Organizational Culture and Quality Practices in Six Sigma

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ABSTRACT

Using data collected from a sample of 226 manufacturing plants, we examine how organizational culture is related to quality practices associated with Six Sigma implementation. Structural equation modeling is used to analyze the relationships between four cultural orientations as defined by the competing values framework and ten quality practices in Six Sigma. The results suggested that three cultural orientations – group culture, developmental culture, and rational culture – are important for implementing the quality practices, and hierarchical culture is not related to any quality practices studied here. Implications of this research are discussed.

Keywords:

Organization Culture, Quality Practices, Six Sigma

1. INTRODUCTION

Quality management programs have been extensively applied around the world, as companies seek to attain and sustain a competitive advantage. Six Sigma is the newest quality management program which helps companies increase both customer satisfaction and financial benefits (Breyfogle, Cupello, and Meadows, 2001; Pyzdek, 1999; Snee, 1999; Tennant, 2001). This quality program seeks to find and eliminate causes of defects or mistakes in business processes by focusing on outputs that are important to customers (Antony and Craig Fergusson, 2004; Snee, 2000). Six Sigma is defined as "an organized and systematic method for strategic process improvement and new product and service development that relies on statistical methods and the scientific method to make dramatic reductions in customer defined defect rates (Linderman, Schroeder, Zaheer, and Choo, 2003, pp 194)."

The Six Sigma successes in major companies including GE, Honeywell, Sony, Caterpillar, and Johnson Controls, promote the adoption of Six Sigma in industry. Nevertheless, as a comprehensive quality program, Six Sigma implementation is a complicated process which requires substantial changes in the way that companies operate and involves many problematic issues. Organizational culture has been recognized as one major factor or challenge to the Six Sigma implementation (Antony and Banuelas, 2002; Coronado and Antony, 2002; Kwak and Anbari, 2004).

Organizational culture is viewed as the pattern of values, beliefs, and assumptions shared by members in an organization, which are perceived by the organization as the valid, correct way to perceive and solve problems (Sigler and Pearson, 2000; Schein, 1985, 1992). These shared values, beliefs, and assumptions in the organization bind its employees together and become the manner or strategies through which the organization achieves its goals (Marcoulides and Heck, 1993). In the context of quality management, the values and beliefs underlying an organization's culture are able to shape its philosophy and policies of managing business, which in turn influence the development of the organization's quality management practices (Waldman, 1993). It has been argued that for an organization to realize the value of implementing quality practices, it must have a culture that is capable of fully supporting their implementation (Sousa-Poza, Nystrom, and Wiebe, 2001).

The role that culture plays in influencing an organization's level of quality management practices has received much attention in the literature (e.g., Buch and Rivers, 2001; Klein, Masi, and Weidner, 1995; Zeitz, Johannesson, and Ritchie, 1997). There have been a number of studies that attempted to identify the cultural characteristics conducive to quality management implementation. However, a majority of prior studies treated quality management as a unidimensional construct. As Prajogo and McDermott (2005) found, the studies that examined quality management as a single construct usually focused on the cultural characteristics related to people and flexibility, and overlooked the potential effect of cultural characteristics about control and standardization.

Much of the quality management research to date has found that quality management is a multidimensional construct which is composed of multiple quality practices (Flynn, Schroeder, and Sakakibara, 1995; Kaynak, 2003). These quality practices have different functions and roles regarding continuous improvement. For example, a typical quality practice – workforce management – is to use the entire capacity of workers and to encourage employee commitment to organizational continuous improvement efforts (Flynn, Schroeder, and Sakakibara, 1995). Workforce management emphasizes the organizational and people side of quality management and uses a variety of techniques to facilitate changes, such as employee participation in decisions, employee recognition, teamwork, and the use of effective communications to create an awareness of organizational goals (Kaynak, 2003). Another typical quality practice – process management – is concerned with using statistical and scientific techniques to reduce process variation, which represents the methodological and technical side of quality management.

Considering the different features of the quality practices, it is very possible that cultural characteristics that support a certain type of quality practice differ from those cultural characteristics that support other types of quality practices. However, there are relatively few studies that examine the different effect of cultural characteristics on different quality practices. Several studies (e.g., Chang and Wiebe, 1996; Dellana and Hauser, 1999; Lagrosen, 2003, Prajogo and McDermott, 2005) that appeared recently are the exceptions in the quality management literature. Prajogo and McDermott (2005), for example, compare a unitarist model of quality management (i.e., that considers quality management as a single construct) with a pluralist model which considers quality management with its multidimensional elements. Based on the data drawn from 194 Australian companies, they find that the pluralist model better describes the relationship between culture and quality management, which indicates that different cultures are associated with different elements of quality management.

Empirical research examining implementation of Six Sigma relative to culture is particularly sparse in today's literature (Goffnett, 2004). The purpose of this study is to add an understanding of the effect of organizational culture on Six Sigma by empirically investigating the relationship between culture and quality practices associated with Six Sigma implementation in US manufacturing companies. This study builds on the literature (e.g., Prajogo and McDermott, 2005) to explore how different cultures affect different quality practices in Six Sigma. The paper is organized as follows: it begins with a section discussing quality practices in

Six Sigma, the organizational culture framework used in this study, and prior studies using this framework to examine culture and quality management. Then research methodology section presents data collection procedures and data analysis methods and results. Finally, discussion of the findings is presented, followed by implications for management and conclusions.

2. LITERATURE REVIEW

2.1. Quality Practices in Six Sigma

As defined by Dean and Bowen (1994), a quality management program can be characterized by its principles, practices, and techniques. The principles provide general guidelines, which are implemented through the practices that are supported by several techniques. When empirically evaluating the degree to which an organization implements a quality program, the quality practices should be the operationalizable construct to be examined because quality practices are the observable components of the quality program, through which managers work to achieve continuous improvements (Sousa and Voss, 2002). In comparison, principles are too general for empirical research and techniques are too detailed to obtain reliable results (e.g., one quality practice may be implemented by various optional techniques) (Sousa and Voss, 2002).

We reviewed both the academic and practitioner literature to identify key quality practices in Six Sigma. While industry is increasingly adopting Six Sigma, there is very little academic research on Six Sigma practices. Lee (2002) identified several critical factors for successful Six Sigma implementation, such as a previous quality program adoption, top management leadership, managerial processes, the Black Belt's background, full-time and part-time Black Belts, Six Sigma training programs, and statistical and analytical tool usage. Based on a survey of UK companies, Antony and Banuelas (2002) found that the key ingredients for

Six Sigma implementation include management involvement and commitment, understanding of the Six Sigma methodology, and linking Six Sigma to business strategy.

Much of the Six Sigma literature published is written by practitioners who worked in major companies that used Six Sigma, including GE, Motorola, Honeywell, etc. For example, Pande, Neuman, and Cavanagh (2000)'s "The Six Sigma Way" was written based on the authors' experiences in companies such as GE and Motorola. It offers an executive overview of Six Sigma, which includes how to adapt an organization to Six Sigma and a roadmap and tools for executing this adaptation. Similar Six Sigma frameworks are provided by Breyfogle et al. (2001)'s "Smarter Six Sigma Solutions (S4) approach" and Bhote (2003)'s "Ultimate Six Sigma." This set of literature provides a basic representation of the common practices in Six Sigma programs used in today's industry, which is also used in this study to identify quality practices associated with Six Sigma implementation. The key practices are discussed below.

Top management support. Senior managers' support for Six Sigma determines the degree to which other quality practices are implemented (Breyfogle, et al., 2001; Henderson and Evans, 2000). During the process of adopting a Six Sigma program, new rules need to be set up, new procedures need to be followed, and new tools need to be learned. Companies often encounter instability, confusion, and resistance in this process. Managers' consistent involvement in Six Sigma activities enables the restructuring of business processes and facilitates changing employees' attitudes toward continuous improvement through the unstable transformation period (Bhote, 2003; Hendricks and Kelbaugh, 1998). Some companies link managers' compensation to their efforts and performance in Six Sigma implementation, which helps to reduce the risk of managers' having a temporary but quickly fading zeal for quality improvement and to ensure a consistent and high level of top management support for Six Sigma (Antony and Banuelas, 2002; Breyfogle et al., 2001; Johnson and Swisher, 2003).

Customer relationship. To achieve quality, it is critical to understand what customers want and to provide products or services that meet their needs and expectations (Ishikawa, 1985; Hackman and Wageman, 1995). Factors important to customers' perception of quality are taken into consideration when companies select, design, and execute a Six Sigma improvement project. A formal evaluation system of customer requirements is needed as a platform for customers to input their voices, using techniques such as customer survey, meetings with customers, and customer visits to the plant (Pande et al., 2000). Critical-to-customer characteristics can be translated into metrics which are then used to define the goal of a project, to monitor its progress, and to evaluate its outcomes (Bhote, 2003). Customer relationship is strengthened if top management takes time to visit the major customers and employees have access to the customers' voice in order to understand the importance of customers and to integrate customer requirements into their daily jobs (Breyfogle et al., 2001).

Supplier relationship. Suppliers' involvement in Six Sigma helps to provide a high quality of products and services to the ultimate customers. Companies put emphasis on obtaining significant benefits from Six Sigma projects, which requires them to explore more avenues for improving quality, including those related to their suppliers. A supplier selection system is set up based on quality considerations and whether suppliers are wiling to cooperate, which helps to establish a long-term working relationship between the company and a small number of its suppliers. In addition, Six Sigma encourages companies to engage their suppliers at the early stage of improvement projects, i.e., early supplier involvement (ESI) (Bhote, 2003). ESI allows parallel development of product and service design in an iterative interaction with the suppliers (Bhote, 2003).

Workforce management. The Six Sigma implementation needs a competent and supportive workforce who is willing to participate in the organization-wide improvement efforts (Bhote, 2003; Pande et al., 2000). In Six Sigma, management policies are taken to strengthen job security, to motivate employees to speak out with ideas, and to provide employees technical and psychological supports (Bhote, 2003). For example, a policy that links employees' performance in Six Sigma projects with their compensation and promotion motivates them to participate in and contribute to Six Sigma (Henderson and Evans, 2000). Also, continual education and training to management and employees assist companies to develop knowledge and skills of its employees for effective quality improvement (Breyfogle et al., 2001; Gale, 2003). It is important that companies manage the workforce in conjunction with a Six Sigma green and black belt system, which is a role structure unique to Six Sigma, in the areas of employee deployment and training. The Six Sigma role structure is discussed later.

Quality information. Six Sigma relies on using extensive data and information to detect and solve problems (Breyfogle, et al., 2001). Information and data are collected relating to customer needs and expectations, business processes, and products and services, which are then analyzed to generate improvement ideas, examine improvement activities, and evaluate and maintain improvement outcomes. Effective use of quality information in Six Sigma is connected with the metrics used in Six Sigma, which is discussed later. Six Sigma emphasizes linking quality improvement with bottom-line benefits and thus the metrics incorporate bottom-line performance measures with the measures of quality defects. To provide appropriate data for evaluating those metrics, the content of quality information must include both operational and financial data (Breyfogle et al., 2001).

Product/service design. To achieve improved quality, it is important to design products for manufacturability and design quality into products and services (Flynn et al., 1995; Kaynak, 2003). Cross-functional teams, consisting of design, manufacturing, and marketing functions, are formed to reduce the number of parts per product, to standardize the parts, and to focus on improving manufacturing processes (Ahire and Dreyfus, 2000). Moreover, Six Sigma applies Design for Six Sigma (DFSS) in the design process. A feature of DFSS is to use a structured, standardized product development procedure, e.g., Plan-Identify-Design-Optimize-Verify (PIDOV) (Brue, 2003). Also, DFSS emphasizes satisfying customer needs with a product/service design that utilizes materials, technologies, and manufacturing processes that are also financially beneficial for the organization (Creveling, Slutsky, and Antis, 2003). A comprehensive set of tools are used in DFSS, such as phase-gate project reviews, benchmarking, measurement system analysis, voice of the customer, Quality Function Deployment (QFD), Pugh concept selection technique, design failure modes and effects analysis, and so forth (Antony, 2002; Creveling, Slutsky, and Antis, 2003).

Process management. Six Sigma emphasizes reducing the variability of the processes that manufacture products and deliver services. Process management means ongoing improvement to manufacturing, transactional, and/or service processes to satisfy customers' needs and expectations by using preventive maintenance, workplace organization, and use of line-stop capability (Flynn et al., 1995; Breyfogle et al., 2001). Six Sigma emphasizes conducting process improvement as projects (Coronado and Antony, 2002). Companies work on improvement projects to solve problems in the processes that critical to customer satisfaction and the organization's strategic goals (Snee and Hoerl, 2003). The potential bottom-line benefits of the project are identified during the project planning period, and the project is continually reviewed throughout the process to evaluate whether the expected benefits are fulfilled.

Six Sigma role structure. The Six Sigma green and black belt system is the role structure used to develop and manage employees by clearly defining their roles and responsibilities for continuous improvement. The employees are classified into the levels of champion, master black belt, black belt, and green belt, based on their knowledge and experience regarding quality management (Slater, 2000). Typically, champions are usually executive-level managers who promote and lead the deployment of Six Sigma in a significant area of the business; master black belts are statistical experts who are quality leaders responsible for Six Sigma strategy, training, mentoring, deployment, and results; black belts work as project managers and facilitators who lead improvement teams, work on projects across the business, and mentor green belts; green belts, who have some quantitative skills as well as teaching and leadership ability, manage the processes of the Six Sigma projects and are responsible for ensuring the smooth improvements of the processes, communicating process knowledge, obtaining necessary approval for any process changes, selecting team members, and maintaining team motivation and accountability (Breyfogle et al., 2001). Six Sigma improvement projects are carried out by teams composed of members performing the above roles (Harry, 2000; Henderson and Evans, 2000). This role structure clarifies the employees' roles so that they know their responsibilities and their benefits from their participation in continuous improvement efforts, which may increase the employees' contribution to Six Sigma (Breyfogle et al., 2001). Also, this role structure requires that each belt receives training in leadership skills, technical skills, and soft skills (e.g. communication, mentoring, etc.) that are commensurate with their ranks (Snee and Hoerl, 2003). Six Sigma includes offering differentiated training programs to employees to increase training effectiveness (Linderman et al., 2003).

Structured improvement procedure. Six Sigma uses a formalized, rigorous procedure to conduct improvement projects, which is Define-Measure-Analysis-Improve-Control (DMAIC) (Pande et al., 2000). DMAIC is a standardized process that consists of specific problem-solving steps with recommended statistical and non-statistical tools in each step (Choo, Linderman, and Schroeder, 2004). This procedure provides a methodological framework to assist members of improvement teams to select possible projects, to design resolutions that are sustainable once applied, and to understand how certain quality tools should be used in each improvement phase to produce an output that can be acted on (Devane, 2004).

Focus on metrics. Six Sigma emphasizes using metrics to generate and control actions where improvements are needed. Six Sigma integrates the traditional quality metrics with some additional metrics to create a more comprehensive measurement system for quality management. The statistical meaning of Six Sigma, 6σ is a measure for evaluating process quality, which means 3.4 Defects per Million Opportunities (DPMO). Typical Six Sigma metrics include defects per unit (DPU), proportion defective, throughput yield, rolled throughput yield, and so forth. These metrics evaluate how well a process is performing in order to direct where and how to conduct appropriate improvement activities, and they evaluate improvement outcomes as well (Breyfogle, et al., 2001; Dasgupta, 2003). Six Sigma uses the metrics with three features. First, the metrics and relevant tools are integrated with Six Sigma's structured improvement procedure. Throughout the DMAIC's five steps, metrics are used to select a project, to develop a project plan, to collect and analyze data, and to evaluate project outcomes. This integration of metrics and tools into the formalized DMAIC procedure is unique to Six Sigma (Linderman et al., 2003).

Second, when developing metrics for project selection and evaluation, Six Sigma takes business-level performance measurement into account (Gupta, 2004). For example, in their Six Sigma framework, Breyfogle et al. (2001) suggest incorporating a balanced scorecard as a performance measurement tool. The balanced scorecard, first introduced by Kaplan and Norton (1996), attempts to "integrate financial and nonfinancial strategic measure variables in a cause-and-effect relationship such as "measures of organizational learning and growth" to "measures of internal business processes" to "measures of the customer perspective" to "financial measures (Nørreklit, 2003, p 591)." By connecting operational performance with financial and marketing performance, Six Sigma metrics help companies make decisions through a systematic consideration of both short- and long-term performance, and nonfinancial and financial performance. Third, Six Sigma metrics are clearly defined and measured to provide clear, explicit, and challenging goals for continuous improvement (Linderman et al., 2003). In Six Sigma, goal setting begins in the early phases of a Six Sigma improvement project. Data are collected from the process for the computation of baseline process performance measures like DPMO and/or Process Sigma (Linderman et al., 2003).

2.2. Framework of Organizational Culture

To describe the values and beliefs underlying an organization's culture, we adopt the competing values framework (CVF) developed by Quinn and Rohrbaugh (1981), which has been widely used to examine organizational culture in the literature (e.g., Denison and Spreitzer, 1991; Henri, 2004; Quinn and Kimberly, 1984; Quinn and McGrath, 1985; Zammuto and Krakower, 1991). According to Quinn and Kimberly (1984), the value orientations in the CVF can be used to explore the deep structures of organizational culture about compliance, motives, leadership, decision making, effectiveness, and organizational forms in the organization. Thus, this framework is able to organize the different patterns of shared values and assumptions that define an organization's culture (Denison and Spreitzer, 1991).

Figure 1 shows the two dimensions upon which the competing values framework is based. The first dimension, a flexibility-control dimension reflects the extent to which an organization focuses on change and stability. Focus on flexibility indicates the organization's desire for flexibility and spontaneity, while focus on control indicates its complementary desire to stay stable, controlled, and in order. The second dimension, an internal-external dimension reflects the organization's focus on the internal organization and the external environment. An internal focus means that the organization emphasizes maintaining and improving the existing organization, whereas an external focus means that the organization focuses on competing, adapting to, and interacting with the external environment ((Denison and Spreitzer, 1991).

=== Insert Figure 1 about here. ===

The two dimensions result in four types of cultural orientations: a group culture, a developmental culture, a rational culture, and a hierarchical culture. Each of the four cultural orientations represents different values about motivation, leadership, and strategic orientation in organizations. An assumption of the competing values framework is that the four cultural orientations are ideals and organizations seldom reflect only one type of cultural orientation, but instead their culture is a combination of the four cultural orientations (Denison and Spreitzer, 1991). As McDermott and Stock (1999) and other studies have found, the four cultural orientations do not exclude each other. The organization's emphasis on the four cultural orientations may vary independently (Quinn and Spreitzer, 1991). For the purpose of this study, the competing values framework allows the examination of how the degree to which an organization emphasizes each of the four cultural orientations influences the quality practices.

The group culture focuses on flexibility and internal integration. Organizations emphasizing a group culture tend to value belongingness, trust and participation. The strategies used in these organizations concentrate on the development of human relations and member commitment. The leaders encourage teamwork, empowerment and concerns for employee ideas. The developmental culture emphasizes flexibility and external orientation. Organizations with emphasis on this cultural orientation tend to focus on growth, resource acquisition, creativity, and adaptation to the external environment. The strategies used to manage business include innovation, resource acquisition, and the development of new market. Leadership styles in such organizations are entrepreneur- and innovator-type. The rational culture is focused on the external environment and control. Organizations with emphasis on a rational culture encourage competition and the successful achievement of well-defined goals. The strategies are oriented toward efficient planning and control of production to achieve competitive advantages and high productivity. The leaders tend to be directive, goal-oriented, and functional. The hierarchical culture emphasizes stability and internal integration. It stresses centralization and regulations. The strategies emphasize clear rules, close control, and routinization. The leaders are conservative and cautious.

Recently, researchers began to apply the CVF to evaluate the effect of culture on quality management (e.g., Al-khalifa and Aspinwall, 2000 and 2001; Chang and Wiebe, 1996; Dellana and Hauser, 1999; Prajogo and McDermott, 2005). Due to their different research purposes and methods, the prior studies reveal different results. One group of studies which attempt to identify cultures conducive to quality management implementation, asked quality experts to describe the ideal cultural characteristics based on the four cultural orientations of the CVF. These studies usually found that group culture and development culture, two cultural orientations which emphasize flexibility and people in their underlying values, are commonly believed to be the ideal cultural orientations for implementing quality management programs. For example, by interviewing quality experts from the Conference Board Total Quality Management Center, Chang and Wiebe (1996) found that while the ideal culture for quality management reflect the four cultural orientations in the CVF, group culture and developmental culture are considered by the quality experts to be the dominant cultures. Also, a survey of quality experts in Qatar conducted by Al-khalifa and Aspinwall (2000) found that the group culture and developmental culture are thought as ideal for quality management.

On the other hand, another group of studies using the CVF examined the relationship between the four cultural orientations and quality practices. Both using the MBNQA framework and the CVF, Dellana and Hauser (1999) and Prajogo and McDermott (2005) found that group culture and developmental culture are associated with higher level of the MBNQA practices. Moreover, Prajogo and McDermott (2005) also found that besides group culture and developmental culture, other two cultural orientations in the CVF – rational culture and hierarchical culture – influence the implementation of quality practices as well, especially those concerning the application of quality methods and tools for quality control.

3. METHODOLOGY

3.1. Sample and Data Collection

Empirical data was collected through a web-based survey to 878 manufacturing plants covered under the SIC codes between 311 and 339 in the US. The research unit was chosen at the plant level because the quality practices in different plants, even those within the same company, may substantially vary (Flynn et al., 1995). We sought the respondents who were familiar with the implementation of quality management programs in their plants. The survey was conduced by following Dillman (2000)'s Total Design Methodology. Four rounds of emails, with a link to the web survey, were sent to the target sample, with a two-week interval between the first and the second emails, and a one-week interval between the other emails. A total of 226 plants responded to the survey resulting in an overall response rate of 26 percent. The respondents included operations manager, quality manager, director of quality, continuous improvement manager, Six Sigma Master black belt, or Six Sigma black belt. The sample represents a diversity of industries and sizes. A majority of the plants came from industries including transportation equipments (32%); electrical equipments (16%); fabricated metal product (10%); and metal product manufacturing (10%). Approximately 16% of the plants had 100 or fewer employees, 40% of the plants employed between 101 to 500 workers, 15% of the plants had 501 to 1,000 workers, and 29% of the plants had more than 1,000 employees.

To assess the potential of response bias, this study tested the difference of the available variables of the early and late respondents (Kaynak, 2003). The final sample was split into two, depending on the dates they were received. The early group consisted of 161 replies which were received before the fourth email, while the late wave group consisted of 65 replies received after the fourth email. The χ^2 tests were performed on the responses of these two groups yielded no statistically significant differences (at 95% significance level) on the demographic variables including number of employees and the types and length of quality training the respondents received. The t-tests indicated no significant difference between means of the two groups in terms of the quality practices and organizational culture. As a result, there does not appear to be systematic response bias in the demographic, operating, and cultural characteristics of the plants sampled.

3.2. Construction of the Instruments

This study used a discrete, seven-point Likert scale with end points of "strongly disagree (= 1)" and "strongly agree (= 7)" to measure the constructs. The items to measure the quality practices associated with Six Sigma implementation were adapted from prior empirical research on evaluating quality practices (e.g., Anderson, Rungtusanatham, Schroeder, and Devaraj, 1995; Choo, 2003; Douglas and Judge, 2001; Flynn, Schroeder, and Sakakibara, 1994, 1995; Kaynak, 2003) and practitioner publications about Six Sigma (e.g., Bhote, 2003; Breyfogle et al., 2001; George, 2003; Pande et al., 2000, 2002).

We adopted Quinn and Spreitzer's (1991) instrument, which contains 16 Likert-scale items to measure the four cultural orientations in the CVF. Quinn and Spreitzer (1991)'s work established evidence of the satisfactory psychometric property of this instrument using multitrait-multimethod analysis and multidimensional scaling. A follow-up study (Kalliath, Bluedorn, and Gillespie, 1999) further established that this culture instrument has excellent validity and reliability estimates using confirmatory factor analysis.

To refine the measurement scales, operations management and organizational management faculty were consulted. Then, seven quality managers who had many years of experience working in manufacturing plants were interviewed to examine the degree to which these items captured the constructs and how easy or difficult these items were to rate. Several items in the initial questionnaire were revised in response to their comments to provide better coverage of the construct contents and to be easier to read.

3.3. Tests of Interrater Agreement

To assess reliability for survey items, a second respondent was contacted when possible. However, only 31 plants returned a second survey. Interrater agreement was run to assess whether one response agreed with another response in the same plant. The within-group agreement index $r_{wg(j)}$ (j is the number of items of the factor) was used to evaluate interrater agreement. This agreement index represents the 'interchangeability' of respondents. That is, it attempts to determine whether one group member's response is basically identical to another group member's response. A mean $r_{wg(j)}$ of .70 or above is usually accepted as a satisfactory value indicating interrater agreement (James, Demaree, and Wolf, 1993). As shown in Table 1, the $r_{wg(j)}$ value of each factor was greater than 0.7, suggesting the agreement between the raters. In addition, the other statistic recommended as a measure of agreement – the Average Deviation (AD) index was also tested to assess the average within-group deviation (Burke, Finkelstein, & Dusig, 1999). The average ADs in Table 1 were calculated by averaging the AD values of the items of a factor. According to Burke and Dunlap (2002), the upper limit of AD for the 7-point scale used in this study is 1.20. As shown in Table 1, the ADs of the factors range from 0.50 to 0.97, lower than the upper limit, which indicate acceptable interrater agreement (Burke and Dunlap, 2002). The above tests of interrater agreement suggested that in this study, the multiple respondents within a plant agree with each other about the ratings of the interest factors (i.e., one response from the plant is consistent with a second response from the same plant). The satisfactory interrater agreement and the absence of differences between the plants having one versus those having two respondents, the same pattern of agreement can be assumed to exist in the sample. This provides strong support for the reliability of the measures considering that results appear to reflect plans' attributes as opposed to individual idiosyncratic interpretations (Henri, 2004).

=== Insert Table 1 about here. ===

3.4. Tests of Unidimensionality, Reliability, and Validity

This study assessed the unidimensionality first because the analysis of reliability and construct validity are based on the assumption of unidimensionality (Al-Hawari, Hartley, and Ward, 2005; Nunnally & Bernstein 1994). Tests of unidimensionality help to reduce the possibility of misspecifications (Gerbing & Anderson 1988). A Confirmatory Factor Analysis (CFA) was conducted to examine the unidimensionality of each theoretical factor. A Comparative Fit Index (CFI) over 0.90 suggests satisfactory unidimensionality for the factor (Al-Hawari, Hartley, and Ward, 2005). To assess the unidimensionality of the constructs, this study tested the CFA models for each of the 14 factors. As shown in Table 1, the CFI index of each model was greater than 0.90, indicating a good fit of CFA model for each scale. Hence, there is strong evidence of unidimensionality for the measurement used in this study.

We assess reliability using composite reliability (i.e., coefficient omega). In comparison with the internal consistency method of Cronbach's alpha, recent research shows that coefficient omega could provide a more realistic reliability assessment for latent factors measured by multiple items (Bacon, Sayer, and Young, 1995). Computation of Cronbach's alpha assumes unit weights for the items and may underestimate the true construct reliability (Bollen, 1989). In many cases (such as ours), the items do not have equal loadings on their factor. Coefficient omega takes this situation into account and gives unequal weights to the items. Actually, coefficient omega encompasses nonhomogeneous item sets as well as unidimensional sets. If the factor analysis yields a unidimensional structure with equal factor loadings for all items, then weighted omega. gives the same numerical result as coefficient alpha (McDonald, 1999). As shown in Table 1, the coefficient omega values are all above 0.75. Construct reliability hence appears adequate.

CFA was performed using EQS 6.1 on the entire set of items simultaneously to build a measurement model. The overall acceptability of the measurement model can be assessed using fit indices such as the ratio of chi-square to degrees of freedom, CFI (comparative-fit index), NNFI (non-normed fit index), SRMR (standardized root mean square residual), and RMSEA (root mean square error of approximation). Based on the criteria for evaluation of model fit suggested by the literature (Byrne, 1998; Hu and Bentler, 1999), the resulting measurement model had an acceptable model-to-data fit. The χ^2 =2125.39, 1548 degrees of freedom, χ^2 per degree of freedom = 1.37, lower than 2; CFI = 0.94, above the threshold value of 0.90; NNFI = 0.93, above the cut-off value of 0.90; SRMR = 0.048, below the cut-off value of 0.08; and RMSEA = 0.041 with the 90% confidence interval of (0.036, 0.045), below the cut-off value of 0.06.

Convergent validity is assed by examining the significance of item loadings through t-tests (Nunnally and Bernstein, 1994). The result shows that the factor loadings for each item are significantly different from zero. Also, a construct's convergent validity is recognized if its eigenvalue is above 1.0 (Hair, Anderson, Tatham, and Black, 1995). In Table 1, each factor has an eigenvalue greater than 1.0. To establish convergent validity, each indicator must share more variance with its construct than with the margin for error which is associated with it (i.e., the average eigenvalue of each factor is > 0.5). This is verified for each factor as shown in Table 1. Hence, the constructs in this study have satisfactory convergent validity.

To test discriminant validity between the constructs in the model, a series of chi-square difference tests has been performed between two constructs by constraining the estimated correlation parameter to 1.0 (Anderson and Gerbing, 1988). A significant lower chi-square value for the unconstrained model provides support for discriminant validity (Bagozzi, Yi, and Phillips, 1991). For every pair of constructs tested, the unconstrained model provides evidence of discriminant validity ($p < 0.05$), as shown in Table 2.

=== Insert Table 2 about here. ===

3.5. Analysis

Structural equation modeling was used to establish a model that describes the relationships between four cultural orientations and ten quality practices in Six Sigma. The objective is to establish a model that makes theoretical sense and provides acceptable fit to the data. The model generation process started with forty paths linking each cultural orientation to every quality practice. The insignificant paths in the initial model were deleted to improve the model fit and then re-tested using the same data. The process was continued until the model with the best fit to the data was found. This search procedure allowed us to find out the most important cultural orientation(s) for a particular quality practice. In the final model, 16 out of 40 paths between cultural orientations and quality practices were found to be significant. Figure 2 displays the structural model results. The model had a good fit (χ^2=2142.04, 1572 degrees of freedom, χ^2 per degree of freedom = 1.36, lower than 2; CFI = 0.94, above 0.90; NNFI = 0.93, above 0.90; SRMR = 0.050, below 0.08; and RMSEA = 0.040 with the 90% confidence interval of (0.036, 0.044), below 0.06) (Hu and Bentler, 1999; Kline, 2004).

=== Insert Figure 2 about here. ===

The results show that three of the four cultural orientations in the CVF, group culture, developmental culture, and rational culture, have significant and positive effects on the implementation level of different quality practices. Group culture supports nine of the ten quality practices. Of these nine practices, five are also supported by the rational culture, and four are supported only by the group culture. The tenth quality practice is supported by the rational culture and the developmental culture.

Group culture appears to be the most important cultural orientation for quality management implementation. The group culture is positively related to nine of the ten quality practices, except for Six Sigma role structure that is strongly supported by developmental culture and rational culture. Effective implementation of quality practices needs an organizational environment that encourages open communication and employee involvement to facilitate changes and provides resources necessary for continuous improvement (Ahire and O'Shaughnessy, 1998; Beer, 2003; Bhote, 2003; Breyfogle et al., 2001; Flynn et al., 1995; Kaynak, 2003). By emphasizing the group culture, which is about participation, trust, and a concern for human resources, the organization is more likely to develop a supportive environment where employees are encouraged to participate in continuous improvement teams and are rewarded for their contribution to better quality.

Rational culture is the second important cultural orientation for implementing quality practices in Six Sigma, which supports six quality practices. Together with the group culture, the rational culture supports five quality practices – top management support ($p = 0.24$, std error = 0.14), customer relationship ($p = 0.30$, std error = 0.11), quality information ($p = 0.30$, std error = 0.14), structured improvement procedure ($p = 0.18$, std error = 0.17), and focus on metrics ($p = 0.34$, std error = 0.14). In addition, the rational culture ($p = 0.19$, std error = 0.19), along with the developmental culture ($p = 0.32$, std error = 0.20), support the establishment of Six Sigma's role structure. These results indicate that the rational culture which focuses on control and goal achievement has joint effect on a wide range of quality practices with either group culture or developmental culture which focus on flexibility. This finding reflects the strategic planning direction in today's industry which stresses control and flexibility simultaneously (Douglas and Judge, 2001). Shea and Howell (1998) suggest that successful quality management implementation requires a company to provide employees with the freedom, autonomy, and range of skills to engage in creative and effective continuous improvement activities, while encouraging the use of a systematic standardized problem-solving approach to use quality tools to control its systems and processes.

The results show that hierarchical culture is not related to any of the quality practices studied in this research. During the model generation process, we found that despite the significant correlations between the hierarchical culture and these quality practices, the paths between the hierarchical culture and the quality practices became insignificant when there were other cultural orientations linking to the practices. This finding indicates that compared with other three cultural orientations in the CVF, the hierarchical culture is the least influential cultural orientation for the Six Sigma quality practices examined in this study. The values of the hierarchical culture may need to work with other cultural orientations in order to contribute to the effectiveness of Six Sigma implementation (Quinn and Spreitzer, 1991).

4. DISCUSSION AND CONCLUSIONS

The organizational culture has been suggested as an explanatory variable for the level to which a company effectively implements its quality practices. The current study represents an effort to conduct a comprehensive assessment of the relationships between different cultural orientations and quality practices in Six Sigma. The findings suggest that organizational culture generally has a significant influence on quality management and different cultural orientations influence different quality practices.

This study finds that three of the four cultural orientations in the competing values framework, i.e., group culture, developmental culture, and rational culture, are the important cultural orientations for implementing quality practices in Six Sigma, and the forth cultural orientation – hierarchical culture – is not related to any quality practices studied here. These findings generally support for the pluralist framework suggested by Prajogo and McDermott (2005) and question the bias toward group culture and developmental culture in the quality management literature as noted in the previous section. Six Sigma is multidimensional, consisting of multiple quality management practices which are driven by and reflect multiple dimensions of organizational culture. It appears that not only emphasis on the flexibility- and people-oriented cultural orientations (i.e., group and developmental culture) but also emphasis on the control-oriented cultural orientation (i.e., rational culture) can lead to higher implementation level of quality practices.

These findings and that by Prajogo and McDermott (2005) generally supports the differential effectiveness of the respective culture types proposed by the literature (Cameron and Freeman, 1991; Smart and St. John, 1996; Wilkins and Ouchi, 1983). The findings of the current study once again suggest that emphasis on one single cultural orientation is not the best for the overall quality management implementation, but instead, different cultural orientations influence different quality practices. The differential effects of cultural orientations found in the current study also reinforce the arguments of Quinn and Spreitzer (1991) and Yeung, Brockbank, and Ulrich (1991) about the importance of balance in cultural orientations. The results of this study suggest that to achieve the full benefits of implementing Six Sigma, companies should put emphases on at least three cultural orientations, i.e., group culture, developmental culture, and rational culture, in order to support the full implementation of Six Sigma.

The aim of this study was to provide a better understanding of the relationships between organizational culture and Six Sigma implementation. As the latest quality program designed to enhance organization-wide continuous improvement, Six Sigma includes a wide domain of quality practices. It is a complicated and difficult task to provide a supportive cultural environment for effectively implementing these quality practices. This study contributes to the quality management literature by exploring the impacts of four cultural orientations on the set of quality practices associated with Six Sigma implementation. We obtained empirical evidences that different cultural orientations support different quality practices in Six Sigma. The understanding of the unique advantage of each cultural orientation for the quality practices is helpful to examine and understand Six Sigma implementation from a holistic perspective of culture.

This study is subject to potential limitation of common method bias. The self-reported perceptual data used in this study bring about systematic informant bias problem. To avoid this problem and to increase construct validity, multiple informants, rather than a single informant should be sampled (Ketokivi and Schroeder, 2004). Results from a single informant tend to attenuate the observed correlations. Using multiple responses can help to estimate the proportion of variance accounted for by the traits (i.e., factors), methods and errors using CFA's multitrait–multimethod (MTMM) analysis so as to provide more accurate assessment of construct validity and relationship of the latent variables. This study collected a validation sample of 31 plants that provided two responses, which was used to assess whether multiple raters agreed with each other about the ratings concerning the plants' culture and quality practices. While the analysis results supported the adequate reliability and validity of the sample, the limited sample size of multiple responses did not allow the use of a MTMM analysis with this data. Second, no clear evidence of causality can be established with survey data obtained from a one-time cross-sectional survey. Causal inferences in this study were derived from existing theory and research only. Third, prior research suggests that there are two possible directions about the relationship between organizational culture and quality management. On one hand, quality management must fit to the existing culture to succeed; on the other hand, quality management implementation may change an organization's culture (Lewis, 1996). This research assumed the first relationship, that organizational culture influences the implementation of quality practices. When an organization starts to adopt a quality program, whether its existing culture can support this quality program is important. However, we acknowledge that with continuously implementing the quality program, employees' beliefs and attitudes may be changed as a result of using the quality improvement principles and practices in their jobs, which may lead to changes in the organization's culture. The cross-sectional survey in this study did not allow the examination of this possible causal direction between culture and quality management. Future research is needed that employs a longitudinal approach to more fully understand the causal direction and possibly reciprocal relationship between quality implementation and organizational culture.

This study has important implications for management practices. Managers should be aware of the cultural values on which their company relies before trying to implement the quality practices in Six Sigma. For instance, it may be easier for a company that has a stronger group culture to enhance workforce management for continuous improvement than for another company that has a weaker group culture. Also, the findings of the current study suggest that companies should strive to create a culture that is strong in the group culture, developmental culture, and rational culture, so that they could perform best in terms of the multiple quality practices associated with Six Sigma implementation. Organizations should avoid putting emphasis on some cultural orientation(s) at the expense of the others. In order to receive the full benefits of a quality management implementation, managers may find that it is important to assess their company's cultural orientations and to develop necessary plans and policies to create a supportive environment in which all quality practices thrive. Furthermore, the implications of this research lead to a task regarding developing and maintaining a culture that is balanced over the group, developmental, and rational cultural orientations. Future research is needed to investigate how to develop balance over these cultural orientations and to provide an understanding of the complexities of maintaining the balance.

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Table 1: Results of interrater agreement, unidimensionality, reliability, and convergent validity

Factors	$r_{wg(j)}$	Average AD	CFA (CFI)	Composite reliability	Eigenvalue	Average Eigenvalue
Suggested cut-off value	> 0.70	< 1.20	> 0.90	> 0.75	> 1.0	> 0.50
Top mgt. support	0.83	0.54	0.97	0.95	3.12	0.78
Customer relationship	0.87	0.50	0.98	0.84	2.11	0.53
Supplier relationship	0.81	0.62	0.96	0.83	2.17	0.54
Workforce mgt.	0.83	0.63	0.92	0.91	2.60	0.65
Quality information	0.87	0.97	0.98	0.96	3.19	0.80
Product/service design	0.82	0.67	0.99	0.87	2.43	0.61
Process management	0.80	0.60	0.94	0.86	2.53	0.51
SS role structure	0.89	0.78	0.98	0.98	3.36	0.84
Structured procedure	0.91	0.55	0.96	0.97	3.49	0.87
Focus on metrics	0.87	0.59	0.96	0.96	5.89	0.98
Group culture	0.77	0.65	0.99	0.96	3.35	0.84
Developmental culture	0.80	0.60	0.96	0.92	2.86	0.71
Rational culture	0.87	0.65	0.94	0.91	2.32	0.58
Hierarchical culture	0.81	0.58	0.99	0.91	2.80	0.70

Figure 1: The competing values framework of organizational culture
(Denison and Spreitzer, 1991, Cameron and Freeman, 1991)

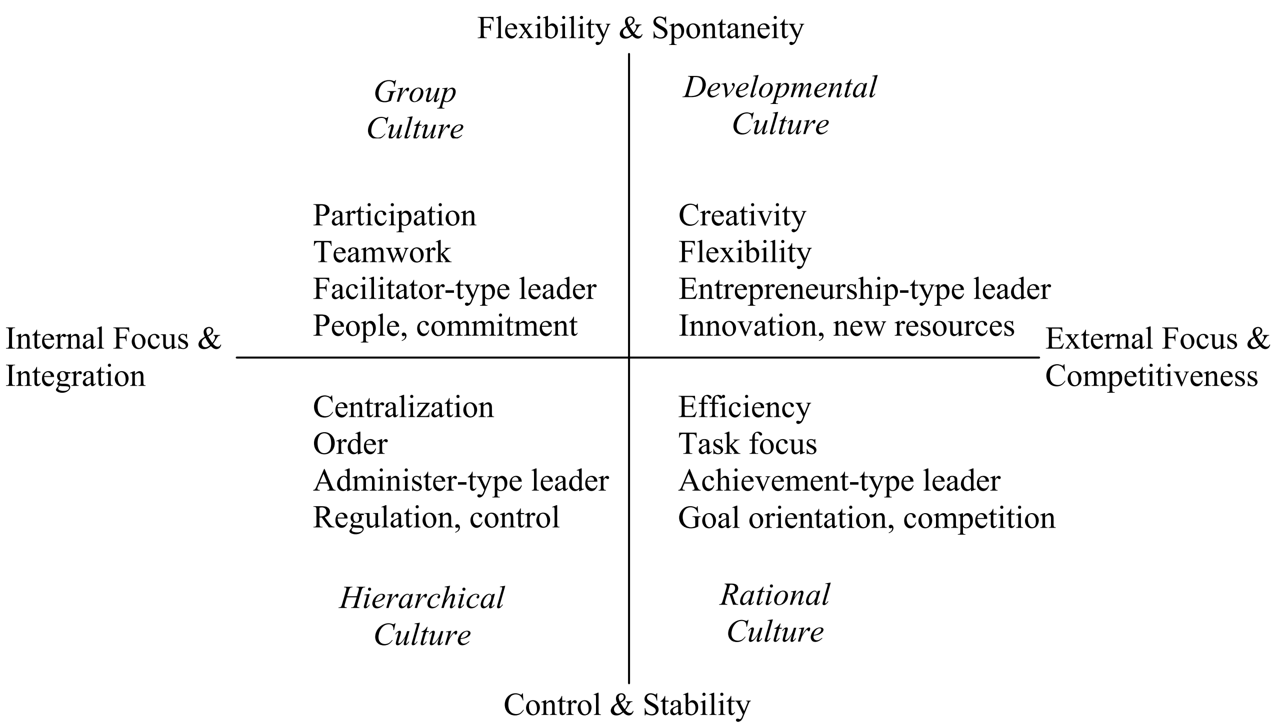

Table 2: Outcomes of testing discriminant validity: Chi-square differences between constrained and unconstrained models

Factors	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 Top mgt. support	–													
2 Customer relationship	184.9	–												
3 Supplier relationship	190.5	226.7	–											
4 Workforce management	138.0	156.4	158.9	–										
5 Quality information	507.6	195.1	236.7	249.1	–									
6 Product/service design	203.8	241.6	135.7	170.7	279.8	–								
7 Process management	163.3	229.9	140.5	103.9	184.5	102.6	–							
8 SS role structure	675.7	286.6	253.8	398.0	1034.2	311.0	335.2	–						
9 Structured procedure	517.2	260.6	193.8	290.5	676.0	196.6	250.2	659.9	–					
10 Focus on metrics	441.8	246.7	207.2	268.9	545.1	190.6	186.0	641.4	871.0	–				
11 Group culture	456.4	251.8	194.2	248.5	684.7	171.0	175.4	722.8	981.1	568.1	–			
12 Developmental culture	390.0	252.5	229.2	324.8	501.9	206.5	215.6	445.0	512.4	360.8	125.2	–		
13 Rational culture	340.8	256.0	226.0	298.0	363.3	253.6	244.6	357.4	398.8	324.9	295.1	271.8	–	
14 Hierarchical culture	324.8	239.1	229.4	240.9	432.7	195.4	196.8	427.6	500.5	301.5	197.6	163.5	128.2	–

Figure 2: Structural model of culture and quality practices in Six Sigma
* p < 0.10, ** p < 0.05, *** p < 0.01