# EMPIRICAL STUDY ON EFFECT OF QUALITY MANAGEMENT ON COMPETITIVE PERFORMANCE IN MANUFACTURING COMPANIES: INTRENATIONAL PERSPECTIVE

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**Abstract**

This paper presents results of an empirical analysis on quality management and its impact on competitive performance. These results have been derived from the third round survey conducted during 2003 and 2004 under the framework of High Performance Manufacturing Project. After presenting a simple analytical framework, the authors establish three hypotheses to be tested; 1) there is no difference in quality management practices across the countries, 2) quality management has significant impact on competitive performance, and 3) there is no difference in the impact of quality management practices on competitive performance across the countries. Then, we suggest eight measurement scales characterizing quality management practices in high performance manufacturing companies, and results of measurement testing show that all of the scales are reliable and valid for one hundred and sixty-three manufacturing companies in five countries: Japan, US, German, Italia, and Korea. Using these scales, we empirically examine similarities and differences in quality management and its relationship with other competitive performance to evaluate the role of quality management. Analysis of variance (ANOVA) and regression analysis were conducted to test hypothesizes.
Statistical results reveal the minor differences in quality management across the countries we investigated. The significant differences exist in such practices like *customer involvement, supplier quality involvement, small group problem solving, and top management leadership for quality*. Regression results indicated significant impact of quality management on competitive performance indexes. In the global basic, *customer involvement*, *cleanliness and organization*, *task- related training for employee*, and *top management leadership for quality* were identified as the primary determinants for improving competitive performance. *Process control* was identified as key predictor for reducing manufacturing cost. *Task-related training for employee* was identified as key predictor for improving conformance quality. *Customer involvement* was found as key predictor for delivery performance. *Cleanliness and organization* was identified as significant success factor for improving flexibility.
Keyword: Quality management, Competitive Performance, Manufacturing Companies

## 1. Introduction

Quality management represents company-wide activities to improve the quality level of products and works through customer orientation, continuous quality improvement, employees' involvement, etc. to establish and sustain a competitive advantage. From a perspective of competitive strategy, quality is often seen as a source of differentiation. Quality improvement is an important issue influencing long-term viability of any business enterprise, especially manufacturing companies producing physical goods. Based on the empirical findings, Flynn et al. [8], Schroeder and Flynn, [24], and Matsui [17] proposed a framework for competitive performance by implementation of quality management practices.

This paper presents results of an empirical study on effect of quality management practices upon competitive performance in manufacturing companies. The main objective of this study is to identify the similarity and difference of quality management practices and their impact on different aspect of competitive performance. The objective is accomplished by surveying a sample of one hundred and sixty-three manufacturing companies in five countries to examine the nature of their quality management practices and competitive performance. The paper is organized as follows. The next section reviews the literature about quality management and its impact on competitive performance. Next, a simple analytical framework is introduced. Results of correlation analysis and stepwise regression are reported. The final section of the paper discusses conclusions and main findings of the study.

## 2. Literature review

Much has been written about how quality should be measured, controlled and improved. In the early stages of empirical research on quality management, Saraph [23] pioneered the effort to identify an empirical validate TQM constructs primary using the quality prescriptions of quality gurus. They described quality management by such measures like management leadership, role of quality department, training, product and service design, supplier quality management, process management, quality data and reporting, employee relation. More recently, Flynn [8] used practitioner, and empirical literature developed a quality management framework for manufacturing companies, including top management support, workforce management, quality information, supplier involvement, product design, process management, and customer involvement. Ahire [1] based on both conceptual literature and empirical and practitioner literature, developed the instrument for quality management, using top management commitment, supplier quality management, supplier performance, customer focus, SPC usage, benchmarking, internal quality information usage. Recently, much of effort is to empirically examine the impact of quality management practices on quality performance and competitive performance. Table 1 presents a summary of typical empirical researches about quality management.

International comparative studies about quality management have been conducted by several researchers (Shroeder and Flynn [24], Rungtusanatham [21]; Flynn and Saladin, [10]). Similarity and differences in quality management have been identified such as customer relationship, process management, etc. Quality management has been compared across the United States, Japan, and European countries, based on Malcolm Baldrige National Quality Award or ISO 9000 framework. One of the early empirical researches on international comparison in quality management practices is a study of Schroeder and Flynn [24] that investigated several manufacturing plants in the United States, Japan, United Kingdom, German, and Italy. They have developed and tested a framework on the relationship of quality management and competitive performance. The main finding of this study is a compatibility of quality capability with other aspects of competitive performance.

From reviewing recent empirical literature (summarized in the Table 1), some remarks on the relationship between quality management and competitive performance could be summarized as follows:

- Quality management is used to indicate an integrated, inter-functional mean of establishing and sustaining a competitive advantage. In order to attain the excellence in competitive performance, manufacturing companies should implement quality management practices covering various perspectives such as process management (cleanliness and organization, and process control), quality information, supplier quality involvement, customer involvement, human perspective (employee training and participation), and top management support. Those factors were found as key determinants for improving competitive position of the companies as mentioned in cited literature.
- The cited literature indicates that quality is a multi-dimensional construct including other dimensions such as features, reliability, durability, aesthetics and customer service, as well as conformance to standards.
- International comparison in quality management should be conducted by not only investigating country effect on each quality management practices but also comparing effect of quality management practices on different dimensions of quality performance. The more empirical findings on the difference and similarity in determinants for quality performance across the countries may deliver many implications for manufacturing managers who are looking for a solution to improve their competitive position.

In this study, the authors adopt the framework of Flynn [8] and Schroeder and Flynn [24], utilize it to measure, and compare quality management practices among five countries: The United States, Japan, Germany, Italia, and Korea.

Table 1: Summary of studies on relationship between quality management and organizational performance

| Author | Operationalization of TQM | Operational definition of performance | Data collection method and analysis | Main findings |
|---|---|---|---|---|
| Anderson *et al*. [2] | Multidimensional construct: Visionary leadership, Internal and external cooperation, Learning Process management, Continuous improvement, Employee fulfillment, Customer satisfaction | Operating performance<br>Customer satisfaction | Questionnaires from management and workers in plant<br>Path analysis | Employee fulfillment has a significant direct effect on customer satisfaction.<br>No significant relationship exists between continuous improvement and customer satisfaction. |
| Flynn *et al*. [8] | Multidimensional construct include core QM practices and QM infrastructure practices: Process flow management, Product design process, Statistical control, Feedback, Customer relationship, Supplier relationship, Work attitudes, Workforce management, Top management support | Operating performance<br>- Quality market outcomes<br>- Percent-passed final inspection with no rework<br>- Competitive advantage (unit cost, fast delivery, volume flexibility, inventory turnover, cycle time) | Questionnaires in 42 plants in US. Responders are top and middle manager, shop floor worker<br>Path analysis | -Process flow management and the product design process have positive effects on perceived quality market outcomes while internal measure of the percent that passed final inspection without requiring rework is impacted by the process flow management.<br>- Both perceived quality market outcomes and percent-passed final inspection with no rework have significant effects on competitive advantage. |
| Choi and Eboch [4] | Single construct is used to analyze the relationship between TQM, plant performance and customer satisfaction<br>TQM practices is summarized from process quality, human resource, strategic quality planning, information and analysis | Plant performance (quality, cost, delivery)<br>Customer satisfaction (quality, cost, delivery ) | Questionnaire<br>Data from 339 responded plants in US<br>Structural equation modeling | TQM practices have a stronger effect on customer satisfaction than they do on plant performance. The plant performance fails to show significant impact on customer satisfaction. |
| Forza and Flippini [12] | Multidimensional construct: Orientation towards quality, TQM linked with customer, TQM links with supplier, process control, human resource | Two dimension of quality performance:<br>- Quality conformance<br>- Customer satisfaction | Questionnaire<br>Data from 43 responded company in Italy and other European countries<br>Structural equation modeling | Process control has a significant effect on quality conformance, and TQM links with customers has a significant effect on customer satisfaction. |

Table 1: Summary of studies on relationship between quality management and organizational performance (continued)

| Author | Operationalization of TQM | Operational definition of performance | Data collection method and analysis | Main findings |
|---|---|---|---|---|
| Samson and Terziovski [22] | Multidimensional construct<br>Leadership<br>Perceived performance (subjective) and self-reported objective data | Operating performance<br>Product quality, customer satisfaction, employee morale, productivity, delivery performance | Questionnaire<br>Multiple regression analysis | Employee commitment, shared vision, and customer focus in combination has a positive impact on quality outcomes. Leadership, human resources management and customer focus (soft factors) significantly and positively relate to operating performance. |
| Kaynat [16] | Multidimensional construct<br>Management leadership<br>Training, Employee Relation<br>Quality Data& report, Supplier quality management, Process Management, Product Design | Financial & market performance<br>Quality performance<br>Inventory performance | Questionnaire<br>Structural equation modeling | Total quality management gives positive impact on financial and market performance through operating performance |
| Matsui [17] | Multidimensional construct:<br>Cleanliness and organization, Continuous improvement, Customer involvement, Customer satisfaction, Feedback , Maintenance, Process control , Quality in new products , Rewards for quality, Supplier quality involvement, Supplier quality involvement, Top management leadership for quality, TQM link with customers | Competitive performance: unit cost of manufacturing, Quality of product conformance, Delivery performance, Fast delivery, Flexibility to change product mix, Flexibility to change volume, Inventory turnover, Cycle time,<br>Speed of new product introduction, Customer support and service, Product capability and performance | Questionnaire 46 Japanese manufacturing plan<br>Canonical analysis | Quality management is strongly influenced by certain organizational characteristics, human resource management, information systems, and manufacturing strategy, and that it plays an important role in determining the competitive performance of manufacturing companies, partly through the impacts upon just-in-time production, information systems, and technology development.<br>Quality management depends on commitment, coordination of decision making, task-related training for employees, small group problem solving, multi-functional employees, distinctive competence, and anticipation of new technology among others. |

## 3. Research framework

To assess the relationship between quality management and quality performance of manufacturing plants, a simple analytical framework was established and depicted in Figure 1.

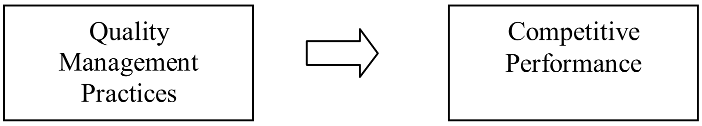


Fig 1: Research framework

Quality management represents an integrated, inter-functional mean of establishing and sustaining a competitive advantage. In this research, the authors used eight scales to measure different aspects of quality management including processes, human activities, leadership, customer, and information. These scales were developed and tested in the framework of High Performance Manufacturing Project by Schroeder and Flynn [24] and Matsui [17] as follows:

- Cleanliness and organization (CO3C): 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
- Process control (PCTL): Measure whether the plants conduct statistical quality control to reduce variance in processes
- Feedback (FDBK): This scale measures whether the plant provides shop-floor personnel with information regarding their performance (include quality and productivity) in a timely and useful manner
- Supplier quality involvement (SQIV): This scale assesses the amount and type of interaction, which occurs with vendors regarding quality concerns
- Top management leadership for quality (TMLQ): This scale measures top management commitment and personal involvement in pursuing continuous improvement
- Customer involvement (CIVM): This scale assesses the level of customer contact, customer orientation, and customer responsiveness.
- Small group problem solving (SGPS): This scale evaluates how the plant uses the teamwork activities to solve quality problems
- Task-related training for employees (TTEM): This scale evaluates whether plant develop the skill of labor by providing training courses

Competitive performance is summarized by four indexes presenting for four aspect of competitive performance as follows:

- Cost: Unit cost of manufacturing
- Quality: Conformance to product standard
- Delivery: On-time delivery
- Flexibility: Volume flexibility

Traditionally, research in comparative management fits within three schools of thought: culture free (Haire, Ghiseli, and Porter [14]), convergence (Form [11]), and culture specific (Hofstede [15]). In this study, culture-free perspective is adopted indicating that, as recognized as the common framework for production improvement, there is no difference between quality management practices between countries: United States, Japan, German, Italia, and Korea. Then, we propose the hypotheses on the relationship between implementation of quality management and competitive performance as follows:

H 1: There is no difference in quality management practices across the countries
H 2: Quality management has significant impact on competitive performance
H 3: There is no difference in the impact of quality management practices on competitive performance across the countries

## 4. Data collection

Data used for the subsequent analyses were gathered through an international joint research on High Performance Manufacturing Project (HPM) started in 80s by researchers at the University of Minnesota and Iowa State University. The overall target of this project is to study "best practices" in manufacturing plants and their impact on plant performance in the global basic. The Round One survey was conducted in 1989 gathering information from forty-six US manufacturing plants. In 1992, the project was expanded to include researchers from Germany, Italy, Japan, and the UK (see Flynn et al., 1997). The Round Two survey gathered data from one hundred and forty-six manufacturing plants from above countries. In 2003, the project was expanded in include other researchers from Korea, Sweden, Finland and Austria. Total number of manufacturing plants participated in Round Three survey is two hundred and ten. Within each country, the surveyed manufacturers are the plants with more than 100 employees belonging to one of three industries – electronics, machinery, and transportation. The researchers, based on business and trade journals, and financial information, identified and selected plants as having either a ''World-Class'' or a non-''World-Class'' reputation. This selection criterion allowed for the construction of a sample with sufficient variance to examine variables of interest for the research agenda (Schroeder and Flynn [24], Rungtusanatham et al.[21])

Some of the significant results of studies conducted based on this project are shown in Flynn *et al.* [8], Schroeder and Flynn [24], Matsui [17], and Rungtusanatham *et al.* [21]. They are concerned with some important aspects of manufacturing plants: quality, JIT production, information systems, information technologies, and technology development, manufacturing strategy, improvement, and performance.

In this research, the authors used data from one hundred and sixty-three plants located in five industrialized countries: Japan, the United States, Germany, Italia, and Korea during the Round Three survey during 2003 and 2004.

Implementation of quality management practices in each plant was evaluated by seven individuals in several positions from manager to direct labor. Direct labor, quality manager, and supervisors answered the question about small group problem solving, cleanliness and organization, customer involvement. Questions concerned with feedback, and process control were assessed by direct labor, quality managers, and production engineers. Plant superintendent, supervisors, and human resource managers evaluated task-related training for employees. Inventory manager, quality manager, and direct labor evaluated supplier quality involvement. Quality manager, production manager and plant superintendent assessed top management leadership for quality. The measurement scales of quality management practices are constructed by four to eight question items evaluated on a seven-point Likert scale (1=Strongly disagree, 4=Neither agree nor disagree, 7=Strongly agree). Individual question items are shown in the appendix.

Competitive performance was evaluated by quality manager. He or she subjectively judged the competitive position of his/her plant on seven-point Likert scale (1= Significantly worse, 2= Worse, 3= A little worse, 4= About the same, 5= A little better, 6= Better, 7= Significantly better).

Table 2: Characteristic of survey's respondents

| **Industry** | US | Japan | Germany | Italia | Korea | Total |
|---|---|---|---|---|---|---|
| Electrical & Electronic | 9 | 10 | 9 | 10 | 10 | 48 |
| Machinery | 11 | 12 | 13 | 10 | 10 | 56 |
| Automobile | 9 | 13 | 19 | 7 | 11 | 59 |
| Total | 29 | 35 | 41 | 27 | 31 | 163 |
| **Plant characteristics** | | | | | | |
| Average Market Share (%) | 25.50 | 25.05 | 30.21 | 23.38 | 31.54 | |
| Average Sale ($000) | 284.181.0 | 1.118.492.0 | 1.736.23.3 | 71.209.0 | 2.266.962.3 | |
| Number of employee* | 480 | 1336 | 598 | 393 | 4965** | |

** Including both salary personnel employee and hourly personnel*
*** Data from 19 plants only*

Table 3: Measure Analysis (pooled sample 5 countries)

| | Alpha | Eigen value | Percentage of variance | TTEM | SGPS | CO3S | FDBK | PCTL | SQIV | TMLQ |
|---|---|---|---|---|---|---|---|---|---|---|
| Customer Involvement (CIVM) | .69 | 2.31 | 46.29 | .330 | .571 | .440 | .507 | .510 | .619 | .383 |
| Task Training for Employee (TTEM) | .79 | 2.46 | 61.47 | 1 | .655 | .536 | .446 | .391 | .341 | .528 |
| Small Group Problem Solving (SGPS) | .82 | 3.14 | 52.35 | | 1 | .643 | .677 | .598 | .533 | .532 |
| Cleanliness and Organization (CO3S) | .80 | 2.82 | 56.34 | | | 1 | .462 | .455 | .452 | .407 |
| Feedback (FDBK) | .80 | 2.79 | 55.83 | | | | 1 | .742 | .627 | .422 |
| Process Control (PCTL) | .82 | 2.95 | 59.03 | | | | | 1 | .594 | .406 |
| Supplier Quality Involvement (SQIV) | .78 | 3.21 | 44.63 | | | | | | 1 | .354 |
| Top management leadership for quality (TMLQ) | .73 | 2.44 | 48.71 | | | | | | | 1 |

*** Correlation is significant at the 0.01 level (2-tailed), * Correlation is significant at the 0.05 level (2-tailed).*

## 5. Measurement Analysis

### 5.1 Reliability

Reliability is an estimate of measurement consistency. In this research, Cronbach's alpha coefficient (Flynn *et al.* [7]) is calculated for each scale to evaluate the reliability. Table 2 shows that alpha values for all scales exceeded the minimum recommended alpha value of 0.6 for newly developed scales (Nunnally, [19]). All the scales have alpha value above 0.75 indicate that the scales were internally consistent.

### 5.2 Validity

The validity of measurement scales can be tested against content, construct.
*Content validity.* An extensive review of literature and empirical researches was undertaken about quality management practices, production management and organization performance to ensure content validity. This research follows the works of Flynn, *et al.* [8], and Matsui [17] that developed and tested a set of measurement scales of quality management.
*Construct validity.* Construct validity was conducted to ensure that all question items in a scale all measure the same construct. Within-scale factor analysis was tested with the following criteria: 1) uni-dimensionality, 2) a minimum eigenvalue of 1, and 3) item factor loadings in excess of 0.4. The results show that all scale had good construct validity. Table 2 shows that eigenvalues of each scale are all more than 2. Factor loading for each item (shown in appendix) is more than 0.4, mostly ranged between 0.7 and 0.9.

Table 4: Quality management practices classified by countries (mean value)

| | United States | Japan | Germany | Italy | Korea | Total 5 countries | F | Sig. |
|---|---|---|---|---|---|---|---|---|
| CIVM | 5.5614 | 4.8906 | 5.3375 | 5.1572 | 5.1911 | 5.2237 | 10.919 | .000 |
| TTEM | 5.1635 | 5.1300 | 5.1296 | 5.0438 | 5.3713 | 5.1675 | 1.133 | .343 |
| SGPS | 5.3275 | 4.9200 | 4.9591 | 4.8673 | 5.0163 | 5.0119 | 2.632 | .036 |
| CO3S | 5.3888 | 5.2618 | 5.4090 | 5.2870 | 5.4550 | 5.3624 | .572 | .683 |
| FDBK | 5.0470 | 4.8433 | 4.6147 | 4.6044 | 5.1393 | 4.8388 | 2.698 | .033 |
| PCTL | 4.7649 | 4.6272 | 4.9523 | 4.7363 | 4.8971 | 4.8029 | .963 | .429 |
| SQIV | 5.0612 | 4.8310 | 4.7515 | 5.0228 | 5.2035 | 4.9546 | 4.940 | .001 |
| TMLQ | 5.8308 | 5.6243 | 5.4856 | 5.4619 | 5.3616 | 5.5493 | 2.642 | .036 |

After testing data for reliability and validity, the quality management practices were compared to investigate country effect. One- way analysis of variance (ANOVA) was used to identify the similarity and differences across the countries as shown in table 5. We found that, there were significantly differences in five practices among the five countries. These practices are Customer Involvement (CIVM), Small Group Problem Solving (SGPS), Supplier Quality Involvement (SQIV), and Top Management Leadership for Quality (TMLQ). It was found that Task-Related Training for Employees (TTEM) Process Control (PCTL), Feedback (FDBK) and Cleanliness and Organization (CO3S) are similar across the countries. Again, this analysis provides statistical evidence that manufacturing plants are similar in process management (including process control, utilization of quality information, maintaining 5S activities). The largest difference exists in aspects associate with customer and supplier.

Extending the results of ANOVA analysis, the authors examine the specific differences that exist among the four countries by using post-hoc Tukey test as shown in Table 6. The results reveal the statistical similarities in quality management between US and Germany; between Italia and other countries like Germany, Japan, and Korea. The authors found that Process Control (PCTL), Cleanliness and Organization (CO3S), Feedback (FDBK), and Task -Related Training for Employee (TTEM) are very similar across the countries. The most significant differences between the countries exist in followings practices:

- Customer Involvement (CIVM) - between US and Japan, Italia and Korea, between Japan and Germany and Korea
- Small Group Problem Solving (SPSG) - between US and Italia
- Supplier Quality Involvement (SQIV)-between Korea and Japan and Germany
- Top Management Leadership for Quality (TMLQ)-between US and Korea

As a result, we reject the null hypothesis H1 and conclude that there are significant differences among the assessment for practices of quality management in Japan, the United States, and Korea.

Table 5: Tukey test values for country comparison

| | US vs. JPN | US vs. GER | US vs. KOR | US vs. ITA | JPN vs. GER | JPN vs. KOR | JPN vs. ITA | GER vs. KOR | GER vs. ITA | ITA vs. KOR |
|---|---|---|---|---|---|---|---|---|---|---|
| CIVM | .000 | .195 | .008 | .004 | .000 | .037 | .107 | .597 | .429 | .998 |
| TTEM | 1.000 | .999 | .708 | .954 | 1.000 | .533 | .984 | .495 | .982 | .286 |
| SGPS | .062 | .094 | .276 | .040 | .999 | .967 | .997 | .995 | .973 | .883 |
| CO3S | .926 | 1.000 | .994 | .973 | .926 | .841 | .715 | 1.000 | .932 | .842 |
| FDBK | .870 | .216 | .993 | .285 | .761 | .609 | .800 | .070 | 1.000 | .115 |
| PCTL | .958 | .867 | .968 | 1.000 | .390 | .643 | .983 | .998 | .808 | .939 |
| SQIV | .322 | .067 | .784 | .998 | .952 | .018 | .531 | .001 | .161 | .614 |
| TMLQ | .664 | .143 | .028 | .166 | .862 | .413 | .839 | .914 | 1.000 | .971 |

## 6. Effect of Quality Management Practices on Competitive Performance

The relationship between the quality management practices and quality performance indexes was tested by stepwise regression. Independent variables are eight quality management practices and dependent variables are four competitive performance indexes.

### 6.1 Manufacturing cost as independent variable

Firstly, the authors examine relationship between quality practices and quality performance with the whole sample data from fiver countries. Regression results shown in Table 6 reveal that Process Control (PCTL) and Small Group Problem Solving (SGPS) were found as primary determinant for improving manufacturing cost. They are accounts for twelve percent of variability of Manufacturing Cost. Applying the same method for analyzing data from member countries, effects of quality management on manufacturing cost were found and shown in Table 6. The authors found the statistical evidence of significant impact of quality practices on manufacturing cost in data from Japanese and German plants. In Japanese plants, Process Control (PCTL) explains twenty-four percent of variability of Manufacturing Cost. In German plants, Process Control (PCTL) explains nine teen percent of variability of Manufacturing Cost.

Table 6: Impact of quality management on manufacturing cost

| | **5 countries** | **US** | **Japan** | **German** | **Italia** | **Korea** |
|---|---|---|---|---|---|---|
| R | .364 | | .516 | .426 | | |
| $R^2$ | .133 | | .267 | .213 | | |
| Adjusted $R^2$ | .121 | | .242 | .191 | | |
| F | 10.942 | NS | 10.900 | 9.750 | NS | NS |
| Sig. | .000 | | .002 | .004 | | |
| Df. | 15 | | 31 | 37 | | |
| Constant | .616 | | -.084 | .667 | | |
| Predictor | PCTL (.206/. 015) | | PCTL (.516 / .002) | PCTL (.462 / .004) | | |
| | SGPS (.235/.006) | | | | | |

*NS: non- significant*

### 6.2 Quality as independent variable

The statistical results point out significant impact of quality management on conformance quality as shown in Table 7. At the whole sample, Task-Related Training for Employee and Top Management Support Quality account for twelve percent of variability of conformance quality. Further test for German, Italian, and Korean data, Task-Related Training for Employee (TTEM) was also found as primary predictor for quality conformance improvement. Testing for Japanese data, Cleanliness and Organization (CO3S) significantly explains seventeen of variability of conformance quality.

Table 7: Impact of quality management on conformance quality

| | 5 countries | US | Japan | German | Italia | Korea |
|---|---|---|---|---|---|---|
| R | .364 | NS | .413 | .366 | .621 | .529 |
| $R^2$ | .133 | | .170 | .134 | .385 | .280 |
| Adjusted $R^2$ | .121 | | .144 | .110 | .361 | .248 |
| F | 11.104 | | 6.363 | 5.564 | 15.668 | 8.565 |
| Sig. | .000 | | .017 | .024 | .001 | .008 |
| Df. | 147 | | 32 | 37 | 26 | 23 |
| Constant | 1.357 | | 1.246 | 2.172 | .084 | .579 |
| Predictor | TTEM (.206/.028) | | CO3S (.413 / .017) | TTEM (.366 / .024) | TTEM (.621 / .001) | TTEM (. 529 /.008) |
| | TMLQ (.207/.027) | | | | | |

*NS: non- significant*

### 6.3 Delivery as independent variable

The authors found the significantly impact of Customer Involvement (CINV) on delivery performance in pooled sample data and from US, Japanese, and German data. Additionally, Process Control (PCTL) and Task-Related Training for Employee (TTEM) were found as primary predictors for improving delivery performance (pooled sample).

Table 8: Impact of quality management on on-time delivery

| | 5 countries | US | Japan | German | Italia | Korea |
|---|---|---|---|---|---|---|
| R | .427 | .515 | .389 | .418 | .540 | NS |
| $R^2$ | .183 | .265 | .151 | .175 | .292 | |
| Adjusted $R^2$ | .166 | .234 | .124 | .152 | .264 | |
| F | 10.731 | 8.649 | 5.533 | 7.618 | 10.307 | |
| Sig. | .000 | .007 | .025 | .009 | .004 | |
| Df. | 147 | 25 | 32 | 37 | 26 | |
| Constant | -.109 | -.857 | -1.558 | -.407 | 1.020 | |
| QM | CIVM (.181/.042) | CIVM (.515/ .007) | CIVM (.389 / .025) | CIVM (.418 / .009) | CIVM (.540 / .004) | |
| Predictor | TTEM (.196/.018) | | | | | |
| | PCTL( .177/.050) | | | | | |

*NS: non- significant*

### 6.4 Flexibility as independent variable

The authors found significant impact of quality management on volume flexibility in pooled sample, Japanese, German, Italian, and Korean data. Cleanliness and Organization (CO3S), Top Management Leadership for Quality (TMLQ), Task-Related Training for Employee (TTEM) and Process Control (PCTL) were found as significant determinant for improving volume flexibility.

Table 9: Impact of quality management on volume flexibility

| | 5 countries | US | Japan | German | Italia | Korea |
|---|---|---|---|---|---|---|
| R | .471 | *NS* | .669 | .608 | .498 | .590 |
| $R^2$ | .222 | | .448 | .369 | .248 | .348 |
| Adjusted $R^2$ | .211 | | .411 | .333 | .218 | .319 |
| F | 20.689 | | 12.154 | 10.255 | 8.259 | 11.571 |
| Sig. | .000 | | .000 | .000 | .008 | .002 |
| Df. | 147 | | 32 | -.163 | 26 | 23 |
| Constant | .106 | | -2.785 | 37 | .454 | -.389 |
| Predictor | CO3S (.331/.000) | | CO3S (.350 / .026) | CO3S (.386 / .014) | CO3S (.498 / .008) | TTEM (.590 / .002) |
| | TMLQ (.227/.005) | | PCTL ( .442 / .006) | TMLQ (.333 / .032) | | |

*NS: non- significant*

The regression results support the hypothesis H2 that quality management has significant impact on competitive performance. However, results of stepwise regression analysis show that there are different success factors for improving quality performance across the countries as summarized in the Table 10, therefore we reject hypothesis H3 and state that there are significant differences in the impact of quality management practices on competitive performance across the countries.

Table 10: Summary of significant determinant of improving competitive performance

| | Manufacturing Cost | Conformance Quality | On-time Delivery | Volume Flexibility |
|---|---|---|---|---|
| Customer Involvement (CIVM) | | | 5,U,J,G,I | |
| Task Training for Employee (TTEM) | | 5,G,I,K | 5 | K |
| Small Group Problem Solving (SGPS) | 5 | | | |
| Cleanliness and Organization (CO3S) | | J | | 5,J,G,I |
| Feedback (FDBK) | | | | |
| Process Control (PCTL) | 5,J,G | | 5 | J |
| Supplier Quality Involvement (SQIV) | | | | |
| Top management leadership for quality (TMLQ) | | 5 | | 5,G |

## 7. Discussion

In the previous sections, we presented a result of empirical study about effect of quality management on quality performance in manufacturing plants. We proposed a simple analytical framework for study quality management and competitive performance and thereby established three hypotheses on quality management. Then, based on literature, we proposed eight measurement scales concerning quality management and all of eight measurement scales -Cleanliness and Organization (CO3S), Customer Involvement (CINV), Process Control (PCTL), Top Management Leadership for Quality (TMLQ), Feedback (FDBK), Supplier Quality Involvement (SQIV), Task-related Training for Employees (TTEM), and Small Group Problem Solving (SGPS)- are satisfactory in terms of reliability and validity for the data set of one hundred and sixty-three manufacturing plants in five countries. Using these scales, the authors examined country's effect in quality management system to explore the critical success factors of quality management. The main conclusions we derive from a series of statistical analyses are summarized below.

- There are minor differences in quality management practices across the countries in term of support of top management for quality, involving customer in production and design process, involving supplier in quality improvement, and participation of employees in small group activities. The similarities in quality management practices across the countries exist in the activities related to process management; utilization of information feedback; keeping the workstation clean and well organized; and training for employees.
- Quality management has significant impact on competitive performance for the whole data sample and for each country data: US, Japan, Germany, Italia, and Korea. In the global basic, Customer Involvement (CIVM), Cleanliness and Organization (CO3S), Task Related Training for Employee (TTEM), and Top Management Leadership for Quality (TMLQ), were identified as the primary determinants for improving competitive performance. Process Control (PCTL) was identified as key predictor for reducing manufacturing cost. Task related Training for Employee (TTEM) was identified as key predictor for improving conformance quality. Customer Involvement (CINV) was found as key predictor for delivery performance. Cleanliness and Organization (CO3S) was identified as significant success factor for improving flexibility.
- The statistical results reveal the similarity and difference in quality management practices and their impact on competitive performance across the countries. In general, the authors found the similarity between Japanese and German plants. Japanese and German plants show significant impact of quality practices on every aspect of competitive performance. The common primary determinants of competitive performance in Japan and German are Process Control (PCTL), Customer Involvement (CIVM), and Cleanliness and Organization (CO3S). Italian plants show significant impact of Task-related Training for Employees (TTEM), Process Control (PCTL) and Cleanliness and Organization (CO3S) on quality, delivery, and flexibility respectively. Korean plants show significant impact of only one human factor on quality and flexibility - Task-related Training for Employees (TTEM). It could be explained because of Korean plants' size. The large number of employee is utilized probably to make the plants pay more attention on job training, and allow the massive participation on small group problem solving activity. In US plants, significant determinant for delivery performance is Customer Involvement (CIVM), which is the practice that differentiates US's quality management with other countries.
- In term of competitive performance, Japanese and Germany plants show that all the aspect of competitive performance are significantly affected by quality management practices. The number of aspect of competitive

performance that was significantly affected by quality management practices in Italian, Korean and US plants are three, two and one, respectively. From these statistical results, it is possible to conclude that the impact of quality management on quality performance in Japanese and German plants is statistically stronger than in Italia, Korean and US plants. Quality management is emphasized in Japanese and German plants as competitive weapon.

- Regression results highlight some primary significant predictors for quality performance such as Cleanliness and Organization (CO3S), Customer Involvement (CIVM), Process Control (PCTL), and Top Management Leadership for Quality (TMLQ). They are important determinants for competitive performance. However, it does not mean that other practices like Supplier Quality Involvement (SQIV) and Feedback (FDBK) are not important. In this study, competitive performance is evaluated by comparing the plant's performance to its competitor in the global basic. Thus, for global competition by quality, implementation of such activities like Supplier Quality Involvement (SQIV) and Feedback (FDBK) is important but insufficient, since correlation analysis reveals that the manufacturing plants are paying the same degree of attention on Supplier Quality Involvement (SQIV) and Feedback (FDBK).

## 8. Limitation and Future Research

One of the limitations of this study is that data was gathered from relatively a small number of manufacturing plants. The expansion of survey population might help to find out more information that is useful. Further research for more comprehensive structure of quality management and competitive performance is supposed to be necessary and fruitful. Path analysis modeling techniques can be used to assess direct and indirect effect of each quality management practice and its infrastructure on competitive performance. Additional research should be undertaken concerning the requirements of quality management regarding its interaction with other management system such as human resource, manufacturing strategy, etc. Impact of contextual factors on quality performance in manufacturing plants should be a topic for future research.

## 9. Conclusion

An analysis of relationship between quality management and competitive performance has been conducted and presented in this paper. The research's analytical framework, hypothesizes, data collection and measurement has been presented. The results of this study prove the significant impact of quality management practices on competitive performance. The main findings of this study are the significant differences on quality management practices and their significant impact on different aspects of competitive performance across the countries. This study highlights significant impact of customer involvement, support from top management, cleanliness and organization...for improving competitive performance.

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## Appendix -Question items of quality management scales

(Value inside bracket show factor loading for each question item)

**Cleanliness and Organization**

Our plant emphasizes putting all tools and fixtures in their place (0.69)
We take pride in keeping our plant neat and clean (0.85)
Our plant is kept clean at all times (0.86)
Employees often have trouble finding the tools they need (0.57)
Our plant is disorganized and dirty (0.79)

**Feedback**

Charts showing defect rates are posted on the shop floor (0.71)
Charts showing schedule compliance are posted on the shop floor (0.71)
Charts plotting the frequency of machine breakdowns are posted on the shop floor (0.68)
Information on quality performance is readily available to employees (0.81)
Information on productivity is readily available to employees (0.76)

**Process Control**

Processes in our plant are designed to be “foolproof” (0.75)
A large percent of the processes on the shop floor are currently under statistical quality control (0.84)
We make extensive use of statistical techniques to reduce variance in processes (0.81)
We use charts to determine whether our manufacturing processes are in control (0.70)
We monitor our processes using statistical process control (0.87)

**Customer Involvement**

We frequently are in close contact with our customers (0.69)
Our customers seldom visit our plant (removed)
Our customers give us feedback on our quality and delivery performance (0.70)
Our customers are actively involved in our product design process (0.58).
We strive to be highly responsive to our customers’ needs (0.72)
We regularly survey our customers’ needs (0.71)

**Supplier Quality Involvement**

We strive to establish long-term relationships with suppliers (0.64)
Our suppliers are actively involved in our new product development process (0.72)
Quality is our number one criterion in selecting suppliers (0.55)
We use mostly suppliers that we have certified (0.61)
We maintain close communication with suppliers about quality considerations and design changes (0.80)
We actively engage suppliers in our quality improvement efforts (0.77)
We would select a quality supplier over one with a lower price (removed)

**Top Management Leadership for Quality**

All major department heads within the plant accept their responsibility for quality (0.72)

Plant management provides personal leadership for quality products and quality improvement (0.82)

The top priority in evaluating plant management is quality performance (0.52)

Our top management strongly encourages employee involvement in the production process (0.63)

Our plant management creates and communicates a vision focused on quality improvement (0.79)

Our plant management is personally involved in quality improvement projects (0.77)

**Small Group Problem Solving**

During problem solving sessions, we make an effort to get all team members' opinions and ideas before making a decision (0.64)

Our plant forms teams to solve problems (0.80)

In the past three years, many problems have been solved through small group sessions(0.78)

Problem solving teams have helped improve manufacturing processes at this plant (0.78)

Employee teams are encouraged to try to solve their own problems, as much as possible (0.65)

We don't use problem solving teams much, in this plant (0.72)

**Task-Related Training for Employees**

Our plant employees receive training and development in workplace skills, on a regular basis (0.87)

Management at this plant believes that continual training and upgrading of employee skills is important (0.76)

Employees at this plant have skills that are above average, in this industry (0.58)

Our employees regularly receive training to improve their skills (0.89)

Our employees are highly skilled, in this plant (removed)