 118,213$ and $D=0$ if $X < 118,213$. The joined point value 118,213 was obtained by LM method.

The smallest value of ASSR and RE is from TP which are $134 \times 10^6$ and 0.3709, respectively. This means that, in this particular case, TP seems to be the best. In addition, TP regression model with its joined point estimated by LM yields smaller ASSR than that by Quandt's method. Take into consideration the situation when the value of household income is zero Baht (no income) then the expenditure is about 8,116 and 9,886 baht as predicted by TP and PW models, respectively. Meanwhile, it is 23,408 baht by LS model and is 22,072 baht by Tobit model. We can see that TP and PW yield more reasonable results than both LS and Tobit. In addition, there exists the same results for other regions as shown in section 2) to 5) as follow.

**Figure 1** Observations and Four Regression Lines from Four Methods of fitting Household-Expenditure on Household-Income in Bangkok Metropolis Region

**Source of Data**: SES 2009, National Statistical Office, Thailand

**Figure 2** Expansion of Figure 1 for the Range of Household Income between 0 and 300,000 Baht and of Expenditure between 0 and 200,000 Baht
2) For the Central region, the four regression lines can be obtained as the followings:

- **LSE** : \( \hat{Y} = 13,530.76 + 0.218X \)
- **Tobit** : \( \hat{Y} = 13,591.15 + 0.212X \)
- **PW** : \( \hat{Y} = 4,691.43 + 0.619X - 0.638X^* \)
- **TP** : \( \hat{Y} = 5,582.46 + 0.571X - 0.598X^* \),

where \( X^* = (X - 146,221)D \), \( D = 1 \) if \( X \geq 146,221 \) and \( D = 0 \) if \( X < 146,221 \). The joined point value at 146,221 which is estimated by LM method makes TP regression line attains the smallest ASSR at \( 6.53 \times 10^6 \) and RE at 0.3727. And we also found that TP regression model with its joined point estimated by Quandt’s method yields slightly larger value of ASSR and RE than LM method.

**Figure 3** Observation and Four Regression Lines from Four Methods of fitting Household-Expenditure and Household-Income Data for Central region on SES in year 2009

**Source of Data** : SES 2009, National Statistical Office, Thailand

**Figure 4** Expansion of Figure 3 for the Range of Household Income between 0 and 300,000 Baht and of Expenditure between 0 and 400,000 Baht
3) For the Northern region, we obtain four different regression models as the followings:

\[
\begin{align*}
\text{LSE} & : \hat{Y} = 6,062.13 + 0.408X \\
\text{Tobit} & : \hat{Y} = 6,132.13 + 0.402X \\
\text{PW} & : \hat{Y} = 3,236.19 + 0.582X - 0.626X^* \\
\text{TP} & : \hat{Y} = 3,419.87 + 0.568X - 0.629X^*,
\end{align*}
\]

where \( X^* = (X - 97,281)D \), \( D = 1 \) if \( X \geq 97,281 \) and \( D = 0 \) if \( X < 97,281 \).

The smallest value of each ASSR as \( 39.96 \times 10^6 \) and RE as 0.5683 is of TP regression model where its joined point was estimated by LM method. In addition, this method yields better result than Quandt’s method in terms of ASSR and RE.

**Figure 5** Observation and four Regression Lines from Four Methods of fitting Household-Expenditure and Household-Income Data for North region on SES in year 2009

**Source of Data**: SES 2009, National Statistical Office, Thailand

**Figure 6** Expansion of Figure 5 for the Range of Household Income between 0 and 300,000 Baht and of Expenditure between 0 and 200,000 Baht
4) For the Northeastern region, four different regression models can be obtained as the followings:

\[
\text{LSE} : \hat{Y} = 11,423.80 + 0.172X \\
\text{Tobit} : \hat{Y} = 11,415.66 + 0.169X \\
\text{PW} : \hat{Y} = 3,858.48 + 0.594X - 0.586X^* \\
\text{TP} : \hat{Y} = 4,182.82 + 0.568X - 0.571X^* ,
\]

where \( X^* = (X - 77,965)D \), \( D = 1 \) if \( X \geq 77,965 \) and \( D = 0 \) if \( X < 77,965 \). The value 77,965 comes from LM method and this method yields the smallest value of ASSR as \( 41.49 \times 10^6 \) and RE as 0.3645.

**Figure 7** Observation and four Regression Lines from Four Methods of fitting Household-Expenditure and Household-Income Data for Northeast region on SES in year 2009

**Source of Data** : SES 2009, National Statistical Office, Thailand
5) For the Southern region, four different regression lines are obtained as the followings:

- **LSE**: $\hat{Y} = 11,583.95 + 0.269X$
- **Tobit**: $\hat{Y} = 11,829.82 + 0.253X$
- **PW**: $\hat{Y} = 4,888 + 0.586X - 0.555X^*$
- **TP**: $\hat{Y} = 5,237.88 + 0.564X - 0.571X^*$

where $X^* = (X - 90,790)D$, $D = 1$ if $X \geq 90,790$ and $D = 0$ if $X < 90,790$.

The value 90,790 was obtained by LM method. This method yields better results than Quandt’s method. Moreover, it gives the smallest ASSR at $63.85 \times 10^6$ and RE at 0.4064 among all four different regressions.

![Figure 9](image)  
**Figure 9** Observation and four Regression Lines from Four Methods of fitting Household-Expenditure and Household-Income Data for South region on SES in year 2009.  
**Source of Data**: National Statistical Office
Figure 10 The Expansion of Figure 7 for the Range of Household Income as being between 0 and 300,000 Baht and of Expenditure as being between 0 and 200,000 Baht

IV. Conclusions

Regression outlier problem is troublesome and annoying because these might cause heteroscedasticity problem and can make the LS regression line unfavorable and far away from the most of the data. In addition, the Gauss-Markov assumptions might be violated, and consequently, LS estimator of $\theta$, a vector of regression coefficients, turn out not to be the best linear unbiased estimator (BLUE). Four different regression models, namely LS, Tobit, PW and TP, were applied to fit a regression model on data containing outliers. The constructing of TP regression model obtained by the combination of the Tobit and PW regression models was first introduced in Mekbunditkul[2]. The estimation of a joined point in TP regression model is first interested in Thipbharos[4]. Leading to, an introduction of an estimator for the joined point in TP regression model based on NLS using LM method and on ML Method of Quandt. From simulation results, Thipbharos found that the TP regression model with its joined point estimated by LM method can more “down-weigh” the value or more reduce the effect of outliers than other remaining methods. This is followed by TP with its joined point estimated by Quandt’s method, PW, Tobit, and LS, respectively. Furthermore, the results of numerical analyses found that TP regression line with its joined point estimated by LM method attains the best among all four different estimation methods including the case where the joined point is estimated by Quandt’s method. Moreover, when outliers exist in either x-, y- and xy-directions, they can be down-weighted (reduced effect) by either TP or PW. There was obvious evidence that PW gives slightly different results from TP. That is, both TP and PW regression lines can exhibit the relationship of the bulk of the data. In particularly, household-expenditure and household-income on SES data of the year 2009 are fitted more suitably by TP and PW methods than LS and Tobit methods. For the further research, TP regression where its joined point estimated by LM method to the SES data in the case where other regressor variables besides household income used to predict regressed variable (household expenditure) should be investigated.
V. References


Service Management
Focal determinants of service fairness and service recovery satisfaction in cloud computing

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Abstract. Adopting a service fairness perspective on cloud computing business directs suppliers’ focus in business relationships towards engaging with their customers’ service recovery satisfaction. The purpose of this study is to analyze implications of service fairness on satisfaction recovery in business relationships. In the article it is demonstrated that a service fairness perspective is multi-dimensional (structural and social), enabling the creation of recovery satisfaction, which enhances continued usage of cloud computing system. This perspective enables marketers to better understand how to develop and extend structural and social service fairness through equally service delivery and fair treatment relevant to their businesses.

Keywords. service fairness, recovery satisfaction, IS continuance intention, cloud computing

1. Introduction

Information technology (IT) service providers spend millions of dollars annually trying to retain current customers. In an effort to retain those customers, it appears that service organizations now recognize that long-term relationships do not just happen; they are grounded in the organizations delivery of excellent service, value in the first instance, and complemented by an effective service recovery system when things do go wrong.

Customer service recovery satisfaction in IT service support has a major impact on intentions to maintain contact with service providers who manage and provide a particular technology. There is a subtle distinction between continuing to use a service technology versus continuing to obtain the service from a particular service provider, and a similar distinction between satisfaction with a service technology versus satisfaction with the technology’s service provider. This study focuses on customer service recovery satisfaction with service providers in a context where the service is provided through a technology.

While most prior information system (IS) research has attempted to explain user acceptance of new IT, recent research has focused on IS continuance or continued usage. The Technology Acceptance Model (TAM) and Expectation-Confirmation Theory (ECT) are the dominant theoretical frameworks explaining user acceptance and continuance of IT [1]. In addition, a Post-Acceptance Model (PAM) of IS continuance [2] has been widely adopted in the continuance intention literature.
This research proposes the focal determinants of service fairness influencing recovery satisfaction which enhance continued usage of an IS. Satisfaction is contingent on customer perceptions of service fairness with a service provider organization that provides a technological product together with services. Service fairness, therefore, helps to shape perceptions of recovery satisfaction. In practice, IS service provider organizations in a competitive market seek to meet or exceed customer satisfaction levels, which encourages customers using their systems. Customer retention is critical to long-term profitability in service businesses [e.g. 3]. Customer recovery satisfaction is influenced by numerous variables. Among these is service fairness, which influences customer recovery satisfaction by exerting influence upon individual satisfaction.

This study examines focal determinants of fairness based on Greenberg’s (1993) taxonomy of organizational fairness influencing recovery satisfaction and demonstrates the relationship with recovery satisfaction. The two distinct fairness dimensions are structural and social fairness. Enhancing recovery satisfaction through service fairness would then improve IT continuance intention. Fig. 1 presents the conceptual model and hypothesized relationships of this study.

2. Satisfaction and service fairness

One of the definitions of satisfaction from Spreng, MacKenzie, & Olshavsky (1996) is “an affective state that is the emotional reaction to a product or a service experience” (p. 17). Customer service recovery satisfaction is therefore defined as the end-user’s perception when interacting with a specific application including perception toward service failures and their satisfaction or dissatisfaction with the organization’s approach to service recovery [4]. Levels of customer satisfaction result from many factors, although these are all grounded in the customer’s experiences of the service and the interaction with the service provider.
Organizational fairness is one of the important factors widely discussed in the field of organizational behavior [5, 6]. Although, prior studies have used the term “justice” and “fairness” interchangeably, in this study, the term “fairness” is used for the purpose of consistency. Organizational fairness has also received attention not only in the context of employee perceptions of fairness in the workplace with regard to job satisfaction, complaint handling, human resource management [7], but also in the context of customer satisfaction with services, service delivery, and service recovery [8-13].

Additionally, several studies in management and marketing have investigated the relationship between organizational fairness and satisfaction. The literature suggests that fairness could play a significant role in service failure and recovery [14-17] and service management [9, 18]. In service management, perceptions of fairness are important antecedents of customer satisfaction [19]. Clemmer’s (1993) study found that service fairness leads to satisfaction and another study of hospital patient satisfaction found that equity and expectation affected satisfaction and return intention [20].

Organizational fairness could be defined as “the perception of fairness by an individual in the working environment” [21, 22]. Greenberg (1993) proposed a rudimentary taxonomy that is to highlight the distinction between the structural and social determinants of fairness. The taxonomy is formed with two independent dimensions: category of fairness (procedural and distributive), and focal determinants (structural and social).

The concept of focal determinants has been one of major research areas in organizational psychology [23]. Previous studies have discussed the focal determinants in the area of strategic decision making in leadership and ethics [24, 25], and human resource management in compensation and performance management [26].

Thus, the discussion now turns to an examination of service fairness examined from the standpoint of organizational fairness and with respect to its influence on user recovery satisfaction. This study is motivated to the view of Greenberg’s (1993) taxonomy that positions the focal determinants of fairness as broader areas which are based on the immediate focus of a just action relative to existing categories of fairness. The two specific determinants of service fairness which these give rise to are:

2.1 Structural determinants of fairness

Structural determinants of fairness refers to the structural elements of the organization and focuses on the environmental context within which interaction occurs [27].

In service delivery, structural fairness refers to the structural elements of the service provider that allow for their customers as users involving in decision-
making and provide for fair distribution of outcomes. When customers perceive high structural fairness, they will believe that an unfair outcome was merely an accident and will expect structural fairness to occur the next time. That is, they will be less likely to terminate their relationship with the service provider and they remain satisfied with the service. Additionally, customer recovery satisfaction will increase if the service provider provides advanced technological support to monitor and track their service, especially with online customers.

Empirical research supports the concept of perceived structural fairness that has a direct impact on customer outcomes [24-26]. When customers feel they have been treated equally (or not) with respect to the final service outcomes, customers judge that this comes partly from how the system is structured. Feelings of structural fairness can be important between the customers and the service provider, as individual customers feel they should receive the same services from the service personnel as anyone else. Customers can have negative feelings if they find that they receive fewer resources than others. Customer feelings of having experienced a fair process can be used to increase customer outcomes (i.e., satisfaction). This consideration leads to the following hypothesis:

H1: Customer’s perception on structural service fairness will be positively associated with service recovery satisfaction.

2.2 Social determinants of fairness

Social determinant of fairness is recognized as one of important sources of fairness perceptions and distinguished in the fairness taxonomy [27]. The social fairness focuses on the treatment of individuals and informational exchange by “showing concern for individuals regarding the distributive outcomes they receive” (p. 85), and “may be sought by providing knowledge about procedures that demonstrate a regard for people’s concerns” (p. 84) [27].

For social fairness, several previous studies have revealed a relationship between social fairness and both managerial performance [28] and employee behaviors [29]. Social fairness becomes one of important components of outcome fairness. In a transformational leader study, social fairness had more impact than structural fairness because the leader will care about the needs and well-being of the followers and will want to be open and responsive [25, 30, 31].

In IT service delivery, social service fairness refers to the customers’ perceptions that the service provider cares about their wellbeing and keeps customers informed before and during changes to the service process. Additionally, social fairness can take the form of any information provided by service providers. Customers are given information about services they have
received or with which they have been involved. When customers feel they have been treated fairly, with respect, sincerely and politely by the service provider for personnel throughout the service delivery process, the level of customer recovery satisfaction will increase. High levels of informational fairness may be achieved by being truthful in all communications and tailoring service providers’ explanations to customer needs.

When customers or users perceive a fair interaction and a fair information exchange before, during, and after the service delivery process from the perspective of the social fairness, this can lead to positive or increased customer outcomes. From this, the following hypothesis is developed:

H2: Customer’s perceptions on social service fairness will be positively associated with service recovery satisfaction.

These two service fairness dimensions should have an impact on customer service recovery satisfaction, and H1 – H2 address the question of whether an individual’s perception on the focal determinants of fairness (structural and social) is strong enough to influence customer service recovery satisfaction, thus, indirectly contributing to the IS continuance or continued usage. This study applies a conceptual model in which the perceptions on focal determinants of service fairness influence service recovery satisfaction and enhance IS continuance intention.

2.3 Service recovery satisfaction and IS continuance intention

User satisfaction is a significant factor in the IS context [2, 32, 33]. In an online context, e-satisfaction is a key determinant of technology acceptance and continued usage [34, 35]. PAM views relationship satisfaction as a basis for the continued intention to use IS; user’s satisfaction with prior use has a strong positive impact on user’s intention to continue using the system. The more an individual user is satisfied with prior usage experience, the higher the chance that user will continue to use the system [2]. Other IS researchers have also found that user’s satisfaction is a strong predictor of system usage [36]. Thus, satisfaction is a key factor influencing continuance intention. Thus, the relationship between service recovery satisfaction and IS continuance intention can be hypothesized as:

H3: Service recovery satisfaction with initial IS usage is positively associated with IS continuance intention.

3. Methodology

The context in this study is Software-as-a-Service (SaaS) with the cloud computing environment as the IS application and SaaS users as the IS sample.
Cloud computing is an emerging technology enhancing subscribers’ perceptions of SaaS as a long term solution requiring long-term partners and widely adopts among both businesses and non-profit organizations. It is a good example of the wider SaaS market, which is rapidly growing as developers and service providers continue to make investments in developing the technologies.

This study employed several previously developed measures with some modification and supplementation reflecting the specific IS context and the targeted users. Focal determinants of service fairness items were adapted from a number of works, but generally follow [37-40]. Other items were adopted from Maxham & Netemeyer (2002) for service recovery satisfaction and Bhattacherjee (2001b) for IS continuance intention.

All items were reworded to relate specifically to customer relationship management (CRM). SaaS is called “the software” throughout the survey questionnaire. All survey items are responded based on 7 point Likert-scale ranging from (1) “strongly disagree” to (7) “strongly agree”.

The initial questionnaire was reviewed by an expert panel from both IS academia and IS industrial experts, followed by a pilot survey (n=60). The pilot test showed good results on the service fairness concepts, recovery satisfaction and IS continuance intention. The main survey was then carried out.

3.1 Sample and data collection

The samples in pilot testing and the main study included individuals in small and medium sized enterprises who use business-to-business (B2B) CRM-SaaS in cloud computing platform. For both the pilot and the main study, the respondents were CRM-SaaS users.

A web-based survey is an appropriate choice for this study because of the characteristics of the research subject (i.e., CRM-SaaS subscribers access the software via internet on a daily basis) [41]. Because the sample has frequent and easy access to the internet, and are comfortable using it, they are more likely to answer on the internet. Therefore, web-based surveys do not have restricted geographical location, are likely to gain higher members of responses, and may extract longer and more substantive quality answers than a mail survey [42, 43].

Recruitment e-mails were sent to 31,015 prospective panel members nationwide in the USA identified from company databases of full-time employees working in organizations. The first response rate was 11.58% (3,591). Four stringent screening questions reduced this to 490 questionnaires, at a response rate of 1.58%. The screening questions ensured that
- The respondents used CRM software over the internet in their workplace. A list of specific common CRM-SaaS was used to make sure the applications were comparable.
- The respondents’ organization had used the software for more than 2 years, so their answers are about continuance, rather than adoption and the trial use period.
- Respondents used the software at least once a week for their work, which is considered as using the software as part of normal routine activity, and
- The respondents had contacted the software service provider for support.

If they have not had any interaction(s) with the software service provider and/or the software service provider personnel, they did not qualify to take part in the survey.

Since the usable response rate was relatively low, tests for non-response bias were performed by comparing answers on the last quartile of the responses retuned with those of the first quartile [44]. There were no differences in the mean of any item in the model constructs, and only two differences in the variances. This indicated that non-response bias was not a significant problem and the survey was able to collect adequate data in this research.

The demographic characteristics of the 490 respondents are: males constitute 61.22% of respondents. The majority (64.70%) is in the age range from 30 years to 50 years old, and nearly ninety percent (88.98%) had over 5 years of working experience. The most common positions were operating staffs (16.73%), supervisors (15.51%) and sales representatives (13.06%). Half of the respondents (50%) were from organizations employing between 51 and 500 employees. Respondents from the business services industry (51.84%) made up the highest percentage. In summary, the sample constituted an experienced working-age group, with responsibility at their present company requiring frequent use of CRM software, and who interact with the software service provider.

4. Results

Statistical analyses were performed using PASW Statistics version 18 and SPSS Analysis of Moment Structures (AMOS) version 18 statistical software packages. Statistical analysis such as descriptive statistics, mean, standard deviation, and R² were also performed.

The analysis results of descriptive statistics for the composite variables used, including mean, standard deviation and reliability analysis (Cronbach’s alpha) for each construct measure demonstrated in Table 1. The internal reliability of the measures is .956 for structural fairness and .960 for social fairness. The other two measures are .924 for satisfaction and .893 for continuance intention. All the measures included in the questionnaire showed
adequate levels of initial internal consistency reliability (> .70) [45, 46]. A correlation matrix of variables (not presented) showed that in general, the correlations were consistent with theoretical expectation.

A correlational study analyzed the relationship between independent and dependent variables, employing the Structural Equation Modeling (SEM) technique which is particularly useful when one dependent variable becomes an independent variable in subsequent dependence relationships.

Table 1. Descriptive Statistics and Reliability Analysis Result

<table>
<thead>
<tr>
<th>Variable (number of items)</th>
<th>Mean</th>
<th>S.D.</th>
<th>Cronbach's Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural fairness (12)</td>
<td>5.510</td>
<td>0.957</td>
<td>.956</td>
</tr>
<tr>
<td>Social fairness (10)</td>
<td>5.597</td>
<td>0.990</td>
<td>.960</td>
</tr>
<tr>
<td>Recovery satisfaction (4)</td>
<td>5.629</td>
<td>1.011</td>
<td>.924</td>
</tr>
<tr>
<td>Continuance intention (3)</td>
<td>5.582</td>
<td>1.041</td>
<td>.893</td>
</tr>
</tbody>
</table>

Standardized estimates and standardized regression weights are presented in Fig. 2 and Table 2. All three hypotheses tested were supported. The structural model was accepted and the chi-square was significant (chi-square = 967.920; df = 205, p = .000, relative chi-square = 4.722) (see Fig. 2). The path coefficients for the structural model are shown in Table 2. The relative effect (standardized regression weights) between independent and dependent variables shows a statistical significance for all hypothesized relationships.

Analysis of path coefficients indicates that all hypotheses are supported. The influences of structural fairness (coefficient = .533, p = .000) and social fairness (coefficient = .419, p = .000) on recovery satisfaction were significant. Similarly, the influence of recovery satisfaction on IS continuance intention is significant (coefficient = .820, p = .000) (see Table 2). The impact of the endogenous variables is high, as indicated by the $R^2$ values. The highest $R^2$ appeared in recovery satisfaction (88.1%) and the next $R^2$ was shown in continuance intention (67.3%) (see Table 2). The results of the research model (H1 – H3) show that all three hypotheses are supported, so the model does work well in this context.

Fig. 2. Result of Structural Equation Modelling (SEM)
Table 2. Results of Standardized Coefficients

<table>
<thead>
<tr>
<th>Dependent (R²)</th>
<th>Determinant (hypothesis)</th>
<th>Coefficients (P-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recovery Satisfaction</td>
<td>Structural fairness (H₁)</td>
<td>.533 (.000)</td>
</tr>
<tr>
<td>(R² = .881)</td>
<td>Social fairness (H₂)</td>
<td>.419 (.000)</td>
</tr>
<tr>
<td>Continuance Intention</td>
<td>Recovery Satisfaction (H₃)</td>
<td>.820 (.000)</td>
</tr>
<tr>
<td>(R² = .673)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. Conclusion

The objective of this study is to propose a theoretical model that can explain and predict service recovery satisfaction in relation to the focal determinants of service fairness perceptions. In other words, this study explores the relationship between service fairness and customer recovery satisfaction, and investigates whether recovery satisfaction have direct impact on continuance usage of the cloud computing system. The findings show a positive and significant path from structural and social service fairness to recovery satisfaction. That is, recovery satisfaction with the service delivery process is affected by the processes and value outcome.

This research has offered an important contribution by integrating the focal determinants of service fairness with the IS continuance intention domain. The focal determinants of service fairness do have a significant impact on recovery satisfaction, and thus, indirectly influences IS continuance. This suggests areas that managers of IS support services need to consider, and points out areas that research on IS management must account for. The focal determinants of service fairness are clearly an important issue for IS users.

The implication of this research findings can be translated into practical skills that results in a more satisfying recovery service encounter. For example, the structural fairness related to customer’s involvement in decision-making and fair distribution outcomes. Organizations could include service failure recovery procedures in their Service Level Agreement (SLA) to ensure that customers would receive a specified level of performance and availability if service failure occurs.

In addition, the organizations could implement the social fairness approach in service recovery practices that related to the quality of communication and apology, the time it took to respond and solve the problem, the employee’s ability to a) solve the problem, b) be respectful and empathetic and c) be knowledgeable, honest and reliable. The practitioners in the service industry would find additional usage for the research findings to improve the level of customer service recovery satisfaction.

Nevertheless, the basic concept that the focal determinants of service fairness have an impact on recovery satisfaction was also confirmed. This
study does, of course, have several limitations. First, the scope is limited to the context of SaaS enterprises in a cloud computing environment. While this is an important and increasingly widespread context, it would be beneficial to replicate the study to broaden the contexts. For example, related sorts of environments could be public SaaS, Infrastructure-as-a-Service (IaaS) or Platform-as-a-Service (PaaS) applications. Second, this study employed a one-sided survey response from external customers using SaaS in a cloud computing environment. Further study using a dyadic approach could gain in-depth understanding on the responses from both customers and service providers; notably, by examining the record of the service interaction to examine how specific details of the service interaction correlate with the fairness issues. Finally, this research was cross-sectional surveyed at one period in time. The findings can only reflect that specific time, but customer satisfaction is also a product of cumulative experience, and may change over time.

The limitations have helped to define other potential directions of future research, but we also point out a couple of other useful areas for future work. First, the IS in a large organizational context, where they have their own system and the IS service is for internal customers, is a potential environment to be investigated. Internal organizational employees account for a large percentage of IS users. Studies of these extrinsically motivated users may contribute many theoretical insights to the IS post-acceptance model. Second, testing the research model with different types of IS context will improve the generalizability of the empirical results of this study.

References


Lifestyle Segmentation for Boutique Accommodation in Relation to the Service Quality and Customer Satisfaction

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Abstract

In this research, the researcher investigates (1) how the development of hotel segmentation in the Thai hotel industry is related to the concept of the ‘boutique hotel’, (2) the relationships between the categories ‘boutique’, ‘chic’, ‘hip’ and ‘lifestyle’ hotels and the characteristics of members of their target customer market, (3) the impacts of guest characteristics and behavior patterns vis-à-vis products and services provided by so-called ‘boutique hotels’, and finally, the researcher considers (4) the key components of the ‘boutique hotel’ category insofar as they impinge upon the management and ownership styles, the hospitality marketing mix, service quality, and the levels of satisfaction of guests. In this investigation, theories of market segmentation and service quality developed in hospitality management research are used to explain relationships between lifestyles and levels of satisfaction. The researcher additionally attends to the utilization of management tools which would be implied by findings concerning the characteristics and behaviors of guests as determined by lifestyle and preferences and how these factors affect levels of guest satisfaction.

The researcher has determined that boutique accommodations are characterized in terms of smallness, adherence to themes, particular concepts of design, and efforts to appear unique in products and services offered and provided.

It was also ascertained that there are differences between Thai and international tourists as evidenced by lifestyles and preferences. These differences affect expectations concerning the dimension of service quality. Significant differences between the characteristics and behavior patterns (lifestyles) of Thai and international tourists were identified through an application of the Strategic Business Insights (SBI) Values and Lifestyles or VALS™ model.

In applying this model, the researcher determined that the largest majority of the Thai tourists surveyed had a lifestyle that can be best summarized under the rubric of the category of “strivers,” i.e., those who were primarily motivated by achievement motivation. In contrast, however, the researcher additionally found that the lifestyle of the largest majority of international tourists surveyed manifested a lifestyle that can be best summarized under the rubric of the category of “innovators,” i.e., those who had a high level of resources and a high level of the capacity to produce innovations.
In addition, in applying this model to the next largest majority of both the Thai and international tourists surveyed, the researcher uncovered differential characteristics dependent upon a contrast between Eastern and Western cultural matrices. Thus, in terms of lifestyle, the researcher found that the majority of Thai tourists in this second group belonged to the category of “thinkers,” i.e., those who were primarily motivated by ideals. However, this second group of international tourists belonged to the lifestyle category of “survivors,” i.e., those with low resources and low innovation.

The researcher is of the opinion that the results of this inquiry can constitute a useful tool for hotel entrepreneurs and managers who must be concerned with the relationships between the lifestyles of members of target groups and their preferences. For provided are vital data that can prove useful in determining the appropriateness of hospitality products and services for guests and which provide guidance in efforts to engender higher levels of guest satisfaction with the quality of services provided.

Key words: Boutique Accommodation, Lifestyle Segmentation, VALS™ model and SERQUAL model.

Introduction

Boutique hotel are believe to have been invented in the early 1980s. Two of the first boutique hotels in the world opened their doors to the public in 1981: Blakes Hotel in South Kensington, London (designed by celebrity stylist Anouska Hempel) and the Bedford in Union Square, San Francisco (the first in a series of 34 boutique hotels currently operated under the flag of one of the most eminent players in the boutique hotel world today, the Kimpton Group). In 1984, Ian Schrager opened his first boutique hotel in Murray Hill, New York City, named Morgans Hotel, designed by French stylist Andrée Putnam (Anhar, 2006). This was also when the entrepreneur Ian Schrager and Steve Rubell opened Morgans on Madison Avenue. It was quirky and individual, unlike the big brand-name hotels that were dominant at the time (The independent, 2006).

A boutique hotel has the kind of accommodation favored by high-end visitors nowadays. With architectural beauty, luxury and a unique decor, aspects which distinguish these hotels from others of their kind, the boutique hotel has become a tourism magnet, drawing a greater number of visitors to Thailand each year. At present, Thailand boasts many boutique hotels which are recognized by visitors for their beauty. The Tourism Authority of Thailand (TAT) has produced the publication Thailand 100 Best Boutique Hotels, which presents a list of charming boutique premises located in the major tourist destinations in Thailand, and is a helpful source for visitors who wish to make their own choice (Services Promotion Department, TAT, 2007).

Chiang Mai has been promoted by tourists and travelers alike as a good destination choice, with its reputation as an “ancient and cultural city”, but still
does not attract enough repeat travelers. According to the TAT publication *Thailand’s 100 best Boutique Hotels*, in the northern region, Chiang Mai has 7 of the best boutique hotels out of a total of 12 hotel properties, and in *Thailand Chic Vanity* (Marketing Service Department, 2007); Chiang Mai was also named as having a total number of 9 out of 21 ‘chic boutique’ hotel properties. Since hotels consisting of a new style of accommodation have been launched as destinations tailored to tourists needs, a tremendous number of new hotels with a ‘boutique’, ‘chic’ ‘hip’ and ‘lifestyle’ concept have been built, with 40 to 50 properties posted on various travel and tourism websites, such as: www.asiahotel.com, www.chiangmai-luxuryhotels.com, www.hiphotels-thailand.com and www.chiangmaiboutiquehotels.com, according to a research survey (Tidti, 2009). The first hotel in Chiang Mai to be called a boutique hotel was Tamarind Village, and other hotel developments related to the boutique hotel concept have since been built.

This research aims to study the development of the boutique, chic, hip and lifestyle hotel concepts, the characteristics of these terms with respect to boutique hotels in Chiang Mai, and how perceptions differ among the management, staff and hotel guests. It also aims to explore the ownership characteristics of the hotel segment and the hotels’ management concepts. Lastly, the study explored the characteristics and behavior patterns of the hotels’ guests in terms of value, attitudes and lifestyle (VALS™), with respect to service quality (SERVQUAL), plus their level of satisfaction with regard to this hotel sector.

**Theory and Conceptual Framework**

Market segmentation seeks to identify some easily identifiable characteristics with which the purchasing behavior of subgroups within a market may be predicted and targeted (Johns & Gyimothy, 2002). According to Johns and Gyimothy, the marketers increasingly augment these “secondary segmentation factors” with psychometric measures of attitudes and values, but these are themselves of limited predictive value, though the science of segmentation has concentrated on comparing them. This segmentation will allow one to narrow down to sub-group target in terms of their preferences, lifestyle choices and behavior in relation to travel and hotel products.

Travel market segmentation can be achieved in various ways. In the tourist industry, most producers have no other choice but to deal with certain segments, mainly because of the location and nature of their business. Segmentation enables marketers to define homogeneous groups of consumers according to one or more variables, and it is then possible to describe these segments and to develop specific marketing actions aimed at one or more
groups. Segmentation criteria are usually divided into two categories: general consumer characteristics and situation-specific and behavioral characteristics (Legoherel, 2006).

According to Ernest & Young (2008), hotel companies strive to distinguish themselves while satisfying ever-expanding consumer needs and desires. Boutique or lifestyle hotel concepts have emerged across the globe in every size, style, segment and market. This segment of the market has particular challenges, as consumer tastes are becoming increasingly sophisticated and diversified; brands must keep pace with cutting-edge technology while being environmentally responsible; new lifestyle brands face the challenge of appealing to a wide, international audience, while at the same time differentiating them. Service is considered the fundamental foundation for any operator, and the fusion of indigenous service, design, culture, food, entertainment and even religion into lifestyle hotels, has emerged as a central trend in the segment. Lifestyle hotels are expanding into emerging and other markets across the globe, including secondary markets, as people increasingly search for new and different lodging alternatives. The lifestyle or boutique hotel has emerged in response to changes in consumer tastes, trend and behavior.

Traditionally, psychographic characteristics include social class, personality and lifestyle. The latter concept is held to embody an understanding of individuals’ needs, the benefits sought and their motivations (Middleton, 1997, 2001). Psychographic segmentation is based on lifestyle profiles normally derived from survey responses to AIO (Attitudes, Interests, and Opinions) statements. Psychographics seeks to describe the human characteristics of consumers that may have a bearing on their responses to products, packaging, advertising, promotions and public relations efforts. Such variables may range from self-concepts and lifestyles, to attitudes, interests and opinions, as well as perceptions of product attributes (Reid et al. 2006, 2010).

Lifestyle segmentation is used by hoteliers and hotel management for the design of products and services, for differentiating consumer needs or hotel guests demanding personalized services in a unique setting; even traditional hotel companies are introducing lifestyle segments. The lifestyle niche has become an established sub-category among the upper upscale and luxury segments, and is making headway into the select-service segment. This segment targets the personal values of customers in terms of their decision-making on the hotel category or classification they wish to frequent, based on their preferences and satisfaction levels.

**Hospitality Marketing Mix:** The hospitality marketing mix is used as a tool for hoteliers and hotel management staff in the design and provision of their
products and services (the mix of marketing activities that are directed toward an identified target market), those used to attract hotel customers and guests. Ford et al. (2000) describe a hospitality marketing mix as the effort to align an organization’s strategy, staff and systems to meet or exceed customer expectations with respect to the three facets of a guest’s experience: service product, service setting (service environment) and service delivery. These three aspects or elements need to be carefully woven together to give guests what they want and expect.

**Lifestyle Concepts**

According to Plummer (Plummer, J.T. (1974); cited in Bowie et al. (2008)), lifestyle used in lifestyle segmentation research measures people’s activities in terms of: 1) how they spend their time, 2) their interests, what they place importance on in their immediate surroundings, 3) their opinions in terms of their view of themselves and the world around them, and 4) some basic characteristics such as their stage in the life cycle, income, education and where they live (demographics and geographic locations).

For the discussion on lifestyle segmentation, this research will apply these terms to the hospitality segmentation in terms of products and services design, based on the characteristics of boutique accommodation concepts and guest values and behavior patterns. Lifestyle segmentation has been referred to as having the same meaning as psychographic segmentation. Lifestyle market segmentation offers a way to combine both psychological and behavioral variables into a single segmentation approach (Moscardo, 2004). Lifestyle segmentation can be defined as representing the goals that people shape for themselves and the means they employ to reach them (Lawson et al., 1999).

This method of segmentation will be used to define those guest characteristics and behavior patterns that relate to products and services, and also those that relate to the ownership or management style of the boutique accommodation concept.

**VALS™ Concept and Framework**

VALS can be defined as a method that separates types of customers based on psychological characteristics and four key demographics. The US VALS system classifies customers into eight segments using primary motivations (e.g., thinking experiences) and levels of financial resources (high or low) (Bowie et al., 2008).

The VALS™ system (VAL stands for "Values, Attitudes and Lifestyles") is a psychographic segmentation. It was developed in the 1970s to explain changing US values and lifestyles. It has since been reworked to enhance its ability to predict consumer behavior. Segmentation research based
on VALS is a product of SBI Consulting Business Intelligence (SBI, 2010). It is considered to be generally applicable as a product specific lifestyle segmentation scheme developed to inform decision-making about specific products and services (Mitchell, 1983). The VALSTM framework can be used to predict consumer behavior on the basis of attitudes and lifestyles. VALS states that consumer’s purchasing behavior is an expression of their personalities. The VALS framework allows marketers to identify meaningful market segments based on consumer personality traits and provide a means to predict purchasing behavior (Reid & Bojanic, 2010).

**VALSTM Segments**

1. *Innovators* are successful, sophisticated, ‘take charge’ people with high self-esteem.
2. *Thinkers* are motivated by ideals. They are mature, satisfied, comfortable and reflective people who value order, knowledge and responsibility.
3. *Believers* are motivated by ideals. They are conservative, conventional people with concrete beliefs based on traditional, established codes; family, religion, community and the nation.
4. *Achievers* are motivated by the desire for achievement. Achievers have goal oriented lifestyles and a deep commitment to career and family. Image is important to achievers; they favor established, prestige products and services that demonstrate success to their peers.
5. *Strivers* are trendy and fun loving. Because they are motivated by achievement, Strivers are concerned about the opinions and approval of others.
6. *Experiencers* are motivated by self-expression. As young, enthusiastic, and impulsive consumers, Experiencers quickly become enthusiastic about new possibilities, but are equally quick to cool.
7. *Makers* are motivated by self-expression. They express themselves and experience the world by building a house, raising children, fixing a car or canning vegetables, and have enough skills and energy to carry out their projects successfully.
8. *Survivors* live narrowly focused lives. With few resources with which to cope, they often believe that the world is changing too quickly. They are comfortable with the familiar and are primarily concerned with safety and security.

The VALSTM framework can be used to predict consumer behavior on the basis of attitudes and lifestyles. VALS states that consumer’s purchasing behavior is an expression of their personalities. The VALS framework allows
marketers to identify meaningful market segments based on consumer personality traits and provide a means to predict purchasing behavior (Reid & Bojanic, 2010). I have applied the VALS™ framework to investigate the differentiation in lifestyles and characteristics between Thai and international tourists, those who stay in boutique hotels.

Researcher applied the VALS™ framework to investigate the differentiation in lifestyles and characteristics between Thai and international tourists, those who stay in boutique hotels.

**The Concept of Service Quality**

Parasuman, Zeithaml and Berry (1985, 1988) define service quality as a perception resulting from attitudes formed by customer’s long term, overall evaluations of performance, and as the degree and direction of discrepancy between the consumer’s perceptions and expectations, or the extent to which a service meets or exceeds customer satisfaction. Douglas and Conner (2003) state that consumer perceptions are based on the actual service they have received, while consumer expectations are based on past experiences and information received. These statements represent the determinants or dimensions of service quality. There are five key dimensions (Berry and Parasuman, 1991), as follows:

1) **Reliability** - the ability to perform the promised service dependably and accurately.
2) **Tangible** - the appearance of physical facilities, equipment, personnel and communications materials.
3) **Responsiveness** - the willingness to help the consumers and to provide a prompt service.
4) **Assurance** - the knowledge and courtesy of employees and their ability to convey trust and confidence.
5) **Empathy** – the provision of caring, individualized attention to consumers.

The SERVQUAL instrument was first introduced by Parasuman, Zeithaml and Berry in 1985. They attempted to develop an instrument that would measure service quality across a range of service industries and to ascertain the level of service quality based on the five key dimensions (above).

Researcher has reviewed the concepts and theoretical framework to explain the concept of boutique accommodation, in relation to hospitality market segmentation and the hospitality marketing mix, and linked to hotel management or proprietor characteristics. The literature review has also studied the VALS™ model as a tool that can be used to explain customer or
guest characteristics, attitudes and behaviors pattern, through the use of eight segments. Finally, researcher also discussed the relationship between the SERVQUAL model and guest satisfaction levels in terms of the relationship between the product and service, and the hospitality mix and segmentation. This will present the methodology and research framework, and will also explain a conceptual model based on the theoretical framework that guided the studies discussed as the conceptual model presented.

Figure 1  Conceptual Model and Hypotheses Testing
The research questions of this study were:

*RQ 1:* How does the Thai hotel industry develop the boutique hotel concept as a hotel segment, and what is the relationship between the boutique, chic, hip and lifestyle hotels in terms of hotel segmentation?

*RQ 2:* What are the guests’ characteristics and behavior patterns, those affecting their perception and satisfaction with respect to the service and quality of the products and services provided by the boutique hotel concept?

The specific hypotheses for this study are as follows;

- **H0, 1:** There are significant differences between the boutique, chic, hip and lifestyle segments of the Thai hotel industry.
- **H0, 2:** There are significant differences in management and ownership styles within the boutique accommodation concept.
- **H0, 3:** There is a significant relationship between ownership style and the products and services offered by boutique accommodation.
- **H0, 4:** There is a significant relationship between Thai and international tourists in terms of their lifestyles.
- **H0, 5:** There is a significant relationship between guests’ satisfaction levels and their lifestyle.
- **H0, 6:** There are differences in hotel guests’ characteristics and behavior patterns between the boutique hotel concepts.
- **H0, 7:** The target markets for the boutique accommodation concept reveal significant differences in terms of hotel guest characteristics and behavior patterns.
- **H0, 8:** There are significant differences in terms of guest satisfaction levels with regard to the boutique accommodation concept.
- **H0, 9:** There are significant differences in terms of services quality features valued by Thai and international tourists within the boutique accommodation concept.
- **H0, 10:** There are significant differences in terms of the purpose of travel and service quality features required from the boutique accommodation concept.

**Methodology**

The investigation was based on 50 hotels in Chiang Mai, which differentiate themselves by marketing their product using a boutique accommodation (hotel) concept based on uniqueness. The research and interviews collected information from hotel owners, hotel managers and heads
of department, in order to investigate their perception of the boutique hotel concept in terms of how they differentiate their products and services, how they perceive the characteristics and differentiations of their customers, and to investigate the effectiveness of their management and marketing strategies in terms of hotel competitiveness trends.

A qualitative and quantitative research method was used to collect the information while carrying out the investigation. A primary survey was also used to collect the hotel sample size data, as selected by a purposive sampling method. This sample could be identified in relation to the following concepts: boutique, chic, hip and lifestyle. This survey was conducted by reviewing their websites, brochures and fact sheets (Tidti, 2009).

Research Design, Population, Sampling and Data gathering Method

Phase A: The research focused on the hotel management, heads of department and selected service staff working in the 50 sample properties that identify themselves as boutique, chic, hip or lifestyle hotels. The purposive sampling method was used to collect information from the sample properties which operate hotel businesses registered within an overall population of 299 hotels in Chiang Mai (Chiang Mai, National Statistics Office, 2007).

Phase B: The research focused on Thai and international tourists who visited Chiang Mai and stayed overnight at boutique accommodation during the period of the survey. The total tourist population size was about 766, 354 tourists that year (Office of Tourism Development, 2008) and the primary sample were determined using the Stratified Random Sampling method and a secondary sample using the Simple Random or Accidental Random Sampling Method. The resulting sample of 400 used in the study was selected by a Stratified Random Sampling method and the sample size calculated using the Yamane Method (1973) and also calculated using the Krejcie & Morgan method (1970). Using both methods helped to produce a correlated number for the sample size. Thus, the sample size set was 400 respondents, and this was then used to calculate the sample size in each sub-group. This research thus used 400 respondents: 200 Thai tourists and 200 international tourists.

Research Instrument

Use of the self-administered questionnaire was divided in two phases, as follows; the questionnaire for Phase A developed key questions based on segmentation theory and the hospitality marketing mix, and consisted of three sections as detailed; the respondents’ demographics and personal data; the respondents’ perceptions and understanding of the boutique accommodation (hotel) concept, ownership styles, hotel management and marketing strategies
and the differentiation of products and services based on hospitality segmentations and the hospitality marketing mix- all related to customer satisfaction and the open-ended questions was designed to investigate other issues related to the boutique hotel concept and its management style.

The questionnaire for Phase B contained key questions based on the VALS™ model and SERVQUAL instrument, and consisted of four sections, as detailed; The respondents’ demographic, the second section, using multiple choice 35 questions, covered the values, attitudes and lifestyles of the respondents, based on the VALS™ model, by describing the opinions of the respondents using the answer sets: “Mostly disagree”, “Somewhat disagree”, “Somewhat agree” and “Mostly agree”, The third section used the Likert Scale measurement 7-point scale, where 1 equaled “Strongly Disagree” and 7 equaled “Strongly Agree”, based on the SERVQUAL Model (Parasuman et al., 1985). This section contained 22 questions regarding the tourists’ perceptions of service quality, plus questions related to satisfaction levels, and were designed to measure the customers’ attitudes towards the products and services offered by the boutique accommodation, the management, service quality, and their general satisfaction levels with regard to the boutique accommodations and last sections, containing open-ended questions.

Research Variables

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Dependent Variables</th>
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<tr>
<td>Ownership &amp; Management style</td>
<td>Characteristics of Boutique Hotel concept</td>
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<tr>
<td></td>
<td>Products and Services</td>
</tr>
<tr>
<td>Tourists’ profiles</td>
<td>Characteristic and behavior patterns</td>
</tr>
<tr>
<td></td>
<td>Value, Attitude and lifestyles</td>
</tr>
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<td></td>
<td>Perceptions and Satisfaction</td>
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<td>Guest’s satisfaction</td>
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</table>

Data Analysis

Descriptive statistics were used to provide means and percentages of demographic characteristics and other variables in the study, both for the Phase A and Phase B questionnaires. In addition, inferential statistic techniques, including the analysis of Chi-square, variance (ANOVA) and correlations were used to test the relationship between the variables used for hypothesis testing. A correlation coefficient was employed to measure the strength of association.
Results

Phase A: A total of 40 responses were returned and the response rate was thus 80% within a sample size of 50 (hotel owners/hotel management staff). For Phase B, a total of 411 surveys were administered, representing an 82.20% response rate out of the sample size of 500 (Thai and international tourists). The data was manually entered into SPSS 15.0 for Windows, for statistical analysis. And details were presented as follows;

The Owner and Hotel Management Perspectives

In relation to the demographic profiles of the owners and hotel management, the results reveal more females (59%) than males (41%), with the majority of the hotel owners or management staff in this survey (30%) being young adults between 30 and 35 years of age. The work experience of the owners or hotel management staff in this survey shows that the majority of the respondents (75%) had previous hotel work experience. The majority of respondents (36.7%) had less than 5 years hotel work experience.

In terms of work position held, the results show that the majority of respondents (owners and hotel management staff) had work experience as a Head of Department (44.8%), followed by Hotel Managers (37.9 %) and Supervisors (27.6 %). Others indicated that they had had no previous direct work experience in the hotel business.

The Hotel Management Profiles

The majority of respondents (56.8%) had work experience in the hotel business of between 1 and 3 years, followed by 4 to 6 years (29.7%). An in terms of the position held, the majority of respondents (41.2%) were hotel owners/managers.

The majority of hotels had been operating for between 3 and 6 years (47.4. The average number of hotel employees and hotel rooms was 22.3 people and 27.63 rooms respectively. The respondents (52.8%) indicated an average length of stay of customers of between 3 and 4 nights, while 41.7% indicated a stay of between 1 and 2 nights. The average occupancy rates indicated in this survey were 32.79% for the low season and 67.89% for the high season. The majority of room types in the hotels are deluxe rooms (85%), followed by superior rooms (57.50%) and suites (37.50 %).

The room rate survey showed that the average room rates were as follows: deluxe rooms 4,373.13 Baht (700 to 8,532 baht), superior rooms 3,426.67 Baht (1,100 to 7,410 baht), junior suites 7,837.50 Baht (3,000 to 16,000 baht), family suites 5,058.33 Baht (2,250 to 10,000 baht), deluxe suites
4,186.67 Baht (2,800 to 6,960 baht) and suites 11,026.15 Baht (3,000 to 25,000 baht). Other room types could not be identified using the standard terms.

Hotel Management Perspectives

The majority of hotels (33.37%) were independently owned, while almost one-quarter (23.44%) were company owned. The majority of company owned hotels were owned by Thai nationals (93.33%). The majority of both independently and company owned hotels (66.7%) were participating as members of the ‘Chiang Mai Boutique Hotels’ group, whilst 14.81% were not.

The hotel/accommodation concept/design survey showed that the majority of respondents (73%) were operating in the boutique style, while 16.2% were operating in the lifestyle segment.

The key variable affecting hotel design was building style (89.7%), within which the presence of a cultural building stood at 53.8%, a contemporary building design at 33.3% and a historic building design at 17.9%. The second key variable affecting the hotel design was location (82%), within which having a city location was seen as most important at 33.3%, followed by a riverside location (17.9%) and a rural location (7.7%). The third key variable to impact the design was atmosphere (71.8%). The survey required that respondents rank the most important key variables for their hotel design, and as a result, the majority of respondents (64.1%) indicated that service quality was most important variable.

Hotel management responses regarding the profile of the target customers and the age of the customers showed that the majority of target customers (62.2%) were Foreign Independent Travelers (FIT). In terms of the age of the target customers showed that the majority (65%) were aged between 35 and 44 years old.

The hotel management staff provided similar products, facilities and services to their guests. The survey showed that the products and services most often provided to guests were WIFI and high-speed internet access (95%), followed by mini bar services (90%), a flat screen TV with cable or satellite access and a walk–in shower room (both 80%). Provision of an in-room electric kettle with a variety of coffees and teas provided scored 72.5%.

In terms of key influences on hotel concepts and designs, the key influences given were tourist demands (56.4%), followed by individual preferences (51%), and economic situation and competitive advantage factors (both 35.9%).
Tourists’ Profiles and Perspectives

Part 1: Demographics

The majority of Thai tourists (54.3%) were female, as were the majority of international tourists (52%). The ages of the Thai tourists were 33.3% between 25 and 29 years old. For the international tourists the majority (21.5%) were aged between 35 and 44 years of age. These results are representative of the total of the average ages of the tourists, with the majority (25.5%) aged between 25 and 29 years of age.

The profile of Thai tourists by education level shows that the majority (63.5 %) held a college degree. For the international tourists the majority (44.7%) held a graduate degree. In total, the respondents’ education levels showed that 45.6% held a college degree, 36% held a graduate degree and 9.1% had attended 1 to 3 years at college. The occupational survey showed that the majority of Thai respondents (48.7%) were professionals and also the majority of international respondents (19%) were professionals. In total, the majority of respondents (32.4%) were professionals, followed by 16.1% who were self-employed and 12.5% who were managers or administrators in a company.

The profile of the respondents by household income is divided into Thai and international respondents. The results show that the majority of Thai respondents (30.5%) had an average income of less than 30,000 Baht, followed by 26.3% with an average income of 30,001 to 50,000 Baht and 11.1% with an average income of 50,001 to 70,000 Baht. Total household income before taxes for the previous calendar year show that the majority of international tourists (14.5%) had an average income of between US$100,000 and US$199,999, followed by 13.5% for both those with an average income of US$30,000 to US$39,999 and US$40,000 to US$49,999, and that 13% had an average income of between US$50,000 and US$74,999.

The profile of the Thai respondents in terms of purpose of travel shows that the majority of respondents (50%) were travelling for leisure purposes. For international respondents, the majority of respondents (64.5%) were traveling for leisure purposes. In total, the majority of respondents (58.8%) were travelling for leisure purposes, followed by 28.8% on family matters or VFR.

According to the reasons for selecting the hotel, the majority of Thai respondents (54.5%) said that they chose the hotel due to its theme or concept, followed by 33.9% due to the convenient location and 20.1% due to the hotel’s ‘uniqueness’. The majority of international respondents (28%) stated ‘uniqueness’, followed by 27.6% who chose the hotel’s theme and concept and 25.4% due to the hotel’s convenient location. In total, the total majority of
respondents (39.7%) selected their hotel due to its theme and concept, followed by 29.2% who chose it due to its convenient location and 24.5% who chose it due to its ‘uniqueness’. The country of origin survey of the respondents showed that the majority (53.5%) were international tourists, of whom the majority were from Europe (45.9%), followed by 46.5% who were Thai tourists.

**VALS Demographics by Mean Value (4 Scale)**

The majority of Thai tourists were Strivers (3.33), followed by Believers (3.36, 3.31), whilst the majority of international tourists were Experiencers (3.45), followed by Strivers (3.28) and Innovators (3.23)

**Service Quality Section 1: Expected Values Shown by an ‘Excellent’ Hotel (7 scale)**

The majority of Thai tourists had higher expectations than the international tourists, for all items. And the majority of Thai tourists (a value of 6.23) valued empathy (caring, individual attention provided to guests), followed by responsiveness (6.25, 6.23), that is, the hotel’s willingness to help hotel guests and provide a prompt service. **Service Quality Section 3: Perceived Values (7 scale)**

The majority of international tourists (a value of 6.22) valued reliability (the hotel’s ability to perform the promised service dependably and accurately), followed by tangible factors (6.16), including the appearance of the hotel’s physical facilities; the equipment, personnel and communication materials at the hotel.

**Result of Hypotheses Tests**

**Hypothesis 1**: There are significant differences between the boutique, chic, hip and lifestyle segments of the Thai hotel industry.

Hypothesis 1 used a test of independent variables (Chi-Square: $\chi^2$), to statistically determine, the relationship between hotel concept (boutique, chic, hip and lifestyle) and hotel segmentation were detailed first ranked variables ($\chi^2=12.461$, Sig. =0.644), target customer ($\chi^2=16.110$, Sig. =0.585) and age of target ($\chi^2=14.555$, Sig. =0.692). The results show that the hotel concept revealed no relationship with hotel segmentation (at the Statistical Significances level of acceptances = *$\alpha$*≤0.05). Thus, the Null Hypothesis is rejected.

**Hypothesis 2**: There are significant differences in management and ownership styles within the boutique hotel concept.
According to the statistical testing present ($\chi^2=0.666$, Sig. =0.881). The results show that accommodation concepts have no relationship with the management and ownership styles of the hotel (at the Statistical Significances level of acceptances $= \alpha \leq 0.05$). The **Null Hypothesis** is thus rejected.

**Hypothesis 3**: There is a significant relationship between ownership style and the products and services offered by boutique accommodation.

According to the statistical testing present $\chi^2=.468$, Sig. =0.926*, the results show that ownership style has no relationship with the products (facilities) and services offered (at the Statistical Significances level of acceptances $= \alpha \leq 0.05$). The **Null Hypothesis** is rejected.

**Hypothesis 4**: There is a significant relationship between Thai and international tourists in terms of their lifestyles.

**Hypothesis 4**: A T-test was used to investigate two groups of variables; to compare the differences in lifestyle between Thai and international tourists. Also a test of independent variables was used (Chi-Square:$\chi^2$), to statistically determine the relationship in terms of lifestyles between Thai and international tourists. The differences found in lifestyle groups between the Thai and international tourists, show a significance level of 0.01 in the Innovator, Striver, Achiever and Thinker groups. The T-test values found for these groups were 3.178, 2.451, 2.862 and 3.305 respectively. This shows that Thai tourists had higher values in each lifestyle group than the international tourists. These Thai tourists with the highest values were Strivers, followed by Thinkers. International tourists with the highest values were in the lifestyle group Strivers, followed by Survivors. The results also show that the relationship between the lifestyle group and the type of tourists shows a significant difference of 0.01. The majority of Thai tourists’ (69.7%) were in the lifestyle group Believers, followed by Innovators (58.9%). Further to this, the majority of international tourists (76.0%) were in the lifestyle group Experiencers, followed by 72.7% in the Survivors group. **Null Hypothesis is accepted.**

**Hypothesis 5**: There is a significant relationship between guests’ satisfaction levels and their lifestyle. According to the 22 attributes of service quality, the statistical testing present $\alpha \geq 0.05$, the results show that differences in lifestyle groupings have no significant link to differences in satisfaction levels. **Null Hypothesis** is rejected.

**Hypothesis 6**: There are differences in hotel guests’ characteristics and behavior patterns between the boutique hotel concepts.
Hypothesis 6 used a variance analysis (One-Way ANOVA) to determine if there was a significant relationship between hotel guests’ characteristics and behavior patterns (lifestyles) and the hotel concept chosen. According to the 8 groups lifestyle, the statistical testing present $\alpha \geq 0.05$, the results show that differences in the hotel concept had no impact on the hotel guests’ characteristics and behavior patterns (lifestyle). Null Hypothesis is rejected.

Hypothesis 7: The target markets for the boutique accommodation concept reveal significant differences in terms of hotel guests’ characteristics and behavior patterns.

Hypothesis 7 used a variance analysis (One-Way ANOVA) to determine if there was a significant relationship between hotel guests’ characteristics and behavior patterns (lifestyle), and the hotels’ target markets and if the variance analysis (One-Way ANOVA) represents differences in means (for at least one group), a multiple comparison test between groups using the LSD (Least Significant Difference) method can be used to test samples between groups that show differences in mean values.

The results show that the lifestyle groups Achievers, Survivors, Thinkers and Makers have a Sig F value less than 0.01. The differences in target markets reveal differences in terms of the values for the lifestyle group of Achievers, Survivors, Thinkers and Makers, with a statistically significant difference level of 0.01.

There were significant differences to a level of 0.05 between the target market (family group), with an average mean for Achievers higher than in for the leisure travel group. For the target market (business travel) there was a higher average mean for Survivors than for the leisure travel group. In addition, the lifestyle group (Believers) with a target market of leisure travel, revealed a lesser value than the family groups and business travelers. Also, the lifestyle group (Makers) with a target market of business travel revealed a higher value than the leisure travelers and family groups, to a statistically significant level. Null Hypothesis is accepted.

Hypothesis 8: There are significant differences in terms of guests’ satisfaction towards boutique accommodation.

Hypothesis 8 used a variance analysis (One-Way ANOVA) to determine if there were a significant difference guest satisfaction levels and the hotel concept and if a variance analysis (One-Way ANOVA) represents differences in the mean values (for at least one group), a multiple comparison test between groups using the LSD method can be used to test those samples
between groups that reveal differences in mean values. The results show that the satisfaction levels with the service attributes F1 (the hotel has modern equipment), F3 (personnel at the hotel are neat in appearance), and F4 (materials associated with the services [such as brochures or statements] are visually appealing) have a Sig F. value of less than 0.01. This means that different hotel concepts also reveal different values in terms of the guest satisfaction levels, with a statistically significant difference value of 0.01.

The results show that the hotel concepts (boutique, hip and others) revealed an average satisfaction with f1 service attributes (the hotel has modern equipment) with a higher value than lifestyle, to a statistical significance of 0.01. Furthermore, satisfaction with the f3 service attributes (the hotel is neat in appearance) for the boutique hotel concept revealed a higher level of satisfaction than for the lifestyle concept. Also, the level of satisfaction for f4 service attributes (materials associated with the services [such as brochures or statements] are visually appealing) was higher for the boutique hotel concept than the lifestyle concept. Null Hypothesis is accepted.

Hypothesis 9: There are significant differences in terms of services quality features valued by Thai and international tourists within the boutique accommodation concept.

Hypothesis 9 used a variables independence test (Chi-Square:χ²) to statistically determine the differences between Thai and international tourists in terms of those service quality features valued within the boutique accommodation concept. The results show that service quality features have a significant relationship with the type of tourists, to a level of 0.01. The majority of Thai tourists (60.2%) associated with feature 5: empathy (the caring, individualized attention the hotel provides to its guests), followed by 46.7% for feature 3: responsiveness (the hotel’s willingness to help hotel guests and provide a prompt service). Also, the majority of international tourists (77.6%) associated with feature 2: reliability (the hotel’s ability to perform the promised service dependably and accurately), followed by 54.9% for feature 1: tangible (the appearance of the hotels’ physical facilities: the equipment, personnel and communication materials of the hotel). Null Hypothesis is accepted.

Hypothesis 10: There are significant differences in terms of the purpose of travel and the service quality features valued within the boutique accommodation concept.

Hypothesis 10 used an independent variables test (Chi-Square:χ²)
to statistically determine the relationship between the purpose of travel and the service quality features valued. The result shows the five service quality features that revealed a relationship with purpose of travel (or Target MK) – producing a statistical significance of 0.01. The majority of business travelers (17.3%) stated feature 5: empathy (the caring, individualized attention the hotel provides its guests), followed by 14.5% for feature 3: responsiveness (the hotel’s willingness to help hotel guests and provide a prompt service). Also, the majority of leisure travelers (77.8%) rated feature 4: assurance (the knowledge and courtesy of the hotel personnel and their ability to convey trust and confidence), followed by 70.7% for feature 2: reliability (the hotel’s ability to perform the promised service dependably and accurately). The majority of family travelers (38.3%) rated feature 5: empathy (the caring, individualized attention the hotel provides its guests), followed by 36% for feature 1: tangible (the appearance of the hotels’ physical facilities; the equipment, personnel and communication materials of the hotel). Null Hypothesis is accepted.

Summary and Discussions

The goal of this research was to adapt lifestyle segmentation theories in terms of the characteristics and behavior patterns provided by the VALS™ model, and to study those tourist characteristics and behavior patterns that influenced their decision to stay in boutique accommodation, further taking into account the influence of hotel ownership and management styles.

The results of this research study show that boutique hotels are generally of a small size, and deliver a theme and concept in terms of their design, as well as 'unique' products and services. Boutique hotel entrepreneurs and hotel management teams were shown to be independent (of large hotel chains) but were members of a boutique hotel group to aid marketing activities they tended to be young adults with previous hotel work experience. The study also found differences between the Thai and international tourists in terms of their lifestyles and preferences with regard to service quality. Significant differences in characteristics and behavior patterns in this regard were identified using the VALS™ model, which suggests that the majority of Thai tourist were Strivers (whose primary motivation is Achievement), whereas the majority of international tourists were Innovators (high resource levels and highly innovative). The results also reveal differences in characteristics between the eastern and western cultures, as the second largest group of Thai tourists were in the Thinkers group (whose primary motivation is Ideals), whereas the second largest group of international tourists was in the lifestyle group Survivors (low resources and low levels of innovation).
This research provides a tool for hotel entrepreneurs and managers to explore the lifestyle preferences of guests in their target market, and to manage their products and services in order to achieve high guest satisfaction levels based on service quality. Since the research tool used in this research was developed by Vals™ model that applied from the US consumer market. Therefore, the hotel entrepreneurs should apply this tool for an accurate measurement only for guests identified as having a similar context.

Thus, hotel managers should also apply other tools when planning marketing strategies for other customer nationalities, in order to accurately identify their lifestyles and preferences. However, boutique hotels are expanding rapidly, so factors in addition to uniqueness and service quality, and the tourist season in question, might influence consumer decision making on the choice of accommodation in the future.

**Limitations of the Study**

The data used in this investigation into boutique accommodation was collected from hotel management staff or owners, and from tourists who arrived at Chiang Mai and stayed overnight at boutique accommodation between December 2009 and March 2010. The data was collected across a range of boutique hotels for all of the Chic, Hip and Lifestyle concepts, which allowed me to cover various types of hotel, as well as the tourists staying in them during that time. The data represented only a single point in time and presented information for boutique accommodation in Chiang Mai. This research only identified differences between two broad groups of tourists (Thai and international tourists) in terms of what lifestyle characteristics they possessed and also what they felt was important in terms of their stay in the boutique hotels. The VALS™ model, which was first applied in the US consumer market, might not have been appropriate for the different national groups that were a part of this study. And another limitation is that the applications of the VALS™ model, which applies to hotel guests in a western cultural context, might not be suitable for hotel guests who represent an Oriental cultural context. In addition, the SERVQUAL model might also be applied separately for Thai and international tourists, due to differences in lifestyle.

**Recommendations for Future Research**

The question is whether the attitude towards staying in hotels varies significantly between guests with different economic resources and from different backgrounds. Any future research examining lifestyle characteristics might consider either conducting a parallel study in the off-peak season as a
comparison, or alternatively conducting another investigation using a longitudinal data collection method, with the data being collected over different periods of time. This study attempted to control these issues by using a comparison of the sample data against the population data as a whole.

However, it is likely that the model derived from the data collected in this research may not be wholly appropriate when exploring lifestyle characteristics and relationships across other nationalities. Each group in this study was generally representative of the Eastern and Western cultural context; however, in order to produce an appropriate and effective marketing strategy for tourists from other nationalities, future research may need to explore the determinants of boutique accommodation and search for comparative studies among the same group of people on a repeat visit, staying in similar accommodation and at a similar time to their first visit. What are the guests’ expectations in relation to the accommodation style and the products and services provided the second time around, when compared to the first?

Future research might also need to explore the determinants of Western and Eastern cultural contexts, in order to develop a model appropriate for the management of boutique accommodation that caters to both sets of tourists.

Finally, the differences found between international and Thai guests in terms of the lifestyle segmentation created by the VALS™ model in this study, highlights the need to explore other areas of hospitality segmentation.

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The Impacts of co-production and dynamic capabilities on service innovation

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~ To the memory of Dr. Russell K.H. Ching ~

Abstract. Service innovation has been seen as an important issue for business practices and academic research for the past few years. In this study, we investigated how to achieve service innovation through the co-production with business partners (downstream client). In specific, we considered enhancing dynamic capabilities would provide mediating effect for service innovation. We also identified the influencing factors and examined their effects on co-production practices. We conducted an empirical study for knowledge intensive business service (KIBS) firms in Taiwan. 124 useable paired returns from a sale manager and a project manager of each response firm were received. The results of analysis suggested that co-production has the impact on service innovation through the mediating effect of enhancing dynamic capabilities of the KIBS firm. In addition, market orientation and customer match play significant influencing factors of the co-production practices.

1 Introduction

Ever since Vargo & Lusch (2004) proposed the concept of service-dominant logic (SDL), many researchers have followed and emphasized on creating customer values from a more holistic and integrated view. They suggested customers need to become co-producers to obtain core service values, for example, to co-produce with firms by either sharing information (Kelly et al., 1990) or distributing knowledge (Blazevic & Lievens, 2008). Furthermore, in the new product/service development process, customers can take more important roles at different stages. The customers can help the company to identifying problems and generate new ideas; providing user preferences at the analysis and design stages and conducting pilot tests before product/service launch.

Co-production is even important for knowledge intensive business service (KIBS) firms. The definition of KIBS refers to the firm which highly
dependent on their knowledge in order to be able to create value for and with clients (Skjølsvik et al., 2007). Research on the field of KIBS often put emphasize on the importance to co-work with the business partners (downstream clients) and to complete the assigned project (Skjølsvik et al., 2007). While there have been a few studies discussing KIBS firms, only few have paid attention on the learning and growth of the KIBS firms itself. For example, how the KIBS firms can learn and enhance firm capabilities (e.g., dynamic capabilities) and how to co-produce with clients? Thus, in this study, we aim to identify the roles of co-production and dynamic capability of the KIBS firms and investigate the relationships among co-production, dynamic capability, and service innovation. In particular, we are interesting to know how the dynamic capability of the firm can be enhanced by co-production with clients and whether dynamic capability play a mediating role of the effect of co-production on service innovation. Overall, we present a model that links strategic orientation, co-production, dynamic capability, service innovation and organizational commitment in an attempt to contribute the literature on co-production in this study. First, we examined the relationships among co-production, dynamic capability and service innovation. Second, we explored the relationship of antecedents and co-production.

2 Theoretical Background and Hypotheses Development

2.1 Co-production

The concept of co-production is primary developed from the idea of customer involvement. Dabholkar (1990) define customer involvement as the degree of involving in the process of manufacturing and service delivery by customer. Following this concept, Meuter & Bitner (1998) distinct three kinds of service creation based on customer involvement: (1) company produce, (2) co-produce and (3) customer produce. Among the three types, co-produce refers to the interaction between customers and front-line employees and customer participate in the process of creation. The different between customer involvement and co-production is that customer involvement emphasizes the collaboration with customer to produce service; instead, for co-production, companies see customers also as service providers together to produce products/services. Lusch et al. (2007) mentioned that co-production involves the participation in the creation of the core offering itself. It can occur through shared inventiveness, co-design, or shared production and can occur with customers and any partners in the value networks. Moreover, company can gain competitive advantage through engaging customers and
value network partners in co-production activities. Bovaird (2007) defined co-production as collaboration among professional service providers and users or other community or members. It’s through a stable and long-term relationship and all of the members are resource contributors. This effect is even bigger especially in KIBS firms. KIBS firms act as a function as facilitator, carrier or source of innovation, and some KIBS function as co-producers of innovation with client firms. They exchange knowledge and experience with customers and create more innovative and specific solutions through co-production. Building on these researches, we present a framework that links the antecedents (strategic orientations and customer match) and outcomes (enhancing dynamic capability and service innovation) of co-production.

2.2 Co-production and service innovation

Service activities have been emphasized in recent years and many companies try hard to figure out how to provide new service to increase the final value. Gadrey, Galloj & Weinstein (1995) defined innovative service belong to process or organization of innovation which based on the existed service product. Oke (2007) see service innovation as new activities development and deliver core service products which can satisfy many purposes (for example, create core service product to attract more customers). There are six types of innovation which is appropriate for services: (1) radical innovation, (2) incremental innovation, (3) improvement innovation, (4) architectural innovation, (5) formalization innovation and (6) ad hoc innovation. Among these six types, lots of argues are about ad hoc innovation. Some scholars argue that ad hoc innovation is more specific and can’t be reduplicated and formalized. It might lose its economic value. However, Vries (2006) still see service innovation as a kind of ad hoc innovation, which refers to the interaction to solve a specific problem of customers.

In addition, this kind of innovation is not from a single source, Vries (2006) mentioned that service innovation comes from a collaborative network, which includes different employees with different competences, partners and supplier collaboration and the competence from combination of company and deliver technology. Any change in this network can produce new service. As the result, we infer that service firms can create successful service innovation through co-production.

*Hypothesis 1: co-production with customers has a positive effect on service innovation*
2.3 Co-production and dynamic capability

Because of the dynamic environment, the capability to integrate the resources and quickly response to the market become more important. Zott (2003) mentioned that dynamic capability is not a simple addition to resources based view because they management the resources and capabilities itself can directly cause rents. In order to quickly respond to the market, organizations are not only competing on their ability to exploit their existing resources and organizational capabilities, firms also need the ability to renew and develop their organizational capabilities. Teece (1997) define dynamic capabilities as ‘the firm’s ability to integrate, build and reconfigure internal and external competences to address rapidly changing environment’. Since the resources and competences integration and reforming is the core of dynamic capability, there are three core organizational and managerial processes for the creation of dynamic capabilities, which include (1) the coordination and integration of both internal and external activities, (2) learning, seen as ‘social and collective’, (3) reconfiguration and transformation which is based on surveillance of market and technological environments. In order to develop effective dynamic capability, Winter (2003) recognized that ad hoc problem solving is a viable alternative to developing a dynamic capability. For Zollo & Winter (2002), it is created by firms that draw on their experiences from acquisitions or joint ventures to manage projects in systematic and relatively predictable fashion. Due to the close relationship between dynamic capability and resources and competences integration, this kind of capability is more important especially in KIBS firms. The function of KIBS firms is to find out the problem solutions with and for client firms to response the market change. During this process, service providers integrated the resource and capability they already had and learned the knowledge and experience from their clients. Finally, they reorganize and reconfigured all the assets they got, either new or original assets, to provide a specific and innovative solution for their clients. Wu (2006) confirmed the relationship that the cooperation of external support associated has the positive effect on dynamic capability. Accordingly, we infer that KIBS firms can enhance their dynamic capability through co-producing with customers.

**Hypothesis 2: Co-production with customers has a positive effect on dynamic capability**

2.4 Dynamic capability and service innovation
Wu (2006) suggest that the dynamic capability can increase firm’s performances, which include innovation speed in creating new products and process. Organization with dynamic capability can perceive seize the opportunities easily. It’s a kind of capability usually link with change renew. Therefore, we propose that dynamic capability is a key factor in creating service innovation.

**Hypothesis 3: Dynamic capabilities has a positive effect on service innovation**

### 2.5 Strategic orientation and co-production

According to service profit chain, customers’ perception will be affected by front-line employees’ behavior. Therefore, in order to create customer satisfaction and better services, lots of researches focus on the impact factors of organizational behavior. Recently, strategic orientation has been seen as an important factor in the field of innovation. The definition of strategic orientation is the firm’s philosophy of how to conduct business through a deeply rooted set of values and beliefs that guides the firm’s attempt to achieve superior performance. Prior researches usually emphasize on three types of strategic orientation: customer, competitive, and technological orientation. Moreover, some researchers integrated customer orientation and competitive orientation as market orientation. Thus, we are going to see the effect of strategic orientation through discussing market and technological orientation.

**Market orientation** The definition of market orientation refers to require, share and respond the market information to provide the guideline of behavior. Jaworski & Kohli (1993) definite the market orientation from combining customer focus, marketing collaboration and profit till acquiring market intelligence, disseminating among inter departments and the responses of organization. Realizing the target customers and potential competitors and collaborating inter- functional resource and activities are core elements of market orientation.

The consequence of market orientation has been researched a lot. Narver & Slater (1990) indicated that market orientation plays an important role on profit creating and customer value maintenance. In addition, market orientation can lead employee team spirit, customer orientation (who is willing to satisfy customer needs) and job satisfaction.
Hypothesis 4: Market orientation has a positive effect on co-production

Technology orientation. On the contrary, technology orientation reflects the philosophy of technological push instead of customer pull. Namely, customers prefer products and services with better technique. A company with technology orientation will promote R&D, acquire new technology and commitment of new technology applying. Both market orientation and technology orientation are acquired new ideas, but former one tends to acquire the ideas which can satisfy customers’ needs and the latter one encourage employees to use the newest technology. A company with technology orientation usually would endure and encourage their employees have “crazy idea” or come out some interests to invent something new.

Because technology orientation more focus on new technology applying and inter-organizational inventing, and easily leading to not invite here (NIH) syndrome and only-use-here (OUH) syndrome, we assume that technology orientation would hinder co-production developing.

Hypothesis 5: technology orientation is negatively related to co-production

2.6 Customer match and co-production

Traditionally, customers have the right to choose the products or services even company based on their preference. It was quite less to see the contrary (company choose the customer) in the real business. However, researchers figured out that not all of customers are profitable and suggested that company need to concentrate the resources on the profitable one instead of all. Beltencourt et al. (2002) pointed out that company should select customers who match the service company to provide different kind of services. On the other hand, Bendapudi & Leone (2003) pointed out that because customers are easy to have self-serving bias while doing collaborative project with company, selecting the customer who has high autonomy orientation is a way to reduce this bias. Thus, selecting customer becomes a necessary thing which every firm need to pay attention.

Except for general companies, decisions about what type of clients to prioritize are basic for strategic development of successful knowledge intensive business service firms. Beltencourt et al. (2002) suggested that KIBS (knowledge intensive business service) company especially need to pay
attention to the operating philosophies and cultures of perspective clients. They suggested that firms should select the clients who have the similar business orientation and operating methods and this match will contribute to improve the development of cooperative relationship and help to reduce the natural tension. Thus, we infer that the process of co-production will be improved while customers highly match with service providers.

**Hypothesis 6: customer match has a positive effect on co-production**

### 3 Methodology

#### 3.1 Sampling and Data Collection

This study is developed based on KIBS firms. We obtained the sample as follows: First, we acquired a sampling frame from the China Credit Information Service Top 5000 firms in Taiwan and we chose the companies which belong to the four industries we preferred. In addition, in order to increase enough samples, we also referred to the association of each industry, including Information Service Industry Association of R.O.C. (CISA), The Chinese Association of Engineering Consultancy, Business Management Consultants. At first, 1218 copies of questionnaires were mailed to two departments of 609 firms, and each department will receive one questionnaire and a self-address stamped return envelope. 28.74% for computer software and information system service related industry, 20.2% for managerial consultancy service related industry, 26.77% for advertisement and marketing service related industry and 24.3% for engineering consultancy service related industry. In the first page of our questionnaires, we briefly described the research purpose and give our words that we will provide them the summary of the research if they have interest when we received their response. After the first month mailing, we received 53 responses from firms and total 11 firms were collected both questionnaires. In order to increase the response rate, we followed up contacted with these firms which we have not received any response or only replied one questionnaire. After about 3 month, the follow-up contacting resulted in total 135 usable questionnaires from sales managers, 140 valid questionnaires from project managers and in total 124 firms replied both questionnaires. The response rate of total 124 firms is 20.36%. We assessed the independent t-test to reduce the bias of early-late response and the response from two managers. The results show that there is no difference between early and late response and the answer from two managers as well.
3.2 Analysis

To test the hypotheses, we employed partial least squares (PLS). The reason why we used Partial Least Square (PLS) is because the purpose of our study is to explain a series of inter-related dependent relationship between a set of latent constructs. One advantage of PLS is it can compute cause-effect relationship models that allow both formative and reflective measurement models. Beside, the sample size is relative small (n=124) in our study, the integration between measurement and structural model was allowed in PLS. Therefore, PLS was selected and to calculate the result of path coefficient of measurement model and construct model.

4 Results

Based on the purpose of this study, we examine two constructs (Customer Match and Dynamic Capability) both from two sample objects (sales managers and project managers). Thus, to reduce the bias, we compared the reply by independent-sample t-test and the results shows that there is no difference between sales managers and project managers in terms of Customer Match (n=124, p=0.576) and Dynamic Capability (n=124, p=0.853). In addition, as table 1 shows, the path between co-production and service innovation was significant (β=0.145, P>0.05), so that H1 was rejected. Second, the relationship between co-production and dynamic capability was positive and significant (β=0.398, P<0.001), H2 was accepted. Besides, the effect of dynamic capability to service innovation was also positive and significant (β=0.603, P<0.001), H3 was also accepted. About the antecedents of co-production, market orientation has a positive and significant effect (β=0.429, P<0.001), but the relationship of technology orientation and co-production was not significant (β=-0.023, P>0.05), which means H4 was accepted and H5 was rejected. Finally, in consistency with H6, customer match has a positive effect on co-production (β=0.294, P<0.01).

Table 1. Path coefficients and Hypothesis Results

<table>
<thead>
<tr>
<th>Path/Hypothesis</th>
<th>Path Coefficient</th>
<th>t-value</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypothesized Relationships</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Market Orientation → Co-production (H4)</td>
<td>0.429</td>
<td>4.65***</td>
<td>Supported</td>
</tr>
<tr>
<td>Technology Orientation → Co-production (H5)</td>
<td>-0.023</td>
<td>0.23</td>
<td>Unsupported</td>
</tr>
<tr>
<td>Customer Match → Co-production (H6)</td>
<td>0.294</td>
<td>2.95**</td>
<td>Supported</td>
</tr>
<tr>
<td>Co-production → Service Innovation (H1)</td>
<td>0.145</td>
<td>1.87</td>
<td>Unsupported</td>
</tr>
</tbody>
</table>
5 Conclusion

The study attempts to fill the gap between the practices of KIBS firms and researches and provide insights to understand the specific topics. First, the finding indicated that dynamic capability is a key factor in the relationship between co-production and service innovation. In other word, the reason why KIBS firms can create service innovation is because they can enhance dynamic capability through the processes to co-produce with clients. As the result, managers in KIBS firms should pay more attention on the process of co-production. Managers can decentralize the authorities and empower the employees to make decision by themselves while co-produce with customers. By doing so, employees can learn and decide how to solve the ad hoc problems immediately and seize the opportunities when it rises up while interacting with the customers. On the other hand, the appropriate environment for co-production also needs to be noticed by managers. Thus, organizational culture should be emphasized. In the finding of this study, market orientation seems better than technology orientation. In addition, dynamic capability can be driven directly by market orientation. Since the dynamic capability is necessary for firms to provide service innovation, any factor which can contribute the capability should be noticed. In order to implement market orientation, the first and the most important is emphasized by top managers and interdepartmental connectedness. Furthermore, market-based reward system is another important factor to improve market orientation. Therefore, if a company wants to implement market orientation in the organization, ensuring managers’ support, connecting between departments and appropriate reward system is necessary. Finally, for effective co-producing process, KIBS firms should co-produce with clients who have the similar culture and object. Sales managers need to personally involve in the process from the beginning and realize the culture and goal of customer deeply to decide the way they create the innovative service.

References

Revenue Management as an Emerging Management Routine: a research proposal

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Abstract. This paper is a research proposal for a multi-year project into revenue management routines in SMEs in the Thai hospitality industry. Professionalizing SMEs for the sake of economic development and growth motivates the research study.

The study uses a mixed-method approach. First, by means of a case survey questionnaire, assess the status quo of existing revenue management techniques in SMEs at 2 and 3-star hotels in the urban area of Chiang Mai city, Thailand. Second, using action research methods, collaboratively develop revenue management routines with a series of participating SMEs from the same sample on the basis of what is already there. We distinguish between the technical aspects of revenue management and the necessary organizational antecedents of revenue management.

The theoretical contribution is within institutional theory, and aims to develop the conceptualization of the performative aspect of routines, based on the variation and retention of successful routines.
1 Introduction

This paper proposes a multi-staged, multi-year research project into evaluating and developing revenue management routines in the Thai hospitality industry, with a specific focus on SMEs in the Chiang Mai region.

The focus of the research proposal is twofold: First, assess the status quo of revenue management techniques in SMEs in the hospitality industry the Chiang Mai, using this as a base position to, second, develop revenue management routines with a series of participating SMEs in the same sector.

The overall purpose of the research proposal is to support and develop competitive, sustainable and profitable business activity that increases employment and value-added services in the region by means of building capacity within the professional management area. The assumption behind the research proposal is that the existing situation in the hospitality industry focuses predominantly on cost control and price competition, resulting in a “race to the bottom” in which continuous competitive pressure erodes profitability and creates bad financial health across the industry [2]. Hence, in order to reverse that situation, the focus would need to shift from cost and price competition, to differentiation and focus strategies. The latter implies shifting managerial attention towards the management of profitability and operating income on the basis of sales revenues, implying the development of professional managerial knowledge about the tools of revenue management and the conditions that need to be in place in order to use those tools.

As such, revenue management is considered the opposite of cost management, in its focus on the top-line by means of differential pricing, marketing efforts, and the development of multiple and distinctly separate revenue streams. Comparing revenue management efforts with cost management efforts, research has found that revenue management contributes more persistently to profitability than cost management [7]. The purpose of revenue management as a tool is to enhance operating profit on a consistent, continuous and predictable basis.

Revenue management, also known as yield management, is a functional tool to increase the occupancy rate of fixed perishable capacity by means of managing customer demand via differential pricing. Its origins are in the airline industry but it has become commonly used also in the hotel and car rental industries.

For revenue management to work as a tool, five conditions need to be in place: (1) relatively fixed capacity, (2) a cost structure of low variable and high fixed costs (also known as high Operating Leverage), (3) perishable inventory, meaning that capacity that is not filled, is lost, which applies mainly to service capacity, (4) time-variable demand patterns, and (5) the ability to forecast demand [4]. All these conditions are commonly met in the hospitality industry.
The two key dimensions that need to be managed are the duration and the price of the capacity-constrained service business. Based on these two dimensions, revenue management decisions usually categorize into three sets: **Structural** (pricing format, terms of business and service delivery, service/product bundling), **Pricing** (price setting, pricing over time, discounting), and **Quantity** (capacity/output allocation across customer segments, channels, and service types) [14]. As a result of its instrumental approach, this implies that revenue management requires data collection, estimation and forecasting, optimization, and control as the four key managerial activities. In other words, revenue management is not “plug and play”, creating profit instantaneously – it needs to be part of a broader change in management context.

As a result, this research proposal distinguishes between the pure tool of revenue management and the necessary conditions that need to be in place for its effective use. This resonates strongly with a similar distinction into ‘technical drivers’ of revenue management and ‘social drivers’ of revenue management [10]. This research proposal builds on the findings of this study, and extends it in terms attempting to develop the concurrent revenue management routines and managerial contexts that have been empirically identified earlier.

### 2 Research Problem

The purpose of the research proposal is to create a competitive, sustainable and profitable hospitality business sector in Chiang Mai. The problem is the singular dominance of cost control and cost management at the level of the individual firm. Based on the assertion that profitability is the result of the differential margin between sales revenues and operating expenses, this project focuses on the sales revenues; how to grow them both in terms of volume and in terms of different sort of revenues?

The problem statement, therefore, is to develop the functional tools and the managerial capabilities of using the tools, for non-price competition. The strategy advocated in this research proposal is to focus on revenue management as the functional tool underlying differentiation and focus strategies in contrast to the existing cost leadership strategy (leading to continuous price pressure and the erosion of margins).

The academic research problem is located within institutional theory and revolves around the change and development of new management accounting routines [1], notably in the literature on the emergence and change of management accounting routines [15]. This theoretical perspective postulates management accounting systems as a set of rules (formal representations of
actions) and routines (actual behavioral patterns). Revenue management consists of such formalized, recurrent and situated computational rules and calculative practices while its numerical outcomes guide managerial decision-making behavior. As such, revenue management has a normative content (formalized in textbooks, decision-making axioms, and software) and a cognitive content, as to what the manager or decision-maker perceives (s)he can use for day-to-day business decision-making behavior. [5].

The normative content is usually described as the \textit{ostensive aspects of routines}, encoded in particular language, terminology, rules, procedures and artefacts such as software packages, otherwise also known as a discourse, “a system of statements which constructs an object” [6]. These are the elements that provide stability and recurrence in practice.

In order to address change in management accounting routines, such as in the development of revenue management routines, we describe the cognitive contents as the \textit{performative aspects of routines}, and are visibly in the “specific actions taken by specific people at specific times when they are engaged in an organizational routines” [3]. The performative aspects of routines are behavior-oriented, and grounded in action and interaction; based on the shared understanding of the revenue management numbers, the individual or collective decision makers decide on a course of action and then act these out. But in order to take action, they need to be informed by a “minimal structure” of information and calculative practice, i.e., the performative aspects requires the ostensive aspect. Vice versa, rules, calculations, manuals and software (the ostensive aspect) require a continuous experimenting on what works and in which context so as to create variation, from, in turn, the best routines are selected and added to the existing repertoire of revenue management practices. As a result, the ostensive and performative aspects are reciprocal [15].

The research problem at the theoretical level thus becomes how to describe the emergence of new management accounting routines based on the reciprocal interaction between the ostensive and performative aspects of routines?

3 Research Contributions

The research proposal will contribute at three levels:

1. Empirical assessment and validation of the use of revenue management tools and accompanying managerial contexts of use in the hospitality sector in Chiang Mai. This contribution is based on survey evidence, and defines the \textit{status quo} at the level of the SMEs constituting the sector, and is of relevance for regional sector policies, with actors such as governmental policy agencies, chambers of commerce, and industry associations [17].
2. The collaborative development between academic researchers and firm-level managers of specific revenue management tools and their accompanying managerial context of use, so as to implement revenue management to the benefit of the regional sector. This contribution is based on interventionist research [16] and participative inquiry [13], and actively supports the sector with the knowledge generated earlier on, which delineates the limits, constraints, and opportunities of the practical relevance of revenue management. This contribution is of relevance to the individual firms participating in the research project.

3. The academic contribution is split into a contribution on a functional level and a contribution on a theoretical level. At the functional level, the contribution is located in the improvement of the functional tools, notably in specifying the ‘technical drivers and social drivers’ of revenue management following the work by [10]. At the theoretical level, the contribution is located in the description and conceptualization of the performative aspects of routines, defining the functional components of revenue management as an instance of management accounting routines [15; 1; 9]. More specifically, of the three inherent characteristics of routines - flow, variation and multiplicity [15], we address the variation characteristics. Variation is created by (a) the location of this study in an emerging economy, non-Western economy, (b) the SME nature of this study, working under constraints of limited financial, human and time resources, and (c) the cyclical and seasonal nature of the hospitality industry requiring a continuous assessment of what works when. This contribution is relevant to an academic audience, and will result in research publications in a functional research journal (in accounting) and in a managerial research journal.

4 Research Statement and Research Questions

The reduction of the problem statement into a research statement revolves around the topical focus of revenue management. Specifically, the research statement is how to develop revenue management as an organizational routine? This is broken down into two components, each of which feed into a specific research questions with delineated focus and accompanying research design and related research knowledge and skills.

First – assessment, resulting in the research question: what is already there in terms of revenue management? This is addressed however rudimentary and irrespective of whether it is actually called Revenue Management by its users.
Following the work by [10], we differentiate into the ‘technical drivers’ of revenue management and its ‘social drivers’. Typically, ‘technical drivers’ consist of market segmentation, pricing, forecasting, capacity allocation, and IT, while ‘social drivers’ consist of organizational focus, aligned incentives, organizational structure, and education & training.

These two sets of drivers will be specified in terms of SMEs in the hospitality sector in Chiang Mai; for example, acknowledging and subsequently rephrasing them in terms of family-owned firms (organizational focus/structure) and in the use of customer data registration (IT), discounting criteria and rules (pricing), and pre-booking arrangements (forecasting). We define SMEs following existing definitions as used by the Thai statistical agency; that is, by means of the criterion of full-time employees, with less than 200 full-time employees constituting a SME.

We expect that the ‘technical drivers’ can be assessed by means of a survey questionnaire that closely follows the one used by [10]. However, we expect to make minimal adjustment to this questionnaire after inviting local experts, originating from sector associations and local agencies such as the Chamber of Commerce, to review it.

However, the ‘social drivers’ are highly unlikely to follow the ones used by [10], and will need to be adjusted far more to the local circumstances in Chiang Mai (a process also known as ‘indiginization’). Hence, we follow a research design and methodology that revolves around the Queenan questionnaire but which contains more open questions in its ‘social drivers’ component. As this is highly local sector specific, collaboration with academic colleagues in hospitality management and using as much as possible pre-existing tacit knowledge of other parties, is expected in this second research question.

Second – development, resulting in the research question: which revenue management tools can be developed as the most relevant ones? This research question is informed by the preceding stage of assessment, which should conclude with a quantitative and qualitative description of the existing tools related to the ‘technical’ and ‘social’ drivers of revenue management. Given that revenue management contains a series of tools all of which a basic data base, the expectation is that such data would need to be generated and maintained before any of the revenue management tools can be used. Hence, the development stage of the research question is considered to involve education, creation, and development of a user-friendly and simply information system based on Excel that can be used as a local information system [12]. To evaluate the impact of a revenue management program, the comparison of two separate periods, the first period without using a formalized revenue management program also indicated as the first, assessment stage of the
research design, addressing the ostensive aspects, and the second period, after the completion of the revenue management program in the second, development stage of the research design, addressing the first iteration of the performative aspects of the new revenue management routines [11]. This research question provides the base for the main academic contributions in terms of theory, as it revolves around co-developing new routines and effectuating change within participating firms.

This research component is based on interventionist research, which is a form of participative action research, in collaboration with a set of volunteering SMEs who participated in the preceding phase.

5 Research Design

The data acquired in the assessment phase, with the research question on what is there already, informs the development phase. Hence, the research design is sequential in time, with the empirical data informing the development and change aspect. As a result, this research proposal clearly intends to change existing practices and not just report on existing practice without further consequences for those involved. An illustrative figure of the research design is inserted below, indicating the mixed-method nature of our research design [8].

Figure 1: The research design.

The assessment phase is based on a case survey questionnaire addressing the ‘technical drivers’ and the ‘social drivers’. The ‘technical drivers’
questionnaire will be based on the questionnaire used by [10]. The survey questionnaire data will be obtained by means of personal visits of the SMEs and not on a postal survey, given the existing propensity not to answer mail surveys. The SME sample size will be limited to formally registered SMEs in the hospitality sector (2 and 3-star hotels) within the central municipality of Chiang Mai, also known as the Muang District, and not the province of the same name. The multiple case-study survey takes the same questionnaire as basis but will be adjusted by information from previously existing Thai research studies in the hospitality management field and in the SME field [2]. The latter will be pre-tested before use as well as will be validated against the opinions of established and experienced experts in the hospitality sector in Chiang Mai. The results of both surveys will be cross-checked, both statistically and analytically, for compatibility, validity, and various biases. Collaboration with academic colleagues in the hospitality management field (both within Payap University as externally), with academic colleagues in questionnaire and multiple-case surveys, with external experts, and with external practitioners from the industry are all envisioned.

The ‘technical driver’ survey is based on accounting and financial topical knowledge, while the ‘social driver’ survey is based on managerial and organizational topical knowledge. In other words, the research design is both multi-disciplinary and mixed method [8].

The development phase is based on action research methodology, commonly used in organization theory and management research. The design of this second phase is inspired in by [13] in how to structure and design participative inquiry. It revolves around a number of collaborations between a team of researchers (a senior and one or two junior researchers) and the management team of the individual firm, with a practical agenda based on education (what is revenue management and what is it supposed to do for you?), design (how can revenue management data be created, and revenue management tools be connected to existing ways of working?), and implementation (what do we do first, and how is the Excel template used in front office and back office activities?).

The collaborative nature of the development phase requires explicit attention for the structure of the research project so as to guarantee participation by all parties involved (SMEs, agencies and associations, and researchers). Hence, the research design is also sequential in the development and creation of its participative base, following the stages of (1) coalition building among participants, (2) information distribution among participants and their respective constituencies, (3) awareness creation of the purposes, outcomes, and involvement, and, finally, (4) initiation of the assessment phase. In other
words, the research design explicitly envisages a pre-project process of engagement that is managed as an integral part of the research project.

Figure 2: The sequential development of the research design.

The various stages of the pre-process are conceived as follows, keeping in mind that each stage can be changed according to the contextual and cultural requirements of each participant category: Coalition building refers to identifying, approaching, engaging, and involving local business (the SMEs mentioned above), tourism associations, and regional development agencies. The later is motivated by the postulate that the development of revenue management routines equals business administration capacity building and making capabilities available to a larger pool of organisations. Information distribution refers to categorizing and disseminating the existence and purpose of the research coalition, bounding its focus as to what it will and will not do. This stage derives its relevance from the fact that a joint effort by a coalition of diverse stakeholders each with different agendas and previous experiences, will need time to establish mutual trust and eliminate barriers for collaboration.

The awareness creation process phase addresses specific topical focus and interest, and establishes “what’s in it for me?” This stage has the characteristic of a dialogue and is the outcome of the preceding information distribution stage. The topic of revenue management is considered to be subject to various contexts and conditions of use, for example, in terms of available information, the use of information technology, the family-owned nature of many SMEs, calculation complexity, integration with existing marketing and sales approaches etc. The everyday reality of the participating SMEs finds itself expressed in preferences for approaches and formulating specific interests and, thus, to simultaneously anchor relevance and awareness of the possibility to
change and improve. Typically, this stage is example-based, following stories and anecdotal evidence provided by participants which are then related to existing available revenue management tools, showing to all involved that a pressing problem in business reality has answers, thus building awareness that continued involvement in the project is beneficial to all parties. These examples are short texts (in Thai), similar to ‘flash cards’, containing the story, figures, and resolution of the depicted problems, which can be publicly distributed.

The selection of SMEs entering into the development phase is on the basis of three criteria: (1) volunteers originating from the original case survey, (2) volunteers originating from suggestions made by local experts, local institutional members of the reference board, and SMEs involved in the pre-project process, and (3) advertisements placed in the local trade newsletter and bulletin. All are volunteers hence there is a deliberate self-selecting bias within the development stage for SMEs with a high propensity for change. The firms originating from suggestions made by local experts and agencies and associations involved in the pre-project process, act as a within research-project control group as compared to the firms entering from advertisements and the assessment phase.

The base for the development phase is the interventionist research methodology that has proven itself in several situations of implanting information and management systems, and has a known template and protocol for structuring the intervention [16].

Given the collaborative and co-developing nature of this stage, it is expected to be the most time consuming part as well as the most demanding in terms of senior researcher expertise.

For that reason, a project organization will be created, containing an external reference board consisting of well-established and experienced international interventionist researchers. Moreover, as this expertise is relevant for the spin-off into the academic research repertoire in Thailand, an important effort will be made to involve junior researchers, doctorate students, and graduate students with the idea to create both critical mass of knowledge that remains valid also after the research project has been concluded.

6 Research Project Organisation

The research project organization is considered important not only for research project execution, but also for fund raising and accountabilities for research results, concrete outcomes towards external parties, and larger academic
contributions at the level of new theory generated and new methodologies introduced.

A core group of researchers (among who are the authors of this proposal) will form the research executive committee. Three researchers will be responsible for one of the three research design modules (‘technical drivers’, ‘social drivers’, development) and directly involved in executing the assigned research design module.

Moreover, the research project organization is considered for the long-term continuity and stability of this research project over a period of 2-3 years. An international reference board will be formed, harnessing relevant international expertise at the level of each one of the three research sub-projects. To assure spill-over of research knowledge, a number of reputed academic colleagues from Thailand will be asked to join this international reference group, once again based on the boundaries between the three sub-projects. Moreover, in order to anchor the research effort into the relevant institutional eco-system for the sake of involvement, implementation, and impact, a selected number of local and regional agencies and authorities will be invited as project team members on a more hands-on basis.

![Figure 3: The research project organization.](image)
The aim is to gradually refine and improve this proposal in terms of its design, questions, and involvements, aiming primarily at a national and regional impact. Funding will be sought initially for further developing the proposal to the level that it is internationally competitive, and then approach various funding agencies that maintain international standards for application of funds.

7 Conclusion

At this point in time, inputs on the following issues are actively sought:

- **Refinement of the problem statement and research questions**, based on which research already has been done at other universities in South-East Asia on this topic. This in order to prevent reinventing the wheel and the build further on existing empirical results, and methodological knowledge and insights obtained from earlier studies. As usually only studies get published that discretely omit the various hard-worn practical lessons learned, we are purposely looking for the small things that make the difference.

- **Suggestions as to which specific revenue management techniques as well as (accounting) information systems are most appealing to SMEs.** With what and how can we adjust the ‘technical drivers’ in [10] to the context of SMEs, to the context of SE-Asia, and to firms with very limited knowledge on how to handle computerized information systems? We want to continue on the SME level of analysis and not get “pushed” by the underlying data requirements of formal revenue management systems into dealing with large firms who have already passed the small vs big firm threshold in terms of professionalization of management and systems. That is, we do not aim to make the good ones better but to lift the average and poor ones up.

- **Suggestions as to the involvement of academic colleagues and practitioners** who have experience with revenue management, with research into SMEs, with the hospitality industry, and with action research methodology in business administration in Chiang Mai, and with action research methodology (the latter not necessarily in the management, business or economics fields).

- **Short-listing of relevant agencies, associations, institutions, and firms to collaborate with** in executing this research project, both in terms of sharing expertise and in terms of possible funding opportunities.
References

Supply Chain 1
A closed-loop supply chain model for product recovery and remanufacturing planning under uncertainty

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Abstract. This paper proposes a mixed integer linear programming model for designing a supply chain as a closed-loop network and planning product recovery for remanufacturing under uncertainty. The supply chain structure consists of a number of plants and disassembly centers (to be selected from a set of potential locations) and a number of existing customer zones and disposal sites at fixed locations. Demand for remanufactured products, return of used products, and the rate of product recovery are all considered as uncertain parameters. A multi-period cost-minimizing stochastic programming model is developed to determine the location of plants and disassembly centers, and to specify, for each period in the planning horizon, the optimal remanufacturing/production quantities, the number of used products to collect and disassemble, the inventory of recovered cores to maintain as well as product flows between the various facilities in the supply chain.

Keywords: Closed-loop supply chains, reverse logistics, remanufacturing, product recovery, mixed-integer programming.

1 Introduction

Attention to product recovery and remanufacturing has increased in recent years due to legislation, economic incentives, environmental concern, and customer awareness. These considerations are forcing original equipment manufacturers (OEM’s) not only to provide more environmentally friendly products but also to take back used products that have reached their end of life. Products may also be taken back for other reasons such as customer dissatisfaction and warranty repair [15].

Returned products are generally sorted for re-use, remanufacture, recycle and disposal. An important field of product recovery is remanufacturing which refers to the process of upgrading used products or their major modules to such quality standards that remanufactured items are just as good as new. Until recently much of the remanufacturing was driven by cost cutting considerations and limited to low-volume high-value items like copiers,
computers, vehicle engines, or medical equipment. For example, the reuse of parts and materials obtained from high-value, end-of-lease copiers, reportedly saves the Xerox Corporation 40% to 65% in manufacturing cost [5]. However, many OEMs, attempting to combine good business sense with environmental sustainability, are now increasingly remanufacturing high-volume low-value items such as single-use cameras, mobile phones, ink-jet printers, and cartridges to reduce waste [6]. Eastman Kodak Company reportedly reuses on average 76% of the weight of a disposed camera in the production of a new one [14].

The production and distribution systems which combine product recovery and remanufacturing are referred to as closed-loop supply chains. Closed-loop supply chains differ from traditional supply chains in many aspects. In a traditional supply chain, the product is moved forward, and the customer is typically at the end of the chain. However, a closed-loop supply chain includes not only the forward processes, but also the reverse activities of product return and recovery. These activities include: acquisition of used products from end-users and their transportation to disassembly sites, recovery and storage of reusable units, disposition of non-reusable units, and remanufacturing of reusable units.

Closed-loop networks link together two distinct markets, namely a “disposer market” from which used products are collected, and a “reuse market” in which demand for remanufactured product exists [3]. The intersection of these two heterogeneous markets produces mismatch between supply and demand. Availability of used products for recovery is less predictable than supply of new input materials in a traditional supply chain. Therefore, mismatch between supply and demand with respect to quantity and timing is more prevalent in closed-loop than in traditional supply chains [3].

Another major characteristic of recovery networks is the level of uncertainty about the quality of used products. In general, used product quality is not known beforehand and can, depending on the condition of the individual product, be subject to considerable variability. As a result, disassembly inspection and testing activities play an important role in transitioning the product from the disposer to the reuse market. The quantity of used products that may be reused, and the quantity to be disposed of, and hence the magnitude and destination of the various reverse flows can only be determined after disassembly and testing. Therefore, the product recovery ratio is subject to uncertainty.

Even if technically feasible, a recovery operation may not be economically attractive as total recovery and remanufacturing costs (collection, disassembly, processing, and transportation) depend to a large extent on the structure of the closed-loop logistics network. The design of such a network is strategic as it involves a decision on the number, location, and capacities of various facilities.
and allocation of material flows between them [1, 2, 7, 10] and is one of the most challenging aspects of managing recovery operations [11].

Remanufacturing can be carried out by a local manufacturer or an original equipment manufacturer [12]. Considered in this paper is the latter case wherein the manufacturer remanufactures products from returned cores and other major components in parallel with the manufacturing of new products in the same facilities. In this environment, recovery networks are not commonly established from scratch but are designed using the existing set of plants and other logistics facilities. To this end, it is important to know which plants and disassembly centers to open and operate, and the number of units to process, store, and distribute out of them. Also, since capacity and recovery cost are facility-dependent, there is interest in determining whether it is economical to collect all returns and, by virtue of consequence, service all customer zone demands; and if not determining the appropriate level of collection remanufacturing and distribution of the recovery operation. Hence, facility and transportation decisions have to be integrated with recovery planning decisions so that material requirements, inventory levels, demand, and capacity constraints over the various stages of collection, disassembly, recovery, and disposition can be coordinated in the most economical way.

Even though a great deal of papers addressing reverse logistics issues have been published in recent years, see for example [4, 6] for a comprehensive literature review, only a few optimization models that address the design of closed-loop supply chain networks under uncertainty have been proposed. Fleischmann et al [3] presented a deterministic facility location model and investigated the impact of different product return rates on the network design by means of a parametric analysis. Salema et al [13] proposed a mixed integer multi-product reverse logistics network model that considers capacity limits and uncertainty on product demands and returns. Lieckens and Vandaele [9] developed a facility location mixed integer linear programming model extended with queueing relationships to incorporate stochastic lead times in network design. A generic stochastic model which accounts for alternative scenarios for demand return was proposed by Listes [8].

In the present work a multi-echelon logistics network model is developed for designing a closed-loop supply chain and planning product recovery for remanufacturing under conditions of uncertainty taken over a multi-period planning horizon. The supply chain structure consists of a number of plants and disassembly centers (to be selected from a set of potential locations) and a number of existing customer zones and disposal sites at fixed locations. Demand for remanufactured products, return of used products, and the rate of product recovery are all considered as uncertain parameters. Decisions provided by the cost-minimizing stochastic programming model determine the following:
1. The plants and disassembly centers to operate during the planning horizon,
2. The quantity to be produced at each plant and shipped to each customer zone in every time period,
3. The quantity of used products to be collected from each customer zone and shipped to each disassembly center in every period,
4. The quantity of reusable units each disassembly center ships to each plant in every time period,
5. The inventory of reusable units held at each disassembly center in every period,
6. The quantity of non-reusable units produced in each disassembly center and shipped to each disposal site in every time period.

2 Model description

The proposed network design and recovery planning model follows the closed-loop network structure. We consider four types of facilities, namely plants where remanufacturing of the reusable units takes place, disassembly centers where the inspection and disassembly function of the used units is carried out, disposal sites where non-reusable units are disposed of, and customer zones in which remanufactured units are sold and from which used units are collected. Moreover, two outcomes are possible for the collected used units: recovery and disposal. Only a given fraction of the used units processed in the disassembly centers is deemed recoverable and therefore reusable during remanufacturing, the remaining units are considered non-reusable and thus disposable. We also consider two types of flows: forward and reverse flows. Forward flows represent shipments of remanufactured units from plants to customer zones. The reverse flows represent: (1) transportation of used units from customer zones to disassembly centers, (2) shipments of reusable units from disassembly centers to plants, and (3) transportation of non-reusable units from disassembly centers to disposal sites.

2.1 Assumptions

In order to facilitate the formulation of the model, the following assumptions are postulated:

1. The supply chain facilities (plants, customer zones, disassembly centers, and disposal sites), already exist.
2. Demand for remanufactured products and supply of used products at customer zones are subject to uncertainties described by a given set of scenarios.
3. Plant production capacities, customer zone collection capacities, and disassembly center capacities are known.
4. A given product recovery ratio determines the number of reusable units resulting from the disassembly and inspection of a certain number of used units. This ratio is common to all used units regardless of the disassembly center they are processed in and the customer zone they are collected from.
5. Inventory of reusable units is held at the disassembly centers.
6. A minimum proportion of the reusable units recovered within a given disassembly center in a time period must be shipped out of that center in that period. This minimum quantity is a management policy designed to achieve an adequate inventory turnover at each center and thereby reduce obsolescence of the reusable unit inventory in the supply chain.
7. Disposal sites have unlimited capacities.

3 Model formulation

The model uses the following sets, parameters, decision variables, objective function, and constraints.

3.1 Primary sets and indices

$I = \text{Set of plants in which the product may be remanufactured, } i \in I$;
$K = \text{Set of disassembly centers in which returns may be processed, } k \in K$;
$J = \text{Set of customer or demand points, } j \in J$;
$M = \text{Set of disposal sites, } m \in M$;
$T = \text{Set of time periods, } t \in T$;
$P = \text{Set of demand of scenarios, } p \in P$;
$Q = \text{Set of product return scenarios, } q \in Q$;
$R = \text{Set of product recovery scenarios, } r \in R$;

3.2 Supply and demand parameters

Demand uncertainty is represented by a set of $p$ scenarios, each having a probability of occurrence equal to $\pi^p$. Likewise, used product return uncertainty is represented by a set of $q$ scenarios, along with their corresponding probability $\pi^q$. Uncertainty of used product quality is, in a similar manner, represented by a set of $r$ scenarios, each having an occurrence probability of $\pi^r$. Also, let $\pi^{pq}$ define the joint probability of the concurrent
occurrence of demand scenario \( p \) and return scenario \( q \). These probabilities will generally satisfy the conditions that 
\[
\sum_{p \in P} \pi^p = \sum_{q \in Q} \pi^q = \sum_{r \in R} \pi^r = \sum_{p \in P} \sum_{q \in Q} \pi^{pq} = 1.
\]

Furthermore let
\[
D^p_j = \text{Customer zone } j \text{ demand under scenario } p \text{ during time period } t;
\]
\[
d^q_j = \text{Customer zone } j \text{ used product return under scenario } q \text{ during period } t;
\]
\[
S_i = \text{Plant } i \text{ production capacity per period};
\]
\[
S_j = \text{Customer zone } j \text{ used product collection/storage capacity per period};
\]
\[
S_k = \text{Center } k \text{ disassembly capacity per period};
\]
\[
m_k = \text{Minimum shipment requirement out of an open center } k \text{ to plants per period};
\]
\[
\theta_i = \text{Center } k \text{ inventory storage capacity};
\]
\[
\lambda^r = \text{Product recovery ratio during disassembly under scenario } r;
\]

### 3.3 Cost parameters

\( f_i = \) Fixed cost for opening and operating plant \( i \);
\( f_k = \) Fixed cost for opening and operating center \( k \);
\( c_{ik} = \) Per unit remanufacturing cost at plant \( i \) using materials sourced from processing center \( k \); this cost comprises unit production cost at plant \( i \), plus unit transportation cost from center \( k \) to plant \( i \).
\( c_{jk} = \) Per unit disassembly cost at center \( k \) of a used product collected at demand point \( j \); this cost includes unit collection cost at point \( j \), transportation cost per unit from \( j \) to \( k \), and disassembly cost of a unit at center \( k \).
\( c_{km} = \) Per unit disposal cost at site \( m \) of a non-recoverable unit processed at center \( k \). This cost includes disposal cost of a unit at \( m \) plus unit transportation cost from \( k \) to \( m \);
\( h_k = \) Per unit per period inventory holding cost of a disassembled unit in inventory at center \( k \);
\( p_j = \) Unit penalty cost for not collecting returns of customer zone \( j \);
\( g_j = \) Unit penalty cost of not serving demand of customer zone \( j \). \( g_j \) could be Quantified by taking the relative importance of different markets into account; alternatively it could be related to the cost of meeting demand by resorting to external suppliers.
\( t_{ij} = \) Unit transportation cost of a product from plant \( i \) to customer zone \( j \);
3.4 Decision Variables

\[ X_{ijt}^p = \text{Forward flow: units shipped from plant } i \text{ to customer zone } j \text{ under demand scenario } p \text{ in period } t; \]

\[ R_{jkt}^q = \text{Reverse flow: units of used product shipped from customer zone } j \text{ and to center } k \text{ under return scenario } q \text{ in period } t; \]

\[ Y_{ikt}^p = \text{Units of cores shipped from center } k \text{ to plant } i \text{ under demand scenario } p \text{ in period } t. \text{ This flow reflects, by the same token, the number of units produced in plant } i \text{ out of cores sourced from center } k \text{ to respond to demand scenario } p \text{ in period } t; \]

\[ W_{kmt}^q = \text{Units shipped from disassembly center } k \text{ to disposal site } m \text{ under return scenario } q \text{ in period } t; \]

\[ B_{jt}^p = \text{Units of unsatisfied demand at customer zone } j \text{ under scenario } p \text{ in period } t; \]

\[ I_{kt}^q = \text{Disassembled units held in inventory at center } k \text{ at the end of period } t \text{ under demand scenario } p \text{ and return scenario } q; \]

\[ U_{jt}^q = \text{Uncollected used units at customer zone } j \text{ under scenario } q \text{ at the end of period } t; \]

\[ Z_i = \begin{cases} 1, & \text{if product is produced in plant } i; \\ 0, & \text{otherwise.} \end{cases} \]

\[ V_k = \begin{cases} 1, & \text{if used product is disassembled in center } k; \\ 0, & \text{otherwise.} \end{cases} \]

3.4 Constraints

\[ \sum_{j \in J} X_{ijt}^p \leq S_i Z_i, \quad i \in I, \ p \in P, \ t \in T; \quad (2) \]

Constraints (2) specify that the total flow out of plant \( i \), and thereby the total number of units produced at plant \( i \), during period \( t \) must be less than or equal to that plant production capacity if the product is produced in such a plant; and must be equal to zero otherwise.

\[ \sum_{i \in I} X_{ijt}^p + B_{jt}^p = D_{jt}^p, \quad j \in J, \ p \in P, \ t \in T; \quad (3) \]

Constraints (3) ensure product flow balance between forward product flows into demand point \( j \), and demand requirement for demand point \( j \) at time period \( t \), and account for the possibility of unsatisfied demand at that demand.
point. Unsatisfied demand occurs when not enough returned cores are collected or when product demand is greater than production and/or disassembly capacities.

\[ \sum_{k \in K} Y_{kit}^p = \sum_{j \in J} X_{ijt}^p, \quad i \in I, \ p \in P, \ t \in T; \quad (4) \]

Equation (4) is a material balance constraint ensuring that the sum of the quantities going into a plant \( i \) (or reverse flow) equals the sum of the quantities coming out of that plant (or forward flow) in every time period.

\[ I_{k,t-1}^{pq} + \sum_{r \in K} \sum_{j \in J} \pi_i^r \lambda_{i}^r R_{jk}^q = \sum_{i \in I} Y_{kit}^p + I_{k,t}^{pq}, \quad k \in K, \ p \in P, \ q \in Q, \ t \in T; \quad (5) \]

Constraints (5) ensure product flow balance between inventory, recovery, and shipment of disassembled units at disassembly center \( k \) in time period \( t \). Inventory, determined in this case on the basis of the expected number of recovered parts taken over all possible recovery scenarios, may be carried to provide better customer service or to satisfy forecasted demand that exceed production capacities in future time periods.

\[ I_{k,t}^{pq} \leq \theta_k V_k, \quad k \in K, \ p \in P, \ q \in Q, \ t \in T; \quad (6) \]

Constraints (6) specify that the total number of disassembled units stored in inventory at center \( k \) in period \( t \) cannot be larger than the inventory storage capacity of that center.

\[ \sum_{k \in K} R_{jk}^q + U_{jt}^q = d_{jt}^q, \quad j \in J, \ q \in Q, \ t \in T; \quad (7) \]

Constraints (7) ensure product flow balance between collection of returns, and forecasted returns at demand point \( j \) in time period \( t \), and by the same token accounts for any uncollected returns at that demand point and time period.

\[ \sum_{k \in K} R_{jk}^q \leq S_j, \quad j \in J, \ q \in Q, \ t \in T; \quad (8) \]

Constraints (8) require that the total number of units collected at demand point \( j \) in time period \( t \) to be less than the specified collection/storage capacity of that demand point.

\[ \sum_{k \in K} R_{jk}^q \leq S_k V_k, \quad k \in K, \ q \in Q, \ t \in T; \quad (9) \]

Equation (9) requires the total flow into center \( k \), and thereby the total number of units processed at such a center, during period \( t \) to be less than or equal to that center processing capacity if returns are disassembled in such a center;
and must be equal to zero otherwise. Used units collected from customer zones are assumed to be processed within the same time period in which they are collected.

\[
\sum_{k \in K} Y_{ikt}^p \geq m_k V_k, \quad k \in K, \ p \in P, \ t \in T; \quad (10)
\]

Constraints (10) require that the total flow out of any open center \( k \) in period \( t \) meets the minimum output requirement for that center.

\[
\sum_{m \in M} W_{kjt}^q = \sum_{i \in I} \sum_{k \in K} \pi^p (1 - \lambda^r) R_{ikt}^q, \quad k \in K, \ q \in Q, \ t \in T; \quad (11)
\]

Constraints (11) specify the number of non-recoverable units transported from disassembly center \( k \) to disposal sites.

### 3.5 Objective function

\[
\min \sum_{i \in I} f_i Z_i + \sum_{k \in K} f_k V_k + \sum_{i \in I} \left[ \sum_{k \in K} \sum_{e \in E} \pi^p \left( \sum_{i \in I} \sum_{k \in K} c_{i\ell k} Y_{i\ell k}^p + \sum_{j \in J} g_{j \ell} B_{jt}^p + \sum_{j \in J} \sum_{t \in T} t_j X_{jt}^p \right) + \right. \\
\left. \sum_{q \in Q} \pi^q \left( \sum_{j \in J} p_j U_{jt}^q + \sum_{j \in J} \sum_{k \in K} c_{jk} R_{jkt}^q + \sum_{k \in K} \sum_{m \in M} c_{km} W_{km}^q \right) \right] \quad (1)
\]

Objective function (1) minimizes the expected value of the total multi-period cost of production, collection, disassembly, disposal, inventory, and transportation of the network taken over all the given scenarios. The components of the objective function may be described as follows:

\[
\sum_{i \in I} f_i Z_i + \sum_{k \in K} f_k V_k \text{ represents fixed costs at plants and disassembly centers over the entire planning horizon.}
\]

\[
\sum_{p \in P} \pi^p \left( \sum_{i \in I} \sum_{k \in K} c_{i\ell k} Y_{i\ell k}^p \right) \text{ accounts for the Multi-period variable production cost at the plants.}
\]

\[
\sum_{p \in P} \sum_{q \in Q} \pi^q \left( \sum_{i \in I} \sum_{k \in K} h_{i\ell k} I_{i\ell k}^q \right) \text{ is the inventory costs of material held at processing centers.}
\]
\[ \sum_{p \in \mathcal{P}} \pi^p (\sum_{i \in \mathcal{I}} \sum_{j \in \mathcal{J}} q_{ij} B_{ij}^p) \text{ determines the penalty cost of unsatisfied demand at customer zones.} \]

\[ \sum_{q \in \mathcal{Q}} \pi^q (\sum_{i \in \mathcal{I}} \sum_{j \in \mathcal{J}} p_{ij} U_{ij}^q) \text{ is the penalty cost of uncollected returns at customer zones.} \]

\[ \sum_{q \in \mathcal{Q}} \pi^q (\sum_{i \in \mathcal{I}} \sum_{j \in \mathcal{J}} \sum_{k \in \mathcal{K}} c_{ik} R_{ik}^q) \text{ represents collection, transportation, and processing costs of used units.} \]

\[ \sum_{q \in \mathcal{Q}} \pi^q (\sum_{i \in \mathcal{I}} \sum_{k \in \mathcal{K}} \sum_{m \in \mathcal{M}} c_{km} W_{km}^q) \text{ specifies disposal and transportation costs of non-recyclable units.} \]

\[ \sum_{p \in \mathcal{P}} \pi^p (\sum_{i \in \mathcal{I}} \sum_{j \in \mathcal{J}} \sum_{l \in \mathcal{L}} f_{ij} X_{ij}^p) \text{ is the transportation cost from plants to customer zones.} \]

The complete mixed integer programming model can now be rewritten as follows.
Min \[
\sum_{i \in I} f_i Z_i + \sum_{k \in K} f_k V_k + \sum_{i \in I} \left( \sum_{p \in P} \pi_p^p \sum_{i \in I} c_{i j} Y_{ij}^p + \sum_{j \in J} \pi_j^p \sum_{k \in K} g_j B_{jk}^p + \sum_{i \in I} t_i X_{ij}^p \right) + \\ \sum_{q \in Q} \pi_q^q \left( \sum_{j \in J} p_j U_{jq}^q + \sum_{j \in J} \sum_{k \in K} c_{ik} R_{jk}^q + \sum_{k \in K} \sum_{m \in M} c_{km} W_{km}^q \right) + \sum_{p \in P} \sum_{q \in Q} \pi_{pq}^{pq} \left( \sum_{k \in K} h_k I_{pq}^{pq} \right)
\] (1)

Subject to:

\[
\sum_{j \in J} X_{ij}^p \leq S_i, \quad i \in I, \quad p \in P, \quad t \in T; \quad (2)
\]
\[
\sum_{i \in I} X_{ij}^p + B_j^p = D_j^p, \quad j \in J, \quad p \in P, \quad t \in T; \quad (3)
\]
\[
\sum_{k \in K} Y_{ki}^p = \sum_{i \in I} X_{ij}^p, \quad i \in I, \quad p \in P, \quad t \in T; \quad (4)
\]
\[
I_{pq}^{pq} + \sum_{r \in R} \sum_{j \in J} \pi_r^r \lambda_r^r R_{jk}^q = \sum_{i \in I} Y_{ij}^p + I_{pq}^{pq}, \quad k \in K, \quad p \in P, \quad q \in Q, \quad t \in T; \quad (5)
\]
\[
I_{pq}^{pq} \leq \theta_{k} V_k, \quad k \in K, \quad p \in P, \quad q \in Q, \quad t \in T; \quad (6)
\]
\[
\sum_{k \in K} R_{jk}^q + U_{jq}^q = d_j^q, \quad j \in J, \quad q \in Q, \quad t \in T; \quad (7)
\]
\[
\sum_{k \in K} R_{jk}^q \leq S_j, \quad j \in J, \quad q \in Q, \quad t \in T; \quad (8)
\]
\[
\sum_{j \in J} R_{jk}^q \leq S_k V_k, \quad k \in K, \quad q \in Q, \quad t \in T; \quad (9)
\]
\[
\sum_{i \in I} Y_{ki}^p \geq m_i V_k, \quad k \in K, \quad p \in P, \quad t \in T; \quad (10)
\]
\[
\sum_{m \in M} W_{km}^q = \sum_{r \in R} \sum_{j \in J} \pi_r^r (1 - \lambda_r^r) R_{jk}^q, \quad k \in K, \quad q \in Q, \quad t \in T; \quad (11)
\]
\[
V_k, Z_i = \{0, 1\}, \quad i \in I, \quad k \in K; \quad (12)
\]
\[
X_{ij}^p, R_{jk}^q, Y_{ki}^p, W_{km}^q, I_{pq}^{pq}, B_j^p, U_{jq}^q \geq 0, \quad i \in I, \quad j \in J, \quad k \in K, \quad m \in M, \quad p \in P, \quad q \in Q, \quad t \in T; \quad (13)
\]

Observe that optional constraints representing logical conditions between the decision variables may be added to further tighten the above formulation.

\[
X_{ij}^p \leq \min\{D_j^p, S_i\} Z_i, \quad i \in I, \quad j \in J, \quad p \in P, \quad t \in T; \quad (14)
\]
\[
R_{jk}^q \leq \min\{d_j^q, S_k\} V_k, \quad j \in J, \quad k \in K, \quad q \in Q, \quad t \in T; \quad (15)
\]
\[
Y_{ki}^p \leq \min\{Z_i, V_k\} S_i, \quad k \in K, \quad i \in I, \quad p \in P, \quad t \in T; \quad (16)
\]
\[
W_{km}^q \leq \sum_{r \in R} \pi_r^r (1 - \lambda_r^r) S_k V_k, \quad k \in K, \quad m \in M, \quad q \in Q, \quad t \in T; \quad (17)
\]
Constraints (14) state that the flow between plant $i$ and demand zone $j$ in period $t$ under scenario $p$ cannot exceed the minimum of the demand at zone $j$ and the capacity at plant $i$ if plant $i$ is open; and must be zero otherwise. Likewise, constraints (15) indicates that the flow of used product between customer zone $j$ and disassembly center $k$ in period $t$ under scenario $q$ cannot exceed the minimum of product return at zone $j$, the collection/storage capacity of zone $j$, and the capacity of center $k$ if center $k$ is open; and must be zero otherwise. Constraints (16) state that the flow between center $k$ and plant $i$ in period $t$ under scenario $p$ cannot exceed the capacity of plant $i$ if both plant $i$ and center $k$ are open, and must be zero otherwise. Observe that in (16) plant $i$ capacity, $S_i$, is used in lieu of center $k$ capacity, $S_k$, to account for the possibility that the flow from center $k$ to plant $i$ can be larger that the center’s capacity because of the presence of inventory at that center. Finally, constraint (17) states that the flow between center $k$ and disposal site $m$ in period $t$ under scenario $q$ may not exceed the capacity of center $k$ multiplied by the expected product reject ratio taken over all scenarios $r$ if that center is open, and must be zero otherwise.

The above formulation is general enough to reflect many practical recovery situations. In particular different market structures, closed-loop and open-loop, can be modeled by selecting the $D_{jt}^p$ and $d_{jt}^q$ parameters accordingly. If $D_{jt}^p \times d_{jt}^q > 0$, then customer zone $j$ belongs to both the disposer and reuse market, and therefore a closed-loop logistics structure applies. Conversely, when $D_{jt}^p \times d_{jt}^q = 0$ customer zone $j$ belongs to either one of these two markets and thus an open-loop logistics structure is implied. Furthermore, both push and pull collection strategies can be modeled. Large penalty costs $p_j$ reduce the values of $U_{jt}^q$ and, by virtue of constraint (7), result in a collection obligation (push strategy). Conversely, an economically driven (pull) collection strategy can be captured by setting $p_j = 0$ for all $j$’s. Likewise, by varying the value of $g_j$ both a push strategy to market for remanufactured products and a demand pull strategy can be modeled.

4. Conclusion

Product collection, recovery, remanufacturing, transportation and distribution are complicated decisions subject to structural constraints of the logistics network as well as environmental factors concerning demand uncertainty for remanufactured products and supply and quality uncertainty of the used products. The proposed stochastic mixed integer model is able to
effectively capture these constraints and uncertainties to determine the optimal design of the recovery network, and specify the optimal flows from customer zones to disassembly centers, from centers to plants, from plants to customer zones, and from centers to disposal sites, along with the optimal levels of unsatisfied demand and non-collection of used units over a multi-period planning horizon in such a way to minimize the total cost of the recovery operation. A computational experiment of this model is being undertaken at this time and its results will be reported at a later date.

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Improvement of Shipping Process in Warehouse Operations Management: A Case Study

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Abstract. The purpose of this study is to improve warehouse shipping process of a case study. An information technology, barcode, is introduced to improve the shipping process flow. The information system of shipping process is also designed for working with automatic handheld barcode scanners. The proposed system achieves 28.03 minutes reduction in total processing time that is 65% improvement. At the same time, working steps are reduced from five to two steps compared with the existing system. In addition, manual forms or paper works required within the existing system are definitely eliminated when the proposed system is employed.

1 Introduction

Warehouse is major component of any supply chain that responses to store goods/material to supply all components within a supply chain. In warehouse, there are many operations, i.e. receiving, storing, picking and shipping, related to incoming and shipping goods. The problems related to warehouse operations planning are interested by many researchers (comprehensive literature reviews can be found in [1]).

The objective of this study is to present an application of information technology (IT) in shipping process improvement in warehouse operations management of one case study conducted in Thailand.

This study starts from data collection of existing shipping process of company’s warehouse. Next, the data are analyzed to identify unnecessary operations steps. After that, the proposed IT based system is introduced to improve the shipping process flow. The proposed system is implemented and the total processing time can be measured to confirm the performance of the proposed system.

The organization of this paper is addressed as follows; literature reviews in section 2, the methodology in section 3, the case study and results in section 4 and conclusion in section 5.
2 Literature Reviews

Warehouse is one component of any supply chain. The role of warehouse is storing goods/material to supply all components within a supply chain. Some warehouse has to perform some process such as final assembly, pricing, labeling, and packing, as well.

There are four processes in warehouse operations addressed in [1].
(1) Receiving: The process of receiving incoming goods. Incoming shipment are brought to warehouse and unloaded at the receiving docks.
(2) Storage: After unloading, goods are stored into storages in order to maximize the use of space utilization and facilities (e.g. material handling machines, workers).
(3) Order Picking: This process is to organize orders to be picked and prepared for order shipping.
(4) Shipping: The process of shipping is to ship goods to customers.

The widespread implementation of IT, such as bar coding, radio frequency communications (RF), and warehouse management systems (WMS), provides opportunities (e.g. real-time control, easy communication, high level of automation, so on) to improve warehouse operations [1]. IT is widely implemented in many companies due to facilitate warehouse operations management. Many enterprise resource planning (ERP) software providers also provide the specific module for managing warehouse operations. The problem of implementation such program is to match between the real work flow and the step of work provided by the application.

One paper research [2] proposed the use of decision support system to deal with strategic warehouse decisions. The warehouse decision support system (WDSS) was designed to help in making decision on warehouse layout design. WDSS helped in (1) smooth flow of inventory, (2) fast tracking of inventory, (3) better utilization of warehouse resources (i.e. space, labor, etc.). In addition, this system can be used to real-time inventory control and evaluate the situation that warehouse layout is adjusted or redesigned.

Beside IT implementation, JIT (or lean) is also a new philosophy that can be applied to improve performances in warehouse operations management, including tighter inventory control and shorter response time.

JIT application in warehouse operations management was presented in [3]. The keys of JIT are demand pull, minimal economic quantity, reducing work-in-process (WIP), supplier reliability, preventive maintenance and eliminating buffers to get reduction in lead time, inventory and through-put time, also in improving in product quality. Addressed in [3], JIT concept was used to improve the operations system of the goods inwards (GI) process by reducing paper work considered as costly and time-consuming. The GI information system was designed and implemented. The results presented that GI
information system helped in increasing value-adding activities and reducing in non-value-adding activities.

Shipping process of warehouse operations is considered in this research. Shipping is one major process of warehouse operations that is the interface of a warehouse for outgoing material flow. In this process, there is much information needed, i.e. information about customer demands, warehouse dock layout, available resources, etc. and it is not easy to work with these information without implementing information technology (IT) system.

Generally, the work flow of shipping goods can be presented as in Fig. 1.

![Fig. 1. Simple Warehouse Shipping Process (Modified from [4])](attachment:image)

Unlike normal shipping process, this company’s shipping process has a communication among company’s warehouse and vendors (who receive parts from this company to carry out the final assembly). The movements of physical parts occur when Kanban cards are withdrawn following the concept of JIT.
The existing shipping process of this company deals with a lot of paper works (manual forms) and it is a time-consuming process. Warehouse’s operators and vendor’s officers take a risk of making mistakes while inputting data to the database system. The detail of this operation flow is explained in the following section.

3 Methodology

The methodology of this research work is presented as Fig. 2.
The first step is data collection of the existing shipping process. Second step is to analyze collected data to identified unnecessary working steps for improvement. Next, the new system is designed in the third step. After that, this system is implemented and the effectiveness of this system can be measured as the reduction in total processing time. Finally, the conclusion can be made.

4 A Case Study and Results

This study is carried out at one company’s warehouse in Thailand. The shipping process at this company’s warehouse is a communication between the company’s warehouse and vendors. The meaning of “Vendor” for this company is the same as “Contractor”. Vendors will come to this company to pick up parts and perform the final assembly before shipping products to customers.

4.1 Existing Operations Flow

The shipping operations process of this company consists of five steps.

1) Entering information and generating invoices: Vendors withdraw Kanban cards and present at company’s warehouse. The warehouse’s operators will used the information on Kanban card to fill in the warehouse database system to record the data of outgoing parts and print invoices for vendors. After that, vendors will receive parts with invoices at the end of this step.

2) Parts receiving confirmation: When vendors receive parts with invoices, they need to check that the received parts and invoices are matching. Then, these data are recorded on manual forms at vendor’s warehouse and acknowledge this receiving to vendor’s purchasing department.

3) Recording withdrawal parts to vendor’s database: Vendor’s production line will withdraw parts from vendor’s warehouse using manual forms and send this form to inform the use of parts to vendor’s purchasing department.

4) Collecting data and feed back to the company: Vendor’s purchasing department will collect information about receiving and withdrawing parts and feed back to the company by email. The lead-time of this process is normally one day.

5) Cutting stock at the company: When the information (via email) from the previous step is received, this information is transformed and input to the company’s database to cut stock of parts. This information will be
used by company’s production department in order to plan for the production consequently.

Figure 3 shows the diagram of the existing shipping process.

![Diagram of the existing shipping process](image)

**Fig. 3. Existing Shipping Process Flow**

### 4.2 Operations Flow Analysis

From previous section, there are four steps considered as unnecessary steps that are 2nd, 3rd, 4th and 5th step.

1. Manual forms are used in 2nd and 3rd steps that errors can be occurred easily.
2. There is delay time at 4th step to wait the feedback emails from vendors and the information is sometimes wrong and lose that has effects on the cutting stock process. The company’s stock cannot be updated correctly in real-time.
(3) During the 5th step, information cannot be directly inputted to the company’s warehouse system. The transformation of data is needed and this is a cause of having errors during this step. Considering these steps mentioned above, the information system should be designed to improve the operations flow of the shipping process.

4.3 System Design for Improvement

The improved system is shown in Fig. 4. The operations are reduced from five to two steps as;

(1) Entering information and generating invoices at company’s warehouse (Existing step 1st + 5th): Vendors withdraw Kanban cards and present at company’s warehouse. The warehouse’s operator will scan (using automatic handheld barcode scanners) the information on Kanban cards to print invoices for vendors. At the same time, stock at the company’s warehouse will be updated and parts will be sent to vendors with invoices.

(2) Parts receiving confirmation and recording to vendor’s database (Existing step 2th - 4th): When vendors receive parts and check with invoices. These data will be simply recorded to the system by automatic handheld barcode scanner. Also, these data will directly send to vendor’s purchasing department simultaneously.

Fig. 4. Improved Operations Flow
4.4 Performance Measurement of Improved System

After implementation of the improved system, the performance of this system is measured and compared with the existing system as shown in Table 1.

Table 1. Performance Measurement Comparison

<table>
<thead>
<tr>
<th>Work Step</th>
<th>Processing Time per Order (min)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Existing System</td>
<td>Improved System</td>
<td>Difference (Existing – Improved)</td>
<td></td>
</tr>
<tr>
<td>1st Step: Entering information and generating invoices at company’s warehouse</td>
<td>5.58</td>
<td>5.75 (1st +5th)</td>
<td>15.08</td>
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<tr>
<td>2nd Step: Parts receiving confirmation</td>
<td>10.48</td>
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<td></td>
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<tr>
<td>3rd Step: Recording withdrawal parts to the vendor's database</td>
<td>6.53</td>
<td>9.41</td>
<td>12.95</td>
<td></td>
</tr>
<tr>
<td>4th Step: Collecting data and feed back to company</td>
<td>5.35</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5th : Cutting stock at company’s warehouse</td>
<td>15.25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Time</strong></td>
<td>43.19</td>
<td>15.16</td>
<td>28.03</td>
<td></td>
</tr>
</tbody>
</table>

From Table 1, the total time of shipping process can be reduced from 43.19 min to 15.16 min. The difference is 28.03 min or 65% compared with the existing system.

5 Conclusion

This study aims to present a case study of shipping process improvement. The company has its own warehouse that supplies parts to vendors for performing the final assembly. The existing shipping process consists of five steps that is the communication between company’s warehouse and vendors. Some work step needs paper works that are easy to have errors when data are inputted to the database system.

The proposed system is designed to reduce the process that using manual forms and combine some operation together via applying IT tool called an automatic handheld barcode scanner. The proposed system helps in reducing
total processing time from 43.19 min to 15.16 min that are 28.03 min (or 65%) reduction compared with the existing system.

The automatic handheld barcode scanner allows the company to record the data directly without paper works and eliminates some operations step that errors can be easily occurred when manually inputting data to the database system.

Nowadays, there are many technologies that provide the same solution as barcode such as QR code, RFID, etc. Many of these tools are provide the same solution with different in some performance aspect and investment cost. The recommendation is to select the tool that provides the required performance with reasonable investment cost.

References

Analysis on determining replenishment lot size and shipment policy in an EPQ model with delivery and quality assurance issues

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Abstract. This paper revisits the existing studies that address the lot size and multi-delivery policy in an extended EPQ model with quality assurance. Specifically, instead of using the classical optimization technique or algebraic method, we present an alternative solution procedure based on the arithmetic-geometric-mean-inequality theorem and marginal analysis to derive the closed-form expressions for the optimal production lot size, the optimal integer number of shipments, and the minimum long-run average cost. We also explore more insight of the model by analyzing the theoretical and numerical results.

1 Introduction

The classical economic order/production quantity (EOQ/EPQ) models have been well documented in many fields such as Operations Research, Production and Operation Management, Purchasing and Materials Management, and Supply Chain Management, etc. Usually, the EOQ/EPQ-type models are constructed as the cost minimization problems, which are often solved by the classical optimization technique. For a simple model with one continuous decision variable, the task of locating an optimal solution through the first- and second-order conditions might be easy. But, for a complex model with two or more decision variables, the above task might be cumbersome, especially to examine the Hessian matrix equation.

In order to let more people recognize how to attain the EOQ formula without the background of calculus, several researchers have suggested alternative approaches. The initial work was presented by Grubbström [7], where the algebra method was used to derive the classical EOQ formula. This method has been extended to the EOQ/EPQ-type models and their variants. A review of different optimization methods that have been adopted to solve the above models, see e.g. Cárdenas-Barrón [1]. Among them, Teng [9] suggested the arithmetic-geometric-mean-inequality (AGMI) theorem, which seems to be the simplest way to attain EOQ so far.

On the other hand, for a model involving a discrete decision variable, such as the lot-size system with discrete units (e.g. Naddor [8]) or the vendor-buyer integrated inventory model in which the number of shipments is discrete
naturally, although the traditional approach can be applied to find a continuous optimal solution, to locate a desired integer solution, extra work is needed. Recently, García-Laguna et al. [6] derived the closed-form expression for determining the optimal integer lot size, where they clearly showed there are one or two optimal solutions. The results explored in [6] have been adopted in later studies, see, e.g. Cárdenas-Barrón et al. [2, 3], Teng et al. [10], etc.

Moreover, the classical EOQ/EPQ models, for simplicities, are constructed under some unrealistic assumptions. One of the assumptions that has often been challenged is all items ordered/produced are of perfect quality. To capture a real situation better, a large body of literature has incorporated the random yield issue or imperfect production process into the EOQ/EPQ models. For instance, in a recent study, Chiu et al. [5] extended the EPQ model to include a random defective rate during production process and imperfect rework process with a scrap rate, where they also considered the multiple deliveries for the finished batch. The problem is to determine the optimal lot size \( Q \) and optimal number of deliveries \( n \) such that the total production-inventory-delivery cost is minimized. To solve the model, [5] used the conventional approach, and later, Cheng and Ting [4] resolved it using the algebraic method. Although both [4] and [5] have derived the closed-form solutions, they are for the continuous variables while the number of shipments is discrete.

In this paper, we present an alternative approach to solve [5]’s model. Our aim is to show how to apply the AGMI theorem along with marginal analysis to derive the explicit closed-form expressions for the optimal lot size, the optimal integer number of shipments, and the minimum total cost. Furthermore, we analyze the theoretical results and conduct sensitivity analysis to gain more insight of the model.

2 EPQ model with quality assurance under multiple deliveries

For later analysis, we first review the backgrounds of concerning model. In [5], for a manufacturing system, they considered that the production process may randomly produce a portion \( x \) of defective items at a production rate \( d \). All items produced are screened, and the nonconforming items are reworked at a rate of \( P \) starting immediately after the regular production process. A portion \( \theta_i \) of reworked items fails during the reworking and becomes scrap. Let \( d_i \) denote production rate of scrap items during the rework process, then \( d_i = P\theta_i \). The finished items are delivered to customers if the whole lot is quality assured at the end of rework, specifically with fixed quantity of \( n \) installments. To avoid shortage, the constant production rate \( P \) is assumed larger than the sum of demand rate \( \lambda \) and production rate of defective items \( d \), that is, \( P - d - \lambda > 0 \), where \( d = Px \). Cost parameters considered in the model include
unit production cost $C$, unit holding cost $h$, setup cost $K$ per production run, unit rework cost $C_R$, disposal cost per scrap item $C_S$ holding cost $h_1$ for each reworked item, fixed delivery cost $K_1$ per shipment, delivery cost $C_T$ per item shipped to customers, and holding cost $h_2$ for each item kept by customer. Figs.1 and 2 depict the on-hand inventory of perfect quality and defective items for this integrated production-inventory-delivery system.

Building upon Fig.1 and Fig.2, [5] evaluated all related costs for the above system and developed the long-run expected cost function $E[TCU(Q,n)]$ as follows (Eq. (12) in [5, p.378]):

\[
E[TCU(Q,n)] = \frac{C\lambda}{1 - \theta_1E[x]} + \frac{(K + nK_1)\lambda}{Q(1 - \theta_1E[x])} + \frac{C_RE[x]\lambda}{(1 - \theta_1E[x])} + \frac{hQ\lambda}{2P(1 - \theta_1E[x])} + \frac{hQ\lambda}{2P_1(1 - \theta_1E[x])} \\
\times [2E[x] - (E[x])^2 - \theta_1(E[x])^2]
\]
By treating that both $Q$ and $n$ are continuous variables, [5] proved that $E[TCU(Q,n)]$ is convex in $(Q,n)$ and derived the optimal $Q^\ast$ and $n^\ast$ by solving the first-order necessary conditions, $\partial E[TCU(Q,n)]/\partial Q = 0$ and $\partial E[TCU(Q,n)]/\partial n = 0$, respectively. Using the algebraic method, [4] derived the same results. Since $n$ should be an integer, to find the optimal solution for the model, they have to take the rounding down/up values of $n^\ast$, calculate the corresponding values of $Q^\ast$, and then plug them into (1) to evaluate which one yields a smaller value of $E[TCU(Q,n)]$.

3 An alternative approach

This section presents an alternative solution procedure for [5]'s model. In order to distinguish our solutions from those given in [5], the optimal solution will be labeled by ‘’**’. For notational convenience, let $E_0 = E[x]$ and $E_i = 1 - \theta_i E[x]$. Then, (1) can be expressed as

$$E[TCU(Q,n)] = \left( C_r + \frac{C + C_x E_0 + C_x E_0 \theta_1}{E_i} \right) \lambda + \frac{(K + n K_i) \lambda}{Q E_i} + h \left[ E_1 + \frac{1 - E_1}{P E_i} + \frac{E_0 (1 - E_0)}{P E_i} + \frac{h_i E_0}{h P E_i} + \frac{h_2}{h} \left( \frac{1}{P} + \frac{E_0}{P_i} \right) \right] \frac{Q}{2}$$

(2)

$$+ (h_2 - h) \left[ E_1 - \lambda \left( \frac{1}{P} + \frac{E_0}{P_i} \right) \right] \frac{Q}{2n}$$

$$= \lambda \gamma + \frac{(K + n K_i) \lambda}{E_i} + \left( \alpha + \frac{\beta}{n} \right) \frac{Q}{2}$$

(3)

where
\[ \gamma = C_r + \frac{C + C_R E_0 + C_S E_0 \theta_1}{E_i}, \]

\[ \alpha = h \left[ E_i + \lambda \left( \frac{1 - E_1}{PE_1} + \frac{E_0(1 - E_0)}{PPE_1} + h_1 E_0^2 \left( \frac{1}{P} + \frac{h}{h_2} \left( \frac{1}{P} + \frac{E_0}{P_1} \right) \right) \right) \right], \]

\[ \beta = h \left( \frac{h_2 h_1}{h} - 1 \right) \left( E_i - \lambda \left( \frac{1}{P} + \frac{E_0}{P_1} \right) \right). \]

The cost structure shown in (3) is similar to that of classical EOQ model. For given \( n \), applying the AGMI theorem (i.e., for \( a > 0 \), \( b > 0 \), \( (a + b) / 2 \geq \sqrt{ab} \), where “=” holds when \( a = b \)) we have

\[ E[TCU(Q,n)] \geq \lambda \gamma + \left( \frac{2\lambda(K + nK_1)}{E_i} \right) \left( \frac{\alpha + \beta}{n} \right), \]

(4)

And when \( \frac{\lambda(K + nK_1)}{QE_i} = \left( \frac{\alpha + \beta}{n} \right) \frac{Q}{2} \), which implies

\[ Q^*(n) = \sqrt{\frac{2\lambda(K + nK_1)}{[\alpha + (\beta / n)]E_i}}, \]

(5)

the expected total cost \( E[TCU(Q,n)] \) becomes

\[ ETCU^*(n) = \lambda \gamma + \left( \frac{2\lambda}{E_i} \right) \left( \alpha K + \beta K_i + n\alpha K_1 + \frac{\beta K}{n} \right), \]

(6)

Next, we determine \( n \) by minimizing \( ETCU^*(n) \), which is equivalent to minimizing the terms related to \( n \) in (6), i.e.,

\[ G(n) = n\alpha K_1 + \frac{\beta K}{n}, \]

(7)

If \( n \) is treated as a continuous variable, we can apply AGMI again to derive \( n^* = \sqrt{\beta K / \alpha K_1} \) and \( G(n^*) = 2\sqrt{\alpha K_i \beta K} \), and then

\[ ETCU^*(n^*) = \lambda \gamma + \left( \sqrt{\alpha K} + \sqrt{\beta K_i} \right) \left( \frac{2\lambda}{E_i} \right) \]

(8)

In fact, \( n^* \) and \( Q^*(n) \) derived in above are the solutions provided in [4, 5].

Since \( n \) is a discrete variable, based on marginal analysis, the optimal value of \( n \) can be determined by the necessary/sufficient conditions (see, e.g. [8]):

\[ G(n) \leq G(n + 1) \quad \text{and} \quad G(n) \leq G(n - 1) \]

(9)
From (7) and (9), after manipulations, we have

$$n(n-1) \leq \frac{\beta K}{\alpha K_1} \leq n(n+1), \quad (10)$$

and then

$$\hat{n}^* = \sqrt{\frac{\beta K}{\alpha K_1} + 0.25 - 0.5} \leq n \leq \sqrt{\frac{\beta K}{\alpha K_1} + 0.25 + 0.5} = \hat{n}^* + 1 \quad (11)$$

From (11), when $\hat{n}^* \in \mathbb{I}$ (integer set), $n^{**} = \hat{n}^*$ and $n^{***} = \hat{n}^* + 1$; when $\hat{n}^* \notin \mathbb{I}$, $n^{**} = \left\lceil \hat{n}^* \right\rceil = \left\lceil \hat{n}^* + 1 \right\rceil$, where $\left\lceil n \right\rceil$ is the smallest integer $\geq n$ and $\left\lfloor n + 1 \right\rfloor$ is the largest integer $\leq n + 1$ (see, e.g. [6]). As long as $n^{**}$ is found, $Q^{**} = Q^*(n^{**})$ and $ETCU^{**} = ETCU^*(n^{**})$ follow by (5) and (6) respectively.

According to the above results, we make the following analysis.

(i) The advantage of alternative approach presented here is that the optimal solution associated with the minimum total cost of the model can be derived easily. Also, for numerical study, using the closed-form expressions, the values $n^{**}$, $Q^{**}$, and $ETCU^{**}$ can be obtained quickly. Note that neither [4] nor [5] has derived $n^{**}$ and $ETCU^{**}$.

(ii) For given problem parameters, if

$$K_1 < \frac{K(h_2-h) \left( \frac{E_1}{\lambda} - \frac{1}{P} - \frac{E_2}{P} \right)}{2 \left[ h \left( \frac{E_1}{\lambda} - \frac{1}{P} + \frac{1}{PE_i} + \frac{E_2(1-E_0)}{PE_i} \right) + h \frac{E_2}{P} + \frac{1}{P} \right]} \equiv W \quad (12)$$

then $n^{**} \geq 2$. That is, the proposed multi-delivery policy is active when the delivery cost per shipment $K_1$ is lower than the threshold $W$. This criterion is derived by the fact that $\hat{n}^* > 1$ implies $n^{**} \geq 2$.

(iii) From (5) and (11), it can be observed that the optimal policy $(Q^{**}, n^{**})$ is independent of the production cost $C$, the rework cost $C_R$, the disposal cost $C_S$, and the delivery cost shipped to customers $C_T$.

(iv) If $x=0$ (i.e., all items produced are of perfect quality), then $E_0 = 0$, $E_1 = 1$, $\alpha = h + (h_2 \lambda / P)$, and $\beta = (h_2 - h)(1 - \lambda / P)$. In this case,

$$Q^*(n) = \sqrt{\frac{2\lambda(K + nK_1)}{h + (h_2 \lambda / P) + [(h_2 - h)(1 - \lambda / P) / n]}} \quad (13)$$

and
\[ n^* = \frac{K(h_3 - h)(1 - \lambda / P)}{K_1[h + (h_2 \lambda / P)]} \] (14)

which are exactly the same as Eqs. (23) and (24) given in [5].

4 Numerical experiments

This section conducts numerical experiments to gain more insight into the model. We take the base data given in [5]: \( P=60000, \ P_1=2200, \ \lambda =3400, \ \theta_1 =0.1, \ K =20000, \ K_1=4350, \ C=100, \ \gamma =0.1, \ C_s =20, \ C_r =60, \ h =20, \ h_1=40, \ h_2=80, \) and \( x \sim U(0,b) \) with \( b=0.3. \) In order to explore the effects of problem parameters \((b, \ \theta_1, \ P_1, \ K_1, \ h_2)\) to the optimal policy, we change the parameter one at a time. For \( b \ (E_0 = E(x) = b/2)\) and \( \theta_1 \ (<1)\), the value is changed from -100% to 100%, and for others, -50% to 50%. The computing results are summarized in Table 1.

Table 1. The results of sensitivity analysis

<table>
<thead>
<tr>
<th>Parameter changed</th>
<th>n**</th>
<th>( Q^* )</th>
<th>ETCU**</th>
<th>( \lambda \gamma )</th>
<th>( \lambda(K + nK_1) )</th>
<th>( \frac{(\alpha + \beta)}{n}Q )</th>
<th>W</th>
</tr>
</thead>
<tbody>
<tr>
<td>( E_0 )</td>
<td>-100% 0.00</td>
<td>3</td>
<td>2276</td>
<td>439101</td>
<td>340340</td>
<td>49380</td>
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<td></td>
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<td>( \theta_1 )</td>
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<td>1673</td>
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<td>490110</td>
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In [5], they have solved two of above cases ($E_0=0.15$ and $E_0=0$). As expected, the results we obtained are the same as given in [5]. Moreover, from Table 1, we see that

(i) As $E_0$ increases, $n^*$ and $Q^*$ decrease, but $ETCU^*$ increases.

(ii) As $\theta_1$ increases, $n^*$ stays at the same level (due to the changing amount of $\hat{n}$ is not significant), $Q^*$ and $ETCU^*$ increase.

(iii) As $P_1$ increases, $Q^*$ increases first and then stays at the same level, $Q^*$ increases, but $ETCU^*$ decreases.

(iv) As $K_1$ increases, $n^*$ decreases first and then stays at the same level, $Q^*$ decreases first and then increases, and $ETCU^*$ increases.

(v) As $h_2$ increases, $n^*$ increases first and then stays at the same level, $Q^*$ increases first and then decreases, and $ETCU^*$ increases.

(vi) For the cases where $E_0=0.3$ (the largest one), $P_1=1100$ (the smallest one), and $h_2=40$ (the smallest one), the condition $K_1<W$ is violated, and hence the multi-delivery policy is not active (i.e., $n^*=1$).

(vii) In each case, as the classical EOQ model, the optimal lot size occurs at a point where the total setup cost $(K+nK_1)\lambda/E_1Q$ is equal to the total holding cost $[\alpha+(\beta/n)]Q/2$.

5 Conclusions

In the field of inventory/production management, seeking alternative approaches to solve the EOQ/EPQ-type models and deriving the closed-form optimal solution for the discrete variable have received a lot of attention in the past decade. This study extended these ideas to solve an existing EPQ model with multiple deliveries and quality assurance. Applying the AGMI and marginal analysis, we derived the closed-form expressions for the optimal lot
size, optimal number of shipments, and the minimum total cost. It should be pointed out that the contribution of original paper [5] is to develop a new model, while the current study enhances its application by providing an easy method to find the optimal policy and by exploring more insight of the model.

6 Acknowledgements

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References

Supply Chain 2
Integration of supplier selection and order quantity decisions: a multiobjective approach

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Abstract. This article presents a multiobjective mixed integer programming approach to simultaneously determine the number of vendors to employ and the order quantities to allocate to these vendors in a multiple-product, multiple-supplier competitive sourcing environment. The selection process is driven by the price, delivery, and quality objectives of the buyer and subject to the capacity constraints of the vendors. In this context, the vendors offer discounts on total amount of sales volumes not on the quantity or variety of products purchased from them. The paper presents a solution methodology to the multiobjective problem. Results of an extensive experiment reveal the computational efficiency of the model and its ability to solve problems of realistic sizes.

Keywords: Purchasing, Vendor Selection, Volume Discounts, Multiobjective Programming

1 Introduction

The selection of vendors (suppliers) and the determination of order quantities to be placed with those vendors are strategic purchasing decisions that commit significant resources and impact the firm's performance [3]. Selecting vendors from a large number of possible suppliers with various levels of capabilities and potential is a difficult and time-consuming task that is often driven by multiple criteria. In his seminal work on vendor selection criteria, Dickson [7] identified 23 different criteria by which purchasing managers have selected vendors in various procurement environments. In practice, item cost, product quality, delivery performance, and supply capacity have been found to be the most frequently used vendor evaluation criteria. A review of 74 supplier selection articles [16] found that these four criteria received the greatest amount of attention in the recent literature.

Identifying suppliers with the lowest item price in a given industry becomes a major challenge for purchasing managers especially when suppliers offer multiple products and volume-based discount pricing schedules. In this environment, the supplier induces the buyer into making large purchases by offering discounts on the total value of sales volume, not on the quantity or
variety of products purchased over a given period of time. In traditional quantity discount pricing schedules, price breaks that are function of the order quantity existed for each product, irrespective of the total magnitude of business the buyer contracts with the supplier over a given period of time. Recently, because of the advent of just-in-time (JIT) purchasing, a strategy which calls for ordering smaller quantities more frequently as needed, vendors are finding it more meaningful to give discounts based on the total value of multiproduct orders placed by a given buyer. Table 1 illustrates a business volume discount schedule with three discount brackets. For example, purchases worth less than $100,000 get no discount. However, when the total purchase value reaches $100,000, but does not exceed $500,000, the buyer gets an across the board 5% discount applicable to all purchases, not just those above the $100,000 cutoff point. A similar explanation applies to the third discount bracket. For example, purchases worth $500,000 are discounted 10% to $450,000.

Table 1. Volume Discount Schedule

<table>
<thead>
<tr>
<th>Sales Volume (in thousand $)</th>
<th>Percent Discount</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to under 100</td>
<td>0</td>
</tr>
<tr>
<td>100 to under 500</td>
<td>5</td>
</tr>
<tr>
<td>500 and over</td>
<td>10</td>
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</tbody>
</table>

Material/product quality is another critical component of the vendor selection decision. Many firms are now willing to purchase entire subassemblies or even finished products from suppliers. Accordingly, the larger the proportion of the final product that gets outsourced the greater the impact suppliers have on overall product quality and cost. It is not uncommon, nowadays, for major buyers to test products before purchase to rate a potential supplier's quality level and determine if this level is commensurate with the buying organization's quality expectations [8, p. 457].

Central to many procurement processes, especially those supporting JIT manufacturing operations is the timely delivery of material. Poor delivery performance disrupts production operations and results in lost sales. As a result, many organizations closely monitor their suppliers’ on-time delivery performance.

A fourth criterion, arising either internally from buyer's policy or externally because of supplier's size, is supply capacity. In situations where purchases are made in substantial quantities, the buying organization may for such matters as hedging against shortages for critical items, use of minority
vendors, and number of vendors to employ, seek to do business with multiple suppliers, and thus imposes maximum order quantity constraints on single-source purchases. Likewise, a potential supplier's production capacity or willingness to do a limited amount of business with the buyer imposes maximum order quantity constraints on the buying decision.

Vendor selection is a multicriterion decision that affects the number and types of vendors to employ, as well as the order quantities to place with these vendors. The joint consideration of procurement cost, product quality, delivery performance, and supply capacity criteria complicates the selection decision because competing vendors have different levels of achievement under these criteria. For example, the vendor with the least expensive price in a given industry may not have the best delivery performance or product quality. Vendor selection is therefore an inherently multiobjective decision that seeks to reduce procurement cost, maximize quality, and maximize delivery performance concurrently. The presence of volume discounts further complicates the selection problem since the buying decision is no longer based on a single product that can be purchased from one or more vendors, but on the collection of items that can be sourced from a single vendor.

Vendor selection is becoming recognized as an important component of supply chain strategy. As organizations seek to provide products to customers cheaper and faster than the competition, managers have come to realize that they cannot do it alone; rather, they must establish and work with a cost-effective and responsive network of suppliers in order to succeed.

The remainder of this paper is organized as follows. The next section cites the relevant literature to the vendor selection problem. Formulation of the mathematical model is presented in Section 3. Also, discussed in this section is the formulation of optional constraints that capture particular characteristics of the procurement environment. In Section 4 a solution methodology to multiobjective optimization is discussed. Section 5 describes the experimental design and discusses results of the computational experiment. Finally concluding remarks are provided in Section 6.

2 Background

Although many vendor selection methods have been proposed, there is to date little evidence of any significant analytical methodology designed to deal with the problem comprehensively in the context of the aforementioned criteria. A review of vendor selection methods [16], enumerates less than 10 articles that have proposed mathematical programming models for the problem [9, 1, 2, 11, 15, 12, 14]. Generally speaking, these models are either application-specific or thus not readily generalizable, or are limited in terms of
the scope of their assumptions and the set of selection criteria. Readers are referred to [16] for a comprehensive review of these models.

Weber et al. [17] developed an optimization approach that uses multiobjective programming (MOP) and data envelopment analysis (DEA) in tandem. Considering a multi-vendor single product environment, this approach first uses MOP to select vendors and then evaluate the efficiency of the selected vendors on multiple criteria using DEA. While extensive research on economic order quantities with quantity discounts exits, only a few methods address the problem from the perspective of vendor selection and order quantity allocation. Chaudhry et al. [4] developed a mixed integer programming approach to situations involving the sourcing of a single product from vendors offering price breaks which depend on the magnitude of the order quantity, not the dollar volume of business. Sadrian and Yoon [13] presented a mathematical formulation of the single-item procurement decision problem under two different business volume discount schedules and described the decision support system used for solution generation. Furthermore, Dahel [6] proposed local and centralized buying constructs for the multiple-item vendor selection problem under supply, demand, quality, and lead-time constraints.

This article introduces a multiobjective mixed integer programming model to support vendor selection decisions in either local buying or centralized buying environment. Local buying applies to situations where the organization either has a single facility (such as a store or plant) or is decentralized into independent facilities and the purchasing decision is made locally by each facility. Centralized buying applies to situations where the organization has several facilities and the procurement decision is made centrally at the request of the local facilities. In this case, management contracts with several vendors the outsourcing needs of all participating plants. The purchasing decision is typically more complex than under local buying, since several facilities, and a large number of items and suppliers are involved.

The multiobjective model is formulated in such a way to simultaneously determine the optimal number of vendors to employ and the order quantities they must supply to each facility or plant in the system so as to concurrently minimize total purchase cost, maximize product quality, and maximize on-time deliveries, while satisfying capacity and demand requirement constraints.

3 Model development

Consider a procurement situation in which \( i = 1, 2, \ldots, I \) items are to be purchased for \( k = 1, 2, \ldots, K \) plants from \( j = 1, 2, \ldots, J \) vendors, that provide
different levels of item price, product quality, delivery performance, and supply capacity for each item they sell. Also, depending on the buyer's total purchases value vendor $j$ offers a business volume discount having $r = 1, 2, \ldots, R_j$ discount brackets. The following subsection lists the notation used to formulate the problem under consideration.

### 3.1 Notation

**Problem parameters**

- $J_i$ = set of vendors offering item $i$,
- $I_j$ = set of items offered by vendor $j$,
- $K_j$ = set of plants that can be supplied by vendor $j$,
- $K_i$ = set of plants demanding item $i$,
- $D_{ik}$ = units of item $i$ demanded by plant $k$,
- $c_{ijk}$ = unit price of item $i$ quoted by vendor $j$ for delivery to plant $k$,
- $q_{ijk}$ = percentage of rejected item $i$ units from vendor $j$ at plant $k$,
- $t_{ijk}$ = percentage of item $i$ units from vendor $j$ missing their scheduled delivery time window at plant $k$,
- $S_{ij}$ = maximum quantity of item $i$ that may be purchased from vendor $j$ due to capacity constraints or other considerations,
- $u_{jr}$ = upper cutoff point of discount bracket $r$ for vendor $j$,
- $d_{jr}$ = discount coefficient associated with bracket $r$ of vendor $j$'s cost function.

**Decision variables**

- $x_{ijk}$ = units of item $i$ to purchase from vendor $j$ for delivery to plant $k$,
- $v_{jr}$ = volume of business awarded to vendor $j$ in discount bracket $r$. Observe that $v_{jr} > 0$ only if the dollar amount of purchases made from vendor $j$ falls within bracket $r$ of its cost function; otherwise it is zero.

$$y_{jr} = \begin{cases} 
1, & \text{if the volume of business awarded to vendor } j \text{ falls on segment } r \text{ of its cost function;} \\
0, & \text{otherwise.}
\end{cases}$$

A mathematical programming formulation of the model is given in subsection 3.2.
3.2 Mathematical formulation

\[
\begin{align*}
\min Z &= [Z_1, Z_2, Z_3] \\
Z_1 &= \sum_{j \in J} \sum_{r \in R_j} (1 - d_{jr}) v_{jr} \\
Z_2 &= \sum_{i \in I} \sum_{j \in J} \sum_{k \in K_i} q_{ijk} x_{ijk} \\
Z_3 &= \sum_{i \in I} \sum_{j \in J} \sum_{k \in K_j} t_{ijk} y_{ijk}
\end{align*}
\]

subject to:

\[
\begin{align*}
\sum_{j \in J} x_{ijk} &= D_{ik}, & i &\in I, & k &\in K_i; \\
\sum_{k \in K} x_{ijk} &\leq S_{ij}, & i &\in I, & j &\in J_i; \\
\sum_{i \in I} \sum_{j \in J_k} c_{ijk} x_{ijk} &= \sum_{r \in R_k} v_{jr}, & j &\in J; \\
v_{jr} &\leq u_{jr} y_{jr}, & j &\in J, & r &\in R_j; \\
v_{j,r+1} &\geq u_{jr} y_{j,r+1}, & j &\in J, & r &= 1, ..., R_j - 1; \\
\sum_{r \in R_j} y_{jr} &= 1, & j &\in J; \\
y_{jr} &\in \{0, 1\}, & v_{jr} &\geq 0, & j &\in J, & r &\in R_j; \\
x_{ijk} &\geq 0, & i &\in I, & j &\in J_i, & k &\in K_j.
\end{align*}
\]

Constraint (2) represents the condition that the total demand of each item at each plant will be satisfied. Constraint (3) ensures that the total number of items procured by each supplier to all plants is within the production and shipping capacity of that supplier. Constraint (4) determines the dollar amount of business awarded to vendor \( j \). Constraints (5)-(6) link the purchase of the item with the business volume discount to the appropriate segment of the discount pricing schedule for each vendor. Constraint (7) ensures that only one discount bracket for each vendor’s volume of business will apply. Constraints (8) and (9) ensure integrality and nonnegativity on the decision variables.

Equation (1) specifies the multiobjective function whose components are given by equations (1a), (1b), and (1c). Equation (1a) minimizes the total purchase cost. Equation (1b) minimizes the number of defective items, and Equation (1c) minimizes the number of items missing their scheduled delivery time window.
3.3 Optional constraints

A number of optional constraints may be added to the above formulation to capture particular characteristics of the procurement environment. These constraints may be applied uniformly across all items and vendors or selectively to specific products or suppliers.

Market share constraint

This constraint specifies that the buyer is willing to purchase no more than a given percentage $P_i$ of item $i$ total demand $\phi_i$ from a given supplier. With $\phi_i = \sum_j D_{ij}$, this market share constraint may be expressed as:

$$\sum_{k \in K} x_{ijk} \leq P_i \phi_i, \quad i \in I, \quad j \in J_i.$$  \hfill (3)

Whenever this option is selected, constraint (3) should be rewritten as:

$$\sum_{k \in K} x_{ijk} \leq \min(S_{ij}, P_i \phi_i), \quad i \in I, \quad j \in J_i.$$

Constraint (3') enforces the dual requirement of supplier's capacity and supplier's market share without increasing problem size.

Business volume constraint

This constraint limits the buyer's volume of business with supplier $j$ to a maximum dollar value $U_j$. Often, larger buyers would like to limit the amount of business they award to a single vendor to achieve their own supplier diversification goal, and also prevent small suppliers from becoming too dependent on them. This constraint is expressed as follows:

$$\sum_{r_h \in R_j} v_{r_j} \leq U_j, \quad j \in J.$$  \hfill (3')

Number of supplier constraint

This constraint limits the number of vendors the buyer is willing to do business with to a maximum of $M$ suppliers. Often, decreasing the number of suppliers helps the buying organization reduce administrative cost due to individual transactions, and facilitate the development of long-term supplier
partnerships. This constraint requires replacing constraint (7) by the following set of equations:

\[
\sum_{r \in R_j} y_{jr} \leq 1, \quad j \in J; \\
\sum_{j \in J} \sum_{r \in R_j} y_{jr} \leq M.
\]

These optional constraints ultimately affect the type and number of vendors selected, their respective order quantities, as well as the total cost, quality and delivery outcomes of the procurement process.

4. Solution methodology

Two basic approaches may be used to solve multiobjective programming problems. These are the preference-oriented approach and the generating approach. The preference-oriented approach consists of techniques that rely on a formal characterization of preferences among the objectives prior to solving the problem. Generating techniques are suitable to situations where the articulation of preferences among the objectives is postponed until a range of alternative noninferior solutions is examined (see Cohon, [5] for a comprehensive discussion). These solutions help the decision maker to better understand the tradeoffs between the objectives before selecting a best-compromise solution. Tradeoffs between the objectives are however relatively difficult to understand when more than two objectives are at hand. For this reason, practitioners often prefer the preference-oriented approach to generating techniques. An application of the preference-oriented approach to our problem is discussed next.

Preference oriented approach

Assume that our procurement manager is in a position to articulate a value judgment between the objectives of high product quality and on-time delivery in the form of some dollar value attached to such objectives. Let \( p_{ik} \) be the dollar penalty caused by one defective unit of item \( i \) at plant \( k \) to the purchasing organization. Also, let \( l_{ik} \) be the dollar penalty the organization suffers as a result of one unit of item \( i \) missing its scheduled delivery time window at plant \( k \). The Multiobjective function (1) can now be rewritten as:
\[
\min Z = \sum_{j \in J} \sum_{r \in R_j} (1 - d_{jr}) v_{jr} + \sum_{i \in I} \sum_{j \in J} \sum_{k \in K_j} p_{ijk} q_{ijk} x_{ijk} + \sum_{i \in I} \sum_{j \in J} \sum_{k \in K_j} l_{ijk} t_{ijk} x_{ijk}
\]

or

\[
\min Z = \sum_{j \in J} \sum_{r \in R_j} (1 - d_{jr}) v_{jr} + \sum_{i \in I} \sum_{j \in J} \sum_{k \in K_j} (p_{ijk} q_{ijk} + l_{ijk} t_{ijk}) x_{ijk}
\]

Equation (1') is a single dimension (dollars) objective function, and our model can be now solved as a single-objective optimization problem. The optimal solution to Equation (1') subject to constraints (2)-(9) represents the best-compromise solution for the person who articulated the values of \( p_{ijk} \) and \( l_{ijk} \).

5. Model validation

5.1 Experimental design

In order to validate the model at hand, a computational experiment was performed by varying the values of the number of products, the number of suppliers, the number of discount brackets, and the number of plants. These four factors are fixed at various values as follows:

1. Number of items: 100, 200, and 300.
2. Number of vendors: 15, 20, 25, and 30.
3. Number of discount brackets: 3, 4, 5, and 6.
4. Number of plants: 1, 2, 3, and 4.

Using all possible combinations of the above values, a total of 192 different procurement environments were designed. Forty-eight of these depicted local buying for a single plant, and 144 represented centralized buying for multiple plants. For each such procurement configuration, 10 randomly generated problems were run, with the clock time elapsing between the beginning of the run and the reporting of the optimal solution recorded. Computational runs were performed on personal computer using LINGO [10], a mathematical modeling language capable of generating and solving linear and nonlinear problems.

5.2 Analysis of results

Table 2 shows the average CPU seconds recorded for all cases of the local buying test problems, and Table 3 provides CPU seconds needed to solve the centralized buying cases. This CPU time includes the time spent by the
LINGO program generating the model, processing, and reporting the optimal solution.

A review of these results reveals two observations. First, solution times appear to grow exponentially in the number of plants. For example, a 200 item-20 vendor-4 discount bracket problem solved in about 4 seconds under a single plant environment, 10 seconds under a two-plant system, and 27 seconds under a four-plant scenario. This increase in CPU time is attributed to problem size. Where $N_{J_i}$ and $N_{K_i}$ denote the number of elements in $J_i$ and $K_i$ respectively, the difference in problem size reduces to $\sum N_{K_i} - I$ constraints, and $\sum N_{J_i} (N_{K_i} - 1)$ variables.

Table 2. Computational Times in CPU Seconds: Local Buying Case

<table>
<thead>
<tr>
<th>Number of Items</th>
<th>Number of Vendors</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>15</td>
<td>1</td>
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<td>30</td>
<td>17</td>
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<td>22</td>
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</tbody>
</table>

Second, solution times appear to be relatively more sensitive to the number of vendors and their respective discount brackets than to the number of items. For instance under the single plant case, a 300 item-15 vendor-3 discount bracket problem solved in about 3 seconds whereas a 100 item-30 vendor-6 discount bracket problem took about 7 seconds to solve. This moderate
increase in solution time is not surprising since the number of binary variables in the model is a function of the number of vendors and their respective discount brackets. Where \( N_{R_j} \) indicates the number of elements in \( R_j \), the number of binary variables, given by \( \sum_j N_{R_j} \), is only a small subset of the total number of variables, explaining the computational efficiency of this mixed integer model. Observe that the relatively large problem of 4 plants, 300 items, 30 vendors, and 6 discount brackets solved to optimality in about 2 minutes.

Table 3. Computational Times in CPU Seconds: Centralized Buying Case

<table>
<thead>
<tr>
<th>Number of Plants</th>
<th>Number of Items</th>
<th>Number of Vendors</th>
<th>Number of Discount Brackets</th>
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</thead>
<tbody>
<tr>
<td></td>
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<td>95</td>
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</table>

713
5.3 Managerial implications

The vendor selection model developed in this paper includes a number of attractive features. The model is driven by multiple desirable objectives. The joint consideration of price, quality, and delivery performance in volume discount environments helps managers select vendors and allocate order quantity using a comprehensive approach that goes beyond just purchase costs. Furthermore, the ability of the model to capture local buying and centralized buying scenarios helps an organization choose between these two procurement strategies using this model. Additionally, the model could be extended to incorporate limits on the maximum number of suppliers to employ, supplier market share, and supplier business volume.

The proposed model is computationally efficient and can be solved in a few seconds on a personal computer. As evidenced by the computational experiment even larger problems can be solved to optimality in a relatively short amount of computing time, making real-world applications of the proposed model both practical and realistic.

6. Conclusion

This paper introduced a multiobjective mixed integer programming model to support purchasing decisions in sourcing environments where competing vendors with different product quality and on-time delivery performance levels offer volume discounts based on the total value of multiproduct orders they receive from the buyer. The model can help an organization determines the optimal set of vendors to employ and allocates product order quantities to
these vendors, in such a way to concurrently minimize total purchase cost, maximize product quality, and maximize on-time delivery reliability.

Optimal solutions to procurement decisions are a valuable tool. They eliminate much of the subjectivity that impacts such decisions under highly competitive and complex sourcing environments. To this end the proposed model provides a comprehensive yet computationally efficient approach that can be used to support purchasing decisions in such environments.

References

Achieving time-based operational performance through supply chain integration and knowledge management: a theoretical framework and measurement

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Abstract. In highly competitive environment, firms have been forced to become more flexible and responsive to business uncertainties such as changes in demand or sudden unavailability of supplies. In order to provide products in a timely, flexible and responsive fashion, firms must be highly dependent on all members of their supply chain. There is little evidence showing the potential impact of both information technology (IT) systems and knowledge management (KM) on supply chain integration (SCI). Prior literatures have addressed the importance of knowledge management practices on the integration of supply chain, there is still a lack of systematic studies providing empirical framework to ascertain that KM improves supply chain integration. This study intends to develop a theoretical framework and a scale development process in order to address the validity in supply chain integration and knowledge management scales using Q-sort technique. This study provides a measurement scale for SCI and KM. This will allow researchers to be confident and bring new insights when exploring the influence of SCI and KM on time-based performance.

Keywords: Information Technology, Knowledge Management, Supply Chain Integration, Operational Performance

1 Introduction

In highly competitive environment, firms have been forced to become more flexible and responsive to business uncertainties such as changes in demand or sudden unavailability of supplies (Wong and Boon-itt, 2008). In order to provide products in a timely, flexible and responsive fashion, firms must be highly dependent on all members of their supply chain (Wong et al., 2011). Integrated relationships and collaborations among internal functions within firms and externally with other members in the supply chain are becoming more essential for achieving operational performance, i.e. manufacturing flexibility and customer delivery. Such capabilities are competitive weapons
for the firms to survive and thrive in today’s fierce competition (Upton, 1994; Christopher, 2000; Golden and Powell, 2000; Boon-itt, 2010).

However, previous literatures show inadequate existing knowledge regarding the impact of information technology (IT) and knowledge management (KM) on supply chain integration (SCI) and subsequently, the firm’s operational performance. First, there is little evidence showing the potential impact of both IT systems and KM on SCI. Second, despite prior literatures about the importance of knowledge management practices on the integration of supply chain (Wadhwa and Saxena, 2005; Chen et al., 2006; Samuel et al, 2010; Khalfan et al., 2010; Liao et al., 2011), there exists a lack of systematic studies providing empirical test to ascertain that KM improves supply chain integration. Third, several studies have produced inconsistent results of the relationship between IT and manufacturing flexibility (Golden and Powell, 2000; Vokurka and O’Leary-Kelly, 2000). In essence, the main purpose of this paper is to provide an evaluation method of a scale development process when applied to a supply chain integration research. As a result, this paper will specifically focus on both the development of theoretical framework and a scale development process, along with the validation of an instrument to measure various constructs. Based on this approach, operational measures for the construct are developed and tested using Q-sort technique. This paper will provide the guidelines that researchers can confidently apply in the future research.

2 Literature Review

2.1 Theoretical Background

The concepts of resource-based view (RBV) proposed by Barney (1991) consist of resources, capabilities, and strategic assets. A firm that possesses and combine the resources and capabilities in a distinctive way may be able to obtain competitive advantage, and subsequently sustainable firm performance (Barney, 1991; Wade and Hulland, 2004). The knowledge-based view (KBV) of the firm, the extended theory of the resource-based view of the firm, considers knowledge as the most strategically significant resource of the firm (Spender and Grant, 1996, Samuel et al., 2010).

2.2 General Background

2.2.1 Information Technology

Information technology (IT) refers to any form of technology used to collect, store, analyze, filter and disseminate information in its various forms (Pereira,
2009) to achieve specific purposes, i.e. more effective decision making (Li et al., 2009). IT provides the manufacturing firm with an effective means to coordinate and transfer more complex and higher volume of information with both internally and across boundaries with its trading partners in a real-time fashion (Prajogo and Olhager, 2011). Such supply chain-related information includes demand forecasts, material sourcing, inventory level, delivery status, production planning and scheduling, production quality, and physical distribution (Ketikidis et al., 2008, Li et al., 2009). Based on resource-based perspective, ability to accumulate valuable, firm-specific, costly-to-imitate, and complex-to-acquire IT resources and capabilities becomes a key source for attaining long-term competitive advantage of the firm (Bharadwaj, 2000). Rai et al. (2006) also assert that the firms in supply chain network should establish a boundary-crossing integrated IT infrastructure that is centrally coordinated so as to facilitate the consistent flows of information and processes.

2.2.2 Knowledge Management

Knowledge management is considered an emerging new management idea and method through the use of knowledge assets within and outside the organization to carry out a series of activities, such as knowledge gathering, knowledge storage and organizing, knowledge sharing, knowledge innovation and knowledge utilization. Based on a domain of supply chain management, knowledge management can be defined as a process which enterprises in the supply chain use collective wisdom, through the acquisition, organization, sharing and use of the explicit and implicit knowledge existing in the internal and external enterprises so as to create synergy, enhance the efficiency of knowledge innovation and application, as well as enhance overall competitiveness of the supply chain (Jing and Chao, 2009).

2.2.2.1 Knowledge Acquisition

Knowledge acquisition refers to the process of creating or generating knowledge internally and obtaining it from external sources (Massa and Testa, 2009), i.e. supply chain collaboration, merger and acquisition, and purchasing of new technology (Li et al., 2008).

2.2.2.2 Knowledge Sharing

Knowledge sharing refers to the process of transferring, disseminating, and distributing knowledge in order to make it available to those who need it (Massa and Testa, 2009). It is worth noting that the shared knowledge has been generated by the cross-organizational collaboration (Li et al., 2008).
2.2.2.3 Knowledge Utilization

Knowledge utilization refers to a process of utilizing and applying existing or recently-gained knowledge resources (Liao et al., 2011) that are shared across organizational boundaries in the supply chain network.

2.2.3 Supply Chain Integration

In today’s business environment, complicated and various competitive capabilities are becoming essential requirements for a firm to survive and thrive. These competitive capabilities and strengths could primarily be achieved by the integration of the firm with supply chain partners who possess special resources and advanced technological knowledge. This means firms closely integrate internal functions within the boundary and effectively link them with external operations of suppliers, customers, and other supply chain members (Kim, 2009). Supply chain integration refers to a process of interaction and collaboration in which firms in supply chain cooperatively and seamlessly work together by linking and integrating processes, activities, information, and physical flows to arrive at mutually acceptable outcomes (Wong and Boon-itt, 2008; Li et al., 2009).

2.2.3.1 Internal Integration

Internal integration is defined as the strategic system of cross-functioning and collective responsibility across functions, where collaboration across product design, procurement, production, sales and distribution functions takes place, rather than operating within the functional silos associated with traditional departmentalization and specialization (Flynn et al., 2010), in order to meet customer requirements at a low total system cost (Wong et al., 2011).

2.2.3.2 Supplier Integration

Supplier integration involves strategic joint collaboration between a focal firm and its suppliers in managing cross-firm business processes, including information sharing, strategic partnership, collaboration in planning, joint product development, and so forth (Wong et al., 2011). Based on the work of Thun (2010), striving for long-term relationship with key suppliers to work closely in a cooperative manner, share problems, and conjointly find more
effective solutions is a way for better performance i.e. reduction of inventory and supplier lead time.

### 2.2.3.3 Customer Integration

Customer integration enables a deeper and better understanding of market expectations and opportunities (Thun, 2010), which contributes to a more accurate and quicker response to customer needs and requirements by matching supply with demand (Wong et al., 2011). Flynn et al. (2010) suggest that a close relationship between customers and the manufacturer offers opportunities for improving the accuracy of demand information, which reduces the manufacturer’s product design and production planning time and inventory obsolescence, allowing it to be more responsive to customer needs.

### 2.2.4 Manufacturing Flexibility

Today, in order to compete in a volatile and highly competitive market, firms are struggling to become more flexible in order to satisfy changing and unexpected conditions (Gunasekaran et al., 2008). Manufacturing flexibility is considered a source of the firm’s competitive advantage to provide adaptive response to changes in market demands (Golden and Powell, 2000; Boon-itt, 2010) with little penalty in time, effort, cost, and performance (Upton, 1994). Boon-itt (2010) considers manufacturing flexibility as a source of competitive advantage that strengthens the ability of the firm to respond quickly and profitably to changes in market demand in order to accommodate unique needs of specific customers. Manufacturing flexibility is defined as the ability of the firm to manage manufacturing resources and uncertainties so as to efficiently produce different products of acceptable quality in order to meet various customer expectations (Zhang et al., 2003; Swafford et al., 2008; Ngai et al., 2010).

### 2.2.5 Customer Delivery

Customer delivery is an essential capability for the firm to survive in today’s time-based competition. The ability to satisfy customers’ desires for ever-shorter delivery times, as well as ensure supply availability to meet peak demands, is increasingly becoming a competitive weapon for a firm’s ability to survive in today’s time-based competition (Christopher, 2000). According to Boon-itt (2010), delivery performance is defined as a competence to deliver products and services in a quick and reliable manner.
3 Conceptual Framework and Research Methodology

3.1 Conceptual Framework and Hypotheses Development

To better understand the antecedents and consequences of an effective supply chain management, an overall theoretical framework is generally established which investigates the relationship between IT and KM, and operational performance, mediated by supply chain integration. The rationale underlying this overall framework is straightforward. First, the two enablers; IT and KM, will lead to enhanced supply chain integration. Second, it is suggested that the firms develop effective knowledge management in order to improve supply chain integration; however, there is little empirical evidence that confirms the association between the two constructs. Third, there is a need to examine indirect effect of supply chain integration on the relationship between IT and manufacturing flexibility because previous empirical studies have yielded inconsistent results.

Figure 1 illustrates that IT and KM will positively relate to the firm’s operational performance, namely manufacturing flexibility and customer delivery. Additionally, it is hypothesized that the relationship is mediated by supply chain integration. The following sections will provide the conceptual framework leading to theoretical support for each hypothesis.

![Theoretical Framework](image)

**Figure 1** Theoretical Framework

3.1.1 Research Hypothesis 1

Previous study of Li et al. (2009) supports the importance of IT by considering IT as a key enabler of supply chain integration that facilitates the capture, organization, and sharing of vital information regarding key business
processes. IT provides the means for companies to better integrate their internal and external activities (Gunasekaran et al., 2008). It is important that IT enables an effective integration of not only internal groups but also groups across the supply chain. IT provides opportunities for firms to expand the markets worldwide and supports seamless integration of partnering firms (Fasanghari et al., 2008). IT has played a crucial role as a facilitator of process integration across the supply chain, which provides significant benefits to the firms, i.e. more effective collaboration with suppliers. This leads to the assumption of the first hypothesis:

\textit{Hypothesis 1: Information Technology has a positive effect on supply chain integration}

3.1.2 Research Hypothesis 2

Knowledge management has recently attracted considerable attention as a powerful tool to increase competitiveness of the firms by means of more efficient governance of firms’ information assets and more effective collaborations and decision making processes in the supply chain. According to the study of Samuel et al. (2010), knowledge is an essential source of coordination of supply chain activities across internal business functions as well as across organization borders. Such coordination implies collaboration, integration, information sharing, and long-term commitment among supply chain parties. In essence, enhanced knowledge management practice, i.e., in terms of knowledge creation, acquisition, retention, dissemination, and utilization, improves coordination and integration through a vast supply chain network and is a major driver of successful supply chain management. Many researchers agree that knowledge management plays a vital role in enhancing both intra- and inter-organizational integration and collaboration, thus improving supply chain performance. This, therefore, leads to the construction of the following hypothesis:

\textit{Hypothesis 2: Knowledge management has a positive effect on supply chain integration}

3.1.3 Research Hypothesis 3 and 4
There is growing empirical evidence highlighting the importance of integrating processes and operations among internal functions, suppliers and customers in the supply chain. It is apparent that higher level of integration contributes to greater benefits to the firms (Devaraj et al., 2007). Frohlich and Westbrook (2001) investigate the relationship between integration strategies, characterized by different degree and direction of integration activities towards suppliers and customers, and performance improvement. The results suggest that the greatest degree of integration with both suppliers and customers have strongest beneficial impact on the firm’s performance. The more integrated flow of information among the supply chain makes it easier to balance supply and demand across the entire network, defeating the bullwhip effect and contributing to higher performance (Frohlich and Westbrook, 2001; Thun, 2010). Majority of the research work has confirmed positive impact of supply chain integration on various dimensions of operational performance of the firm. This contributes to the assumption that supply chain integration has positive relationship with manufacturing flexibility and customer delivery. Therefore, the following two hypotheses are proposed:

**Hypothesis 3:** Supply chain integration has a positive effect on manufacturing flexibility.

**Hypothesis 4:** Supply chain integration has a positive effect on customer delivery.

### 3.1.4 Research Hypothesis 5

Previous studies provide evidence of the relationship between IT and manufacturing flexibility. IT has been proposed as a tool that assists the attainment of flexibility (Golden and Powell, 2000). By facilitating information flow resulting in improved coordination within and across the firms, IT can help the firm proactively anticipate future environmental changes and react accordingly. Lucas and Olson (1994) demonstrate that information technology contributes to organizational flexibility in three ways; 1) by changing organizational boundaries and time 2) by improving pace of work 3) by helping the firm to respond to changes. IT systems profoundly affect flexibility by not only providing a variety of options for each specific business process, but also, with a well-established IT infrastructure, allowing a firm to adapt to new competitive environments (Golden and Powell, 2000). Although it is evident that IT could make a potential contribution to organizational flexibility, Golden and Powell (2000) argue that IT might also restrict flexibility in some ways. This is probably due to the fact that technologies or IT systems adopted by an organization are not able to appropriately adapt to environmental changes. This
is consistently supported by Upton (1995) who finds no correlation between the extent of IT integration and an increase in operational flexibility. He discovers the decrease in the range of products produced in paper factories in the North America after having made a huge investment in computer integrated manufacturing systems.

There exists a mixed argument of the association between IT and manufacturing flexibility. While some prior literature provides empirical evidence of a positive relationship between these two constructs, some researchers contradict the argument and view IT as a source of inflexibility in some ways. This paper, therefore, aims to empirically test the relationship between IT and manufacturing flexibility through a mediating role of supply chain integration. Thus, we propose the following hypothesis.

_Hypothesis 5: IT has an effect on manufacturing flexibility through a mediating role of supply chain integration._

### 3.2 Research Methodology

The development of instruments for all constructs in this study is carried out in three stages (Schwab, 1980). First, in the pilot stage, items for each construct are generated through a literature review, which includes the understanding of the constructs. Then, the initial set of items is pre-tested with practitioners or academicians in order to provide the clarity of the items. The second stage includes scale development through a pilot test using expert opinion and the Q-sort procedure for pre-assessing initial construct validity and reliability. The basic concept of Q-sort method is to have experts act as judges and sort the items into several groups, each group corresponding to a factor or dimension, based on the agreement between judges. It is important to note that theoretical constructs should be carefully defined from the literature and expert opinion to ensure the construction of an instrument and whether the items adequately capture the construct domain or essence of the domain (content validity analysis). In the third stage as scale evaluation, the instruments are further developed based on the result from the pilot test, which is a large-scale survey sample in order to evaluate all the validity and reliability of the constructs.
3.2.1 Item Generation

This empirical research relies on perceptual measure in which the respondents were asked by a structured questionnaire to indicate on a five-point Likert type scales, ranging from 1=strongly disagree to 5=strongly agree. For this reason, proper generation of good measurement items of a construct will determine the validity and reliability of a research.

Once item pools were identified, items from the various constructs were reviewed by four academicians in field of supply chain management and logistics. The main focus was to check the relevance of each construct’s definition and clarity of its related items. Ambiguous items were modified incorporating their feedback and analysis. New items were added as necessary. As a result, there were a total of 9 pools and 45 items in the first round, as shown in the first column of Table 1.

Table 1. Number of items in each item generation round

<table>
<thead>
<tr>
<th>Constructs/Items</th>
<th>Round 1</th>
<th>Round 2</th>
<th>Round 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information Technology</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Knowledge Management</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledge Acquisition</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Knowledge Sharing</td>
<td>5</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Knowledge Utilization</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Supply Chain Integration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internal Integration</td>
<td>6</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Supplier Integration</td>
<td>5</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Customer Integration</td>
<td>5</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Manufacturing Flexibility</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Customer Delivery</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>45</td>
<td>43</td>
<td>40</td>
</tr>
</tbody>
</table>

3.2.2 Scale Developments: Q-sort Methodology

The procedure followed was to show purchasing and productions managers (judges) the conceptual model and definitions of each constructs. One card was printed for each item. The set of cards for each construct were shuffled and given to the judges. Then, they sorted the items into several groups, which each group corresponding to a dimension or construct. A “Not Applicable” category was also included to ensure that the judges did not force any item into a particular category. Items were subjected to three sorting rounds by two independent judges per round and minor modifications were made to the wording of the items. If an item was consistently placed within a particular
category, then it was considered to represent convergent validity with the related construct, and discriminant validity with the others.

To assess the reliabilities of the sorting conducted by the judges, three different criteria were considered (Li et al., 2005). First, the inter-judge agreement scores were calculated. This was done by counting the number of items both judges agreed to place in a certain categories, even though the category into which the items were sorted by both judges may not be the intended one. The second criterion is the Cohen’s Kappa, which is a measure of agreement. It could be interpreted as the proportion of joint judgments in which there is an agreement after chance agreement is excluded (Cohen, 1960). Third, item placement ratios were calculated by counting all the items that were correctly cored into the target category by each of the judges and dividing them by twice the total number of items. The process for evaluating a Q-sort is explained in detail in Li (2002).

The calculations for Cohen’s Kappa coefficient (k) are based on the formula shown below.

\[
k = \frac{N_i X_{ii} - \sum_i (X_{i'} X_{i''})}{N_i^2 - \sum_i (X_{i'} X_{i''})}
\]

The calculation of the k is based on Table 2. \(N_i\) is the number of total items; \(X_{ii}\) is the total number of items on the diagonal (the number of items agreed on by two judges); \(X_{i'}\) is the total number of the items on the i’ row of the table; and \(X_{i''}\) is the total number of items on the i” column of the table.

In the first round, the inter-judge raw agreement (Table 2) scores averaged 82% and the initial overall placement ratio of items within the same target constructs (Table 3) was 0.89 (89%). Moreover, Cohen’s Kappa scores averaged 0.80.

Table 2. Inter-Judge Raw Agreement Scores: First Sorting Round

<table>
<thead>
<tr>
<th>Judge 1</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>NA</th>
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<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>1</td>
<td>1</td>
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<td>3</td>
<td>1</td>
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<td>1</td>
<td>5</td>
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<td>NA</td>
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<td>0</td>
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</tr>
</tbody>
</table>
Table 3. Items Placement Ratios: First Sorting Round

<table>
<thead>
<tr>
<th>Actual Grouping</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>NA</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total items placement = 90</strong></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td><strong>No. of hits = 80</strong></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td><strong>Overall hit ratio = 89%</strong></td>
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<td></td>
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</tr>
</tbody>
</table>

A summary of the first round inter-judge agreement indices is illustrated in the first column of Table 4. Following the guideline of Li et al. (2005) for interpreting the Kappa coefficient, the value of 0.80 indicates an acceptable level of agreement for the judges in the first round. This value is slightly lower than the value for raw agreement which is 0.82. The level of item placement ratios averaged 0.89; internal integration item obtains the lowest item placement ratio value of 0.75, indicating a low degree of construct validity. In contrast, several constructs; i.e., knowledge utilization, customer integration, manufacturing flexibility, and customer delivery, represent a high degree of construct validity with the value of item placement ratio of 100%.
Table 4. Summary of Inter-Judge Agreement Results

<table>
<thead>
<tr>
<th>Measure</th>
<th>Round 1</th>
<th>Round 2</th>
<th>Round 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw Agreement</td>
<td>82%</td>
<td>84%</td>
<td>85%</td>
</tr>
<tr>
<td>Cohen’s Kappa</td>
<td>80%</td>
<td>82%</td>
<td>83%</td>
</tr>
</tbody>
</table>

Placement Ratio Summary

<table>
<thead>
<tr>
<th>Measure</th>
<th>Round 1</th>
<th>Round 2</th>
<th>Round 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information Technology</td>
<td>86%</td>
<td>93%</td>
<td>100%</td>
</tr>
<tr>
<td>Knowledge Acquisition</td>
<td>90%</td>
<td>90%</td>
<td>90%</td>
</tr>
<tr>
<td>Knowledge Sharing</td>
<td>70%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Knowledge Utilization</td>
<td>100%</td>
<td>100%</td>
<td>88%</td>
</tr>
<tr>
<td>Internal Integration</td>
<td>75%</td>
<td>70%</td>
<td>75%</td>
</tr>
<tr>
<td>Supplier Integration</td>
<td>90%</td>
<td>80%</td>
<td>100%</td>
</tr>
<tr>
<td>Customer Integration</td>
<td>100%</td>
<td>80%</td>
<td>88%</td>
</tr>
<tr>
<td>Manufacturing Flexibility</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Customer Delivery</td>
<td>100%</td>
<td>100%</td>
<td>88%</td>
</tr>
<tr>
<td>Average</td>
<td>89%</td>
<td>90%</td>
<td>93%</td>
</tr>
</tbody>
</table>

In order to improve the agreement score and Kappa coefficient, the analysis of the off-diagonal items in the placement matrix was conducted to identify ambiguous items (fitting in more than one category) or indeterminate items (fitting in no category), and were deleted or reworded. Also, it is crucial to note that feedback from both judges was considered on each off-diagonal item, which is intended to modification of the items. Overall, one item from knowledge sharing and one from internal integration were deleted and off-diagonal items were reworded. Therefore, the number of items remaining for each construct after the first round of Q-sort is shown in the second column of Table 1.

Table 5. Inter-Judge Raw Agreement Scores: Second Sorting Round

<table>
<thead>
<tr>
<th>Judge 1</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>NA</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>5</td>
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<td></td>
<td>1</td>
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<td></td>
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<tr>
<td>2</td>
<td>1</td>
<td></td>
<td>4</td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>4</td>
<td></td>
<td>1</td>
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<td>4</td>
<td>4</td>
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<tr>
<td>5</td>
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<td>Agreement ratio = 84%</td>
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Table 6. Items Placement Ratios: Second Sorting Round

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<td>Total items placement = 86</td>
<td>No. of hits = 77</td>
<td>Overall hit ratio = 90%</td>
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After the remaining reworded items were entered into the second round, the inter-judge raw agreement scores (Table 5) were 0.84, while the average placement ratio index (Table 6) was 0.90 (90%). Besides these two indices, the Cohen’s Kappa score averaged 0.82.

A summary of the second round inter-judge agreement indices is shown in the second column of Table 4. The value for Kappa’s coefficient of 0.82 is higher than the value obtained in the first round (0.80), indicating an acceptable level of agreement for the judges in the second round. Hence the high degree of inter-judges agreement shows the high percentage of items placed in the target dimension. Although the second round achieved a good overall agreement index, it was possible to improve and re-validate the dimensions. Evidently, of the level of item placement ratios averaged 0.90; internal integration again obtains the lowest item placement ratio value of 0.70, indicating a low degree of construct validity and raising concern for the level of its internal consistency. Similarly, supplier integration and customer integration, whose item placement ratio value is 0.80, also require modifications.

As a result, in order to improve Cohen’s Kappa measure of agreement, the examination of the off-diagonal entries in the placement matrix (Table 6) was further conducted before going to the third round. Overall, one more item from internal integration, one from supplier integration, and one from customer integration, were removed, and some are reworded. Therefore, the number of items remaining for each construct after the second round of Q-sort was shown in the third column of Table 1.
In the third round, it seems that the agreement indices slightly improved from the previous round. The inter-judge raw agreement scores (Table 7) were 0.85. In addition, the average placement ratio index (Table 8) was 0.93 (93%), and the Cohen’s Kappa score was 0.83.

A summary of the third round inter-judge agreement indices is shown in the third column of Table 4. The value for the Kappa coefficient of 0.83 is slightly higher than the one obtained from the second round (0.82). At this stage, the numbers suggest an excellent level of inter-judge agreement indicating a high
level of reliability and construct validity. From Table 8, internal integration reveals the lowest item placement ratio value; nevertheless, the final refinement of the scales from the pilot test was to reword the items for this construct, resulting in the same number of the total remaining items for each construct after the third round is shown in the third column of Table 1.

At this point, Q-sort method was stopped at round three, since all criteria in considering Q-sort method were excellent, indicating a high level of reliability and construct validity. The resulting measurement scales in all dimensions in this research will be used in the large-scale survey. In the next chapter, the scale evaluation as the quantitative assessment of construct validity and reliability using large-scale sample are presented.

4. Conclusion

This research proposal represents one of the first empirical efforts to systematically investigate the relationship between IT, KM, supply chain integration, and firm’s operational performance. It aims to answer the following major questions: 1) Does IT have direct impact on supply chain integration? 2) Does KM have direct impact on supply chain integration? 3) Does supply chain integration directly affect manufacturing flexibility and customer delivery? 4) Does supply chain integration mediate the association between IT and manufacturing flexibility? As mentioned in chapter one, the highly competitive marketplace makes the firm realizes the importance of improving flexibility and responsiveness of its supply chain processes, so as to satisfy changing consumers’ demands. The model developed in this study aims to investigate the impact of both major enablers; namely IT and KM, on the integration of supply chain. In addition, despite the growing attentions in research studies, KM and its effect on supply chain integration still require a confirmatory test. Moreover, we consider the mediating role of supply chain integration on the associations of the two enablers (IT and KM) and the firm’s operational performance (manufacturing flexibility and customer delivery). This study will contribute to knowledge by representing a first study in an effort to investigate the framework of the relationship between knowledge management and supply chain integration. All dimensions/constructs are operationally defined in terms of their scale development process using Q-Sort method. As a result, this will allow researchers to be confident and bring new insights when exploring the influence of SCI and KM on time-based performance.
References

Author Index

Alan G. Robinson 169
Andreas C. Soteriou 542
Athakorn Kengpol 553
Bahaudin G. Mujtaba 89
Bhubate Samutachak 511
Chaerin Lee 383
Chamaiporn Fung-Fuang 480
Chanchai Rattanaparakarn 511
Chao-Lung Chang 239
Chi Anh Phan 460
Chirasil Chayawan 230
Chompoonoot Kasemset 684
Chutcharit Rinkham 684
Don Kerr 261
Duenren Liu 583
Duen-Ren Liu 350
Eldon Y. Li 375
Eun Young Kim 383
Frank J. Cavico 89
George C. Hadjinicola 542
Guanyu Chen 583
Hanno Roberts 656
Hisashi Onari 496
Ho Jin Jeon 292
Ho Kyung Park 383
Hsi-An Shih 194
Hsin-Cheng Chang 328
Hsin-Hong Kang 128,149
HsiJu Rebecca Yen 375
Hsiuyu Liao 583
Hsu-yao Chen 194
Hung-Chi Chang 693
I-Chan Fang 20
Jae Bum. Park 292
Jarupong Banthao 576
Jashen Chen 239,250,275,646
Jayanth Jayaram 447
Jing Zeng 460
Jongsawas Chongwatpol 303
Juan-Wen Ruan 375
Jung Hoon Lee 292,403
Kang, Hsin-Hong 109
Kannapha Amaruchkul 566
Keah-Choon Tan 447
Kevin Burgess 261
Kingo Udagawa 45
Koshichiro Mitsukuni 45
Krisana Lanumteang 533
Kwa Tran 210
Larry F.K. Chang 375
Liu, Shu-Bing 109
Mansour Alshamali 19
Margaret Meiling Luo 250,275
Ming-Tien Tsai 20,328
Montri Lawkobkit 611
Nasr-Eddine Dahel 671,703
Nithinant Thammakoranonta 230
Pei-Ying Lin 250
Peng Chan 210
Phanasan Kohsuwan 611
Phattarasaya Tantiwattanakul 553
Phongchai Jittamai 576
Phuong Anh Nguyen 169
Poompichai Tarndamrong 66
Priyanut Piboolsravut 511
Ramesh Sharda 303
Ronda M. Smith-Nelson 66
Russell Ching 646
Sakun Boon-itt 716
Seung-Jin Ryu 496
Shekar Shetty 19
SiDi Wu 496
Sinthupuan Somnuek 364
Sophea Chea 239,275
Suheera Atawongsa 31
Teerasak Khanchanapong 418
Terrence C. Sebora 66
Tetsu Saito 45
Tidti Tidtichumrernporn 623
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