KNOWLEDGE CREATION, ORGANIZATIONAL LEARNING AND INNOVATION: A COMPARATIVE STUDY OF THE TRADITIONAL AND HIGH-TECH INDUSTRIES

Teresa L. Ju
Department of Information Management, Shu-Te University
Kaohsiung, Taiwan, R.O.C. , tju@mail.stu.edu.tw

Wann-Yih Wu
Department of Business Administration, National Cheng Kung University
Tainan, Taiwan R.O.C.

ABSTRACT

Taiwan has an outstanding record on its technological manufacturing, and many studies on knowledge creation, organizational learning and organizational innovation have been conducted in high-tech industries. The traditional industries, however, have not been seriously explored. The goals of this study are to understand the current state of knowledge creation, organizational learning, and organizational innovation in technology manufacturing, general manufacturing, and service industry in Taiwan, and to explore the relationships among the factors of knowledge creation, organizational learning, and organizational innovation in different industry categories and different stages of product life cycle. Multiple theoretical perspectives are synthesized to hypothesize an organizational learning model. Implications and limitations of this study are also discussed.

Keywords: knowledge management, organizational innovation, organizational learning

INTRODUCTION

Firms in Taiwan are facing increasing international competition as Taiwan's accession to WTO approaches. Not only facing competitions from Europe, America, and Japan, the traditional manufacturing sectors that once have boosted Taiwan's economic development are now facing considerable competition from the newly developed Asian countries, most notably China. To sustain the economic success of the past three decades, Taiwan realized that innovation is indispensable. Government efforts in this regard included the development of a favorable environment for high-tech industries as well as a concerted emphasis on innovation. Along this line, the government is also promoting a National Innovation System to assist domestic firms to build up competitive advantage. Since innovation results from effective use of knowledge, knowledge management will be an important activity in any form of competitive potential.

Taiwan has an outstanding record on its technological manufacturing, and many studies on knowledge creation, organizational learning and organizational innovation have been conducted in high-tech industries. The traditional industries, however, have not been seriously explored. To fill in this gap, this study tried:
To understand the current state of knowledge creation, organizational learning, and or-

ganizational innovation of traditional and high-tech firms in Taiwan.
To explore the relationships among the factors of knowledge creation, organizational learning, and organizational innovation in different industry categories and different stages of product life cycle.

THEORETICAL BACKGROUND AND RESEARCH MODEL

Knowledge Creation

Knowledge is at the heart of innovation and competitiveness; the better we understand the process of knowledge creation, the more likely innovative behaviors can be fostered in organizations. Krogh (2001) proposes that the creation of knowledge cannot be managed, only enabled. This means that attempts to control and administer creativity and innovation will generally fail to achieve the desired outcomes and will result in inefficient use of already limited resources, time, and energy.

This study adopts the definition of knowledge creation from Nonaka (1994), who posits that knowledge management within a firm should assist in creating new processes, and improving and redesigning old processes. Nonaka clearly asserts that companies must have creative knowledge before they can innovate. According to Nonaka, the most suitable environment for creating knowledge should include: (1) Intention of the organization: often expressed as vision, which is shared with employees; (2) Autonomy: allowing employees to act on their own to introduce unexpected approaches to problems as well as improving self-motivation; (3) Creative chaos: where fluctuation is purposely introduced into an organization to breakdown routines and habits; (4) Redundancy of information: so that knowledge could be shared beyond immediate employees and departments; and (5) Requisite diversity: allowing organization members to cope with environmental complexities and rapid change.

Organizational Innovation

The extent of organizational innovation has been measured in many different ways. Some measures have a narrow focus while others aggregate innovative behaviors across a set of innovations or stages in the assimilation lifecycle (Fichman, R. G. 2001). Drucker (1986) has emphasized organizational innovation and suggested seven factors that lead to innovation opportunity: (1) Unexpected events, including success, failure, or other unexpected incidents; (2) Uncoordinated events where an expected result is different from the actual outcome; (3) Innovation due to the need for progress; (4) Sudden market and industry structural change; (5) Change in demographics; (6) Change of perception; and (7) New knowledge from scientific progresses. Sources of the first four innovation factors come from within the organization and are easily understood and noticed by employees. Sources of the last three innovation factors come from external environment of the organization or industry and are more difficult to manage.

Organizational Learning

In recent years scholars have regarded organizational learning as essential for sustaining an organization because business is becoming more complex, dynamic, and globally competitive. Both academics and management specialists emphasize that if organizations cannot continue learning and absorbing the newest knowledge and the latest technology

from markets, environments, and customers, they will lose their competitive advantage quickly. Some scholars have explored the issues surrounding organizational learning (Badaracco, 1991; Nonaka & Hirotaka, 1995) from the perspective of cooperation, networks and knowledge transformation. In The Fifth Discipline Senge (1990) defined organizational learning in terms of five disciplines of increasing sophistication: personal mastery, improving mental models, building shared vision, team learning and systems thinking. The first three disciplines have particular application for the individual participant, and the last two have group application.

Drucker (1993) argues that the only tool for creating and maintaining competitive advantage is knowledge, and previous research equated the organizational learning to continuing update of organizational knowledge. Therefore, we propose that knowledge is a key to link organizational learning and innovation ability and organizations must ensure that their employees appreciate the importance of continuing learning of new knowledge.

Research Model and Research Hypotheses

A proposed organizational learning model for this study is shown in Figure 1 that depicts the following research hypotheses:

H1: Knowledge creation has a positive effect on organizational innovation.

H2: Organizational innovation has a positive effect on organizational learning.

H3: Knowledge creation has a positive effect on organizational learning.

H4: Different industry categories perform differently in the dimensions of knowledge creation, organizational learning and organizational innovation.

H5: The product life cycle (maturity) performs differently in the dimensions of knowledge creation, organizational learning and organizational innovation.

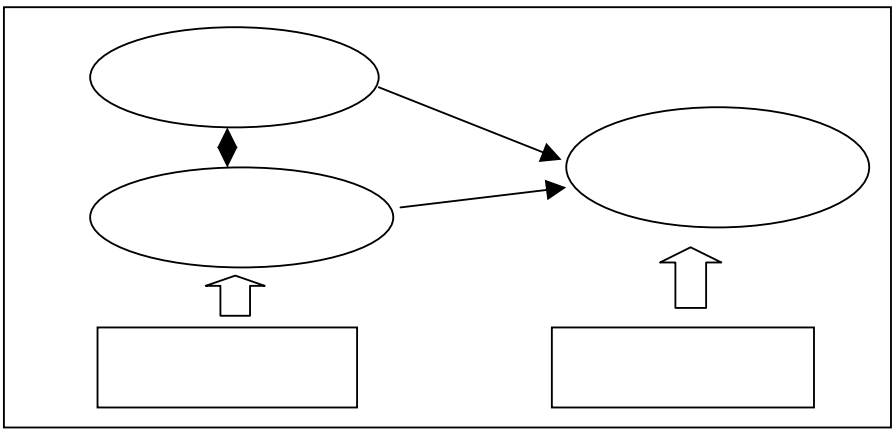

Figure1: The proposed organizational learning framework

RESEARCH DESIGN AND METHODOLOGY

Research Variables

The concept of innovation includes not only improvement of a technology or a product, but also the introduction of something new, such as a new idea, method, or device etc. Based on existing literature, this study divided the decisions surrounding organizational

innovation into two categories. The first category is the external organization factors including competitors, customers, and technology. The second category is the internal organization factors including competition, customer, law, technology and organization. While prior research on organizational innovation factors have mostly been supported by conceptual or inferential research and less often by empirical data, this study combines internal and external factors to evaluate organizational innovation through an empirical investigation.

Basic information includes category of industry, and product life cycle stage, are measured by comparative measurement and nominal scale. Knowledge creation ability, following Nonaka's and Takeuchi's classification (1995), are divided into 5 categories: (a) innovation intention, (b) employees autonomy, (c) unclear environment, (d) sufficient resources, and (e) sufficient diversity. This section included 15 questions measured on a Likert 5 point scale. Organizational innovation concerns both internal and external factors. It is divided into 5 sections: competitive factors, customer factors, legal factors, technology factors and organizational factors. A total of 17 questions measured on a Likert 5 point scale were included. Organizational learning tendency, based on Senge's The Fifth Discipline (1990), included personal mastery, systems thinking, team learning, shared vision and mental model. A total of 15 questions measured on a Likert 5 point scale.

Sampling Design

The sampling for this study was directed at three industries: technology manufacturing, general manufacturing, and service industry. The sample source was drawn from the top 2000 manufacturers and top 500 service industries, published by Chung-Hwa Credit Institute. A random sample was drawn from this list and a total of 500 survey forms were distributed to high-level managers (presidents or general managers). Survey distribution is detailed in Table 1, Table 2.

Table 1. Survey industries and response rates

Industry type	Technology manufacturing	General manufacturing	Service industry	Total
Industry	Information product Electronic product Precision machine product Industry related to semiconductors Other technology industry	Clothing & textile industry Food industry Petrochemical product Shoe-making industry Hardware product Sports product Transportation industry Other manufacture	Warehouse transportation Insurance Vehicle business Information service International trade Restaurant chain Communication media Other service industry	
Sample size	170	170	160	500
Size of effective feedback	45	43	35	123
Percentage (%)	26.5	25.3	21.9	24.6

Table 2. Survey sample details

Category	Technology manufacturing	General manufacturing	Service industry	Total

	Number of responses	%	Number of responses	%	Number of responses	%	Number of responses	%
Company History								
01-08 year	16	13.0	6	4.9	4	3.3	26	21.1
09-16 year	21	17.1	3	2.4	12	9.8	36	29.3
17-27 year	4	3.3	21	17.12	14	11.4	39	31.7
28-40 year	4	3.3	8	6.5	4	3.3	16	13.0
41-58 year	0	0	5	4.1	1	0.8	6	4.9
Life Cycle Stage								
Introduction stage	5	4.1	1	0.8	3	2.4	9	7.3
Growth stage	19	15.5	1	0.8	4	3.3	24	19.5
Maturity stage	21	17.1	39	31.7	28	22.8	88	71.5
Decline stage	0	0	2	1.6	0	0	2	1.6

RESULTS

Analysis of Different Industries

Table 3 shows the differences among industries in each dimension. The knowledge creation dimension shows that technology manufacturing and service related industries have higher innovation intention and a more diverse work (F=4.20~6.67; P=0.001~0.05). Employee autonomy (average=2.9419~3.3571), unclear environment (average =3.7841~3.4985), and sufficient resources (average=3.7442~3.9429) show no apparent difference among the three industries.

Table 3. Differences of research factors among industries

Constructs	Factors	Technology manufacturer n=45	General manufacturer n=43	Service industry n=35	F value	Duncan test
Knowledge creation	Innovative intention	3.93	3.47	3.71	6.67**	1>2
	Autonomy	3.28	2.94	3.36	3.71	
	Unclear environment	3.53	3.50	3.78	2.98	
	Sufficient resources	3.91	3.74	3.94	1.27	
	Diverse work	3.47	3.04	3.41	4.20*	1,3>2
Organizational innovation	Competitive factors	3.07	3.84	3.11	10.72***	2>3,1
	Mature technique	3.16	3.43	3.61	4.32*	3>1
	Customer factors	3.64	3.57	3.90	2.13	
	Legal factors	2.11	2.30	2.83	5.09**	3>2,1
	Organizational factors	2.65	3.19	3.30	6.88**	3,2>1
Organizational learning	Personal mastery	3.47	3.16	3.29	1.37	
	Mental models	4.16	3.91	4.14	1.51	
	Shared vision	3.78	3.51	3.77	3.05*	1,3>2
	Team learning	3.76	3.44	3.50	2.56	
	Systems thinking	3.78	3.64	3.80	0.88	

*P<.05 **P<.01 ***P<.001

To the organizational innovation dimension, general manufacturing industry has the

highest competitive factors score (F=10.72; P<.001~.05). Service related industries are most likely to experience increased legal restrictions (such as government protectionism) while their maturity of technique is also high (F=4.32~6.88; P<.001~0.05). Organizational factors are significantly lower for the technology manufacturing industry (F=6.88; P<.01). There is no apparent difference among the three industries in relation to customer factors. To the organizational learning tendency dimension, team learning in technology manufacturing and the service related industries are higher than that in traditional manufacturing industry (F=3.05; P=0.05). Personal mastery (average=3.162~3.4661), mental models (average=3.6395~3.8000), shared vision (average=3.4419~3.7556), systems thinking (average=3.9070~4.1429), and all show no significant difference among the three industries.

The above results strongly support hypothesis H4; Different industry categories will perform differently in the dimensions of knowledge creation, organizational learning, and organizational innovation.

Analysis of Different Product Life Cycle

Because the sample contains few firms with products at the introductory (n=9) or decline (n=2) stage, the analysis centers on the growth and maturity stages. Table 4 shows the results for each research construct. Knowledge creation's innovation intention is higher in the growth stage than in the maturity stage (T=2.68, P=0.05), and organizational learning's systems thinking is higher in the growth stage than in the maturity stage (T=3.87; P=0.01). There are no apparent differences among other factors across the product life cycle. This result partially supports hypothesis H5; Different stages of the product life cycle will perform differently in the dimensions of knowledge creation, organizational learning, and organizational innovation.

Table 4. Differences between growth and maturity stage of product life cycle

	Factor	Growth n=24	Maturity n=88	T value
Knowledge creation	Innovative intention	4.04	3.61	2.68*
	Autonomy	3.60	3.06	1.93
	Unclear environment	3.94	3.81	1.74
	Sufficient resources	3.58	3.27	1.73
	Diverse work	2.96	3.56	-0.83
Organizational innovation	Competitive factors	3.36	3.46	-1
	Mature technique	2.60	3.49	-1.18
	Customer factors	3.36	3.76	-0.24
	Legal factors	2.33	2.41	-1.23
	Organizational factors	2.65	3.09	-0.41
Organizational learning	Personal mastery	3.38	3.23	1.84
	Systems thinking	4.50	3.91	3.87**
	Team learning	3.98	3.57	0.39
	Shared vision	3.65	3.55	0.93
	Mental models	3.88	3.69	0.34

*P<.05 **P<.01 ***P<.001

Interrelationships between Knowledge Creation, organizational Learning and Organizational Innovation

The interrelationships between knowledge creation, organizational learning and organiza-

tional innovation have been tested through canonical correlation analysis. The overall relationship between organizational innovation and knowledge creation can be seen in the canonical correlation (CAN R-square=0.3649, F=4.406, P<0.0007, RI=0.2335). Figure 2 shows that most of the signs of the independent and dependent variables are opposite for most values, meaning that generally the factors leading to organizational innovation are negatively correlated with the factors leading to knowledge creation. Customer factors, however, exhibit the same direction of influence as four of the dependent variables, showing that knowledge creation increases as customer factors increase. This indicates that when customers are not highly loyal and more critical, firms may respond with higher levels of knowledge creation, especially in the areas of innovative intention and diverse work. Organizational factors show the highest loading among the independent variables (.83) with diverse work exactly opposite (-.83) among the dependent variables. This relationship clearly shows that larger scale organizations exhibit higher level of formalization, which discourages knowledge creation. Thus, these results generally support hypothesis H1; Knowledge creation has a positive effect on organizational innovation.

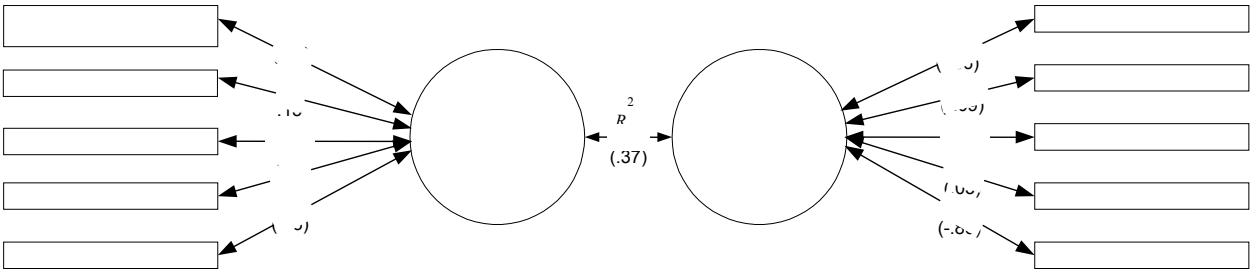

Figure 2. Organizational innovation and knowledge creation canonical correlation

Organizational innovation and organizational learning also show a statistically significant canonical correlation (CAN R-square=0.4557, F=4.6401, P<0.001, RI=0.2423), supporting hypothesis H2; Organizational innovation has a positive effect on organizational learning. Figure 3 shows that organizational innovation and organizational learning exhibit similar signs and thus tend to increase together. Competitive factors are a surprising exception, with a negative loading (-.51), suggesting that less competitive industries are related to higher levels of organizational learning. In the same direction, mature technique shows the highest loading (.56) among the independent variables while shared vision (.80) and systems thinking (.73) are highest among the dependent variables. The results reveal that firms employing more standardized manufacturing techniques and processes tend to achieve higher levels of organizational learning.

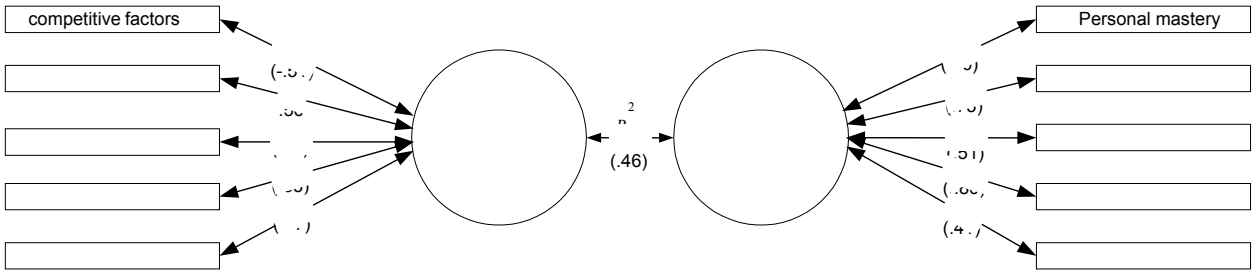

Figure 3. Organizational innovation and organizational learning canonical correlation

Knowledge creation and organizational learning also have a statistically significant relationship (CAN R-square=0.6012, F=10.3044, P<0.001, RI=0.2917), supporting hypothesis H3; Knowledge creation has a positive effect on organizational learning. Figure 4 shows that the relationship between knowledge creation and organizational learning is strong and positive, as all loadings are large and exhibit the same sign. Innovative intention shows the strongest influence on knowledge creation with personal mastery receiving the strongest influence from organizational learning.

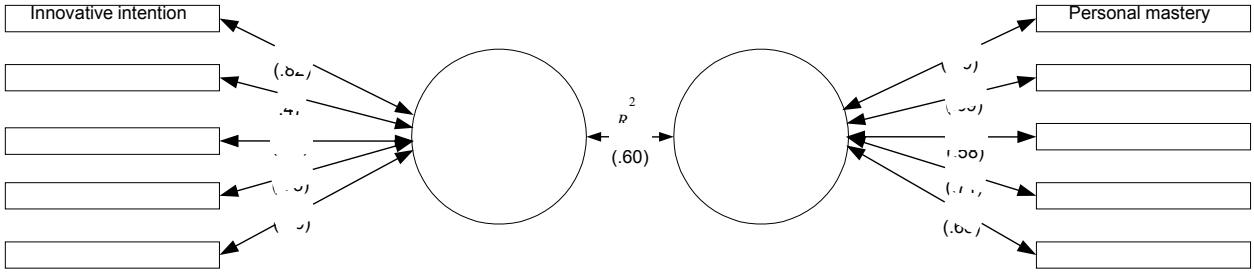

Figure 4. Knowledge creation and organizational learning canonical correlation

CONCLUSIONS

Discussion

Traditional manufacturing firms in Taiwan tend to have lower level of knowledge creation and organizational learning capabilities, so do the firms with mature products. These results show that after rapid expansion these mature firms are now facing rising labor costs at home and increased competition abroad, primarily from Mainland China. These firms may have difficulty developing innovation within their employees, because they are in decline and simply do not find it cost effective to improve innovation. Traditional industry, such as umbrella manufacturing, may emphasize cost reduction above all else, and prefer high level of formalization rather than the chaos required for knowledge creation. Under this circumstance, government policies may be more productive if directed towards the service industry and technology related manufacturing. These industries may still have time to develop, within their employees, innovation-oriented behaviors that can lead to competitive advantages, and avoid the trap of depending solely on lowering the costs. With Mainland China's enormous labor cost advantage, it is extremely difficult for Taiwan to compete on this dimension alone.

With the development of high-tech and service industries in Taiwan, firms are increasingly counting on knowledge as a competitive weapon. The main feature of this economic shift is the benefit of innovation introduced into the value chain. Government support should be oriented towards increasing this benefit.

Traditional firms facing higher level of competition clearly exhibit a serious decline in both knowledge creation and organization learning. Under hostile competitive environment, and short of competent work force and other resources, these firms will be reluctant to engage in knowledge creation and organizational learning that are time consuming and cannot see cost-effectiveness in the short run. On the other hand, it is really urgent for these firms to raise enough knowledge to upgrade their competence for survival. Thus, how to break the learning barriers to improve knowledge creation and organizational learning in these traditional mature manufacturing firms will affect future economic development of Taiwan.

Drawing upon this empirical study, the other major conclusion is that increase in the size of a firm tends to decrease both knowledge creation and organizational learning. While researchers have found both positive (Kimberly & Evanisko, 1981) and negative correlation (Teece, 1986) between organizational innovation performance and the size of a firm, the results of this study seem to support the negative correlation. Reasons for this include the fact that larger scale allows these firms to relocate and simply buy the skills they require, thus eliminating the need to have high level of innovation internally. This does not exclude the possibility that classical bureaucratic structures are popular among these mature Taiwan firms and innovation simply cannot flourish in such an environment. Thus we caution against any inference of direct causation, but instead suggest that other common variables are at work, likely even involving culture.

Limitations and Future Research

This study centered on describing the innovation situation in firms in Taiwan today, but this does not answer questions of causation. Of major importance are questions surrounding the negative relationship of both increased competition and scale to knowledge creation and organizational learning. Do these results describe the situation of traditional/mature industries in Taiwan? Or is this relationship the result of growth and expansion. Will the technology related manufacturers of today become the traditional manufactures of tomorrow and face deterioration in innovation? Or are the mature firms of today suffering from a lack of innovation due to indifference of innovation decades ago? These questions remind us the importance of longitudinal studies as well as case studies in Asia, where rapid change (economically, politically, and socially) often brings into question the appropriateness of simply adopting Western models.

REFERENCES

Badaracco, J. L. Jr. The Knowledge Link: How Firms Compete Through Strategic Alliances, Boston, Mass.: Harvard Business School, 1991.

Betz, F., Managing Technology Competing Through New Ventures, Innovation, and Corporate Research, Prentice Hall, 1993.

Drucker, Peter F, Post-Capitalist Society, NY: Harper Business, 1993.

Drucker, Peter F., Innovation and Entrepreneurship - Practice and Principles, 1986.

Kimberly, J. R. and Evanisko, M. J., "Organization Innovation: The Influence of Individual, and Contextual Factors on Hospital Adoption of Technological and Administrative Innovation," Academy of Management Journal, 571-597, 1981.
Kotler, P., Marketing Management, New Jersey:Prentice-Hall, 1998.
Nonaka, I, "A Dynamic Theory of organizational Knowledge Creation," Organization Science, 15(1), 14-37, 1994.
Nonaka, I. and Hirotaka, T., The Knowledge-Creating Company, N.Y.: Oxford University Press, 1995.
Nonaka, Ikujiro and Takeuchi Hirotaka, "The Concept of 'Ba': Building a Foundation for Knowledge Creation," California Management Review, 4, 40-54, 1998.
Porter, M. E., Competitive Advantage, New York: The Free Press, 1985.
Rothwell, R., Zegveld., Industrial Innovation and Public Policy, 1981.
Sanche, C. M., "Environment Regulation and Firm- Level Innovation-- The Moderating Effects of Organizational and Individual- Level Variables," Business & Society, 36(2), 140-168, 1997.
Senge, P. M., The Fifth Discipline- The Art and Practice of The Learning Organization, NY: Doubleday, 1990.
Teece, D. J., "Profiting From Technological Innovation: Implications for Integration, Elaboration, Licensing and Public Policy," Research Policy, 15, 1986.
Utterback J.M. "Innovation In Industry and the Diffusion of Technology," Science, Feb., 620-626, 1971.
Utterback J.M. "The Process of Technological Innovation Within the Firm," Academy of Management Journal. 14(1), 1971b.
Venkatraman, N., and Ramanujam, "Measurement of Business Performance in Strategy Research: A Comparison of Approaches," Academy of Management Review, 1986.
Yap, C.M. and Sounder, W.M. E. "Factors Influencing New Product Success and Failure in Small Entrepreneurial High-tech Electronicsfirms," JPIM, 11, 418-432, 1994.