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Mapping the critical links between organizational culture and TQM/Six Sigma practices

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ABSTRACT

This study investigates how organizational culture influences the implementation of different practices incorporated in the recent Six Sigma approach as well as those associated with traditional total quality management (TQM). We employed the competing values framework to capture the underlying value orientations of organizational culture. Using survey data collected from 226 US manufacturing plants, the relationships between four culture types and 10 TQM/Six Sigma practices were examined via the structural equation modeling technique. The results reveal the differential effects of the culture types on the implementation of TQM/Six Sigma practices. The implications of the links between different cultures and different TQM/Six Sigma practices are discussed. While the relationship between TQM practices and culture has been the subject of prior research, this is the first look at the relationship between organizational culture and a comprehensive set of quality management practices including the new Six Sigma practices. The understanding of the advantage of each culture type should help managers achieve effective implementation of TQM/Six Sigma practices from a holistic perspective of both quality management and culture.

1. Introduction

Improving the quality of products and services is fundamental to a firm's business success. In an attempt to improve quality, firms have pursued many continuous improvement programs, most notably total quality management (TQM) and more recently, Six Sigma. As companies such as Motorola, General Electric, Honeywell, Sony, Caterpillar, and Johnson Controls claimed substantial financial benefits from their investments in Six Sigma, the adoption of Six Sigma showed an upward trend in industry (Desai, 2006). However, despite the claimed benefits from TQM and Six Sigma implementation, there are numerous reports of problems in the process of implementing them (e.g., Ahire and Ravichandran, 2001; Gijo and Rao, 2005; Sila, 2007; Szeto and Tsang, 2005). In order to better understand whether and how quality management approaches affect organizational performance, it is important to study the organizational contexts in which these approaches are implemented (Sousa and Voss, 2002).

An appropriate organizational culture is widely considered a necessity for successful implementation of TQM (Buch and Rivers, 2001; Lagrosen, 2003; Lewis, 1996; Prajogo and McDermott, 2005) and Six Sigma (Antony and Banuelas, 2002; Cheng, 2007; Kwak and Anbari, 2004). While the impact of organizational culture on TQM has been extensively studied in the literature, little research has been done to examine the implementation of Six Sigma relative to culture, despite the recognized importance of organizational culture for Six Sigma adoption and deployment (Antony, 2004; Goffnett, 2004). Recently, Schroeder et al. (2008) have called for

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research investigating the question of internal fit in Six Sigma implementation, i.e., what types of organizations can successfully adopt Six Sigma and what changes in culture and structure may be required.

This study investigates the influence of the organizational context on individual quality management practices by empirically examining the links between different culture types and different TQM/Six Sigma practices. In addition to the traditional TQM practices, this study includes three distinctive Six Sigma practices that are identified as essential in applying Six Sigma principles and methods, which addresses the lack of empirical research on Six Sigma and its implementation in the literature. The results of this study can provide an up-to-date view of the effect of culture on quality management and supply managers with more pertinent information and guidance. Moreover, when examining the culture–quality management relationship, this study conducts a comprehensive assessment of different cultural characteristics. Most prior studies have focused on the effects of people- and flexibility-focused cultural characteristics on quality management, but "there has been little effort to synthesize what dimensions of culture have been studied to date or, more important, to identify which of these culture dimensions are more related to the implementation of change programs and subsequent improvements in important human and organizational outcomes" (Detert et al., 2000, p. 850). This study adopts the competing values framework (CVF) of culture to capture the underlying value orientations of an organization's culture. This culture framework has been widely used to examine the relationship of different culture types and organizational practices. In this study, we seek to analyze in detail, how different culture types as defined in the CVF model affect the implementation of various TQM/Six Sigma practices in order to produce guidelines on how to better implement the TQM/Six Sigma practices in an organization according to its specific cultural environment.

2. Literature review

The literature review is presented in three sections. It starts with a description of TQM and Six Sigma and their key practices. This is followed by a section discussing organizational culture and the CVF model that is used to assess different culture types in this study. The third section discusses the relationship between organizational culture and quality management.

2.1. TQM and Six Sigma practices

TQM is among the most prominent operations management approaches in the 20th century (Ahire and Ravichandran, 2001). An enormous amount of research has been done on TQM practices and their effects on organizational performance. Several studies by Sousa and Voss (2002), Kaynak (2003), and Nair (2006) have demonstrated that in the quality management literature there is substantial agreement as to what are the key TQM practices. Based on a review of empirical studies on TQM, we examine seven TQM practices in this study, those being top management support, customer relationship, supplier relationship, workforce management, quality information, product/service design, and process management.

Treading in the steps of TQM, Six Sigma is a new approach to quality management (Su et al., 2006; Kumar et al., 2008). Six Sigma was initiated by Motorola Inc. in the 1980s and has been 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 et al., 2003, p. 195). Some argue that Six Sigma is just a repackaging of TQM (e.g., Stamatis, 2000) and that "TQM makes many of the same claims that Six Sigma makes and with some justification" (Flott, 2000, p. 43). However, recent research suggests that Six Sigma introduces new and distinct concept and practices into quality management. In a grounded-theory-based search for the essence of Six Sigma, Schroeder et al. (2008) argued that although Six Sigma shares the tools and techniques with traditional quality management methods, it provides an organizational structure not previously seen. They suggested that Six Sigma presents "an organized, parallel-meso structure to reduce variation in organizational processes by using improvement specialists, a structured method, and performance metrics with the aim of achieving strategic objectives" (Schroeder et al., 2008, p. 5). In addition, Zu et al. (2008) empirically identified three distinctive practices essential for applying Six Sigma principles and methods, which are Six Sigma role structure, Six Sigma structured improvement procedure, and Six Sigma focus on metrics. Other research about the critical success factors for Six Sigma implementation also supports the existence of these Six Sigma practices (e.g., Nonthaleerak and Hendry, 2008; Szeto and Tsang, 2005). People suggest that Six Sigma should be integrated with TQM to produce synergistic effects on quality improvement (e.g., Ferng and Price, 2005; Revere and Black, 2003; Ricondo and Viles, 2005; Yang, 2004). As found by Zu et al. (2008), the three Six Sigma practices complement the traditional TQM practices in improving quality. Therefore, in this study we include the three Six Sigma practices as well as the seven TQM practices in the analysis to provide a comprehensive assessment of the cultural effect on contemporary quality management practices. The Appendix presents a brief description of these TQM/Six Sigma practices.

2.2. Organizational culture

In general, organizational culture represents the pattern of values, beliefs, and assumptions shared by members in an organization (Sigler and Pearson, 2000; Schein, 1985, 1992). Specifically, organizational culture is defined as "a pattern of basic assumptions—invented, discovered, or developed by a given group as it learns to cope with its problems of external adoption and internal integration—that has worked well enough to be considered valid and, therefore, to be taught to

new members as the correct way to perceive, think, and feel in relation to those problems" (Schein, 1985, p. 9). The values, beliefs, and assumptions underlying an organization's culture bind its employees together and become the manner or strategies through which the organization achieves its goals (Marcoulides and Heck, 1993). As the organization's cultural values shape the character of an organization and enable the employees to define their understanding of reality, it drives the way things are done in the organization (Nahm et al., 2004), organizational culture may be viewed as an explanatory variable that distinguishes one organization from another (Schein, 1985) and affects the way the organization operates and consequently plays an important role in many facets of the organization (Denison and Mishra, 1995; McDermott and Stock, 1999).

In order to empirically assess an organization's culture, in this study we adopt the CVF model developed by Quinn and his associates (Quinn, 1988; Quinn and Kimberly, 1984; Quinn and Rohrbaugh, 1981, 1983; Quinn and McGrath, 1985). The CVF explores the deep structures of organizational culture relating to compliance, motives, leadership, decision making, effectiveness, and organizational forms in the organization (Quinn and Kimberly, 1984). It has been shown that the CVF is both theoretically sound in integrating organizational culture to other organizational components and can be operationalized as a psychometrically sound instrument (Yeung et al., 1991).

The CVF (shown in Fig. 1) is built upon two axes to reflect different value orientations (Denison and Spreitzer, 1991; McDermott and Stock, 1999). The control-flexibility axis (vertical) reflects the extent to which an organization focuses on change and stability. A focus on flexibility indicates the organization's desire for flexibility and spontaneity, while a focus on control indicates a complementary desire to stay stable, controlled, and in order. The internal–external axis (horizontal) refers to 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.

The two axes combine to reflect four culture types, each representing different values about motivation, leadership, and strategic orientation in organizations. Group culture focuses on flexibility and internal maintenance by emphasizing strong human relations, cohesion, and participation of members. Developmental culture emphasizes flexibility but external positioning through growth, resource acquisition, creativity, and adaptation to the external environment. Rational culture puts a focus on the external environment while stressing control by encouraging competition and achievement of well-defined goals. Hierarchical culture emphasizes stability and internal organization and thus stresses centralization and regulations with rules and routinization (Cameron and Freeman, 1991; Denison and Spreitzer, 1991; McDermott and Stock, 1999).

An important assumption underlying the CVF is that the four quadrants are ideals (McDermott and Stock, 1999; Henri, 2006). Organizations seldom reflect only one culture type, rather each organization will exhibit a combination of different culture types, although it may be that one type is more dominant than the others (McDermott and Stock, 1999; Quinn and Spreitzer, 1991). The ratings on the four culture types may vary independently (Quinn and Spreitzer, 1991). In other words, a high rating on one end (e.g., internal orientation) does not

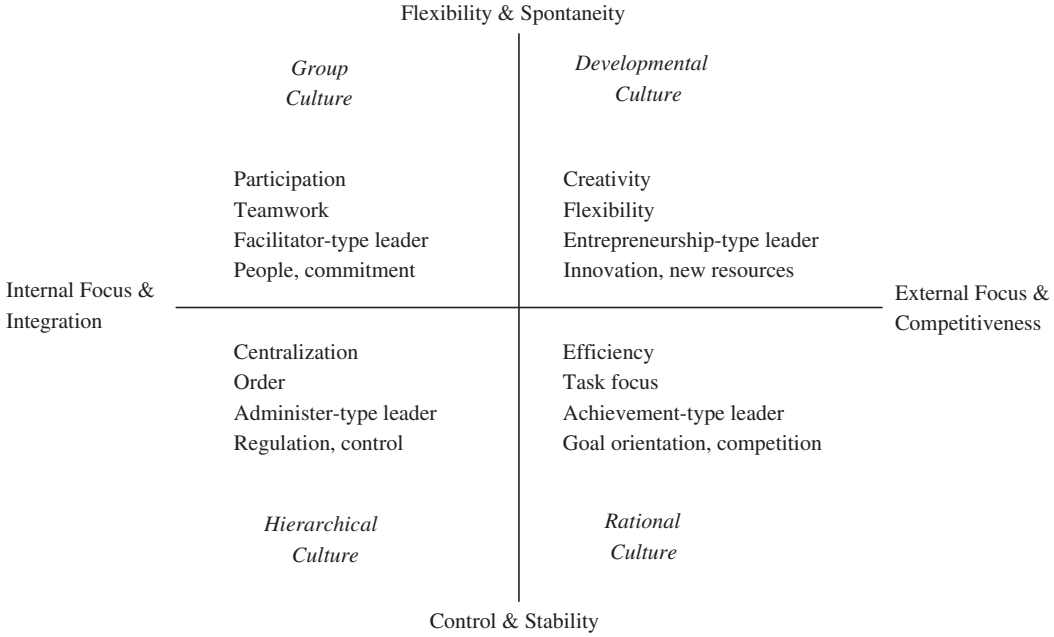

Fig. 1. The competing values framework of organizational culture (Cameron and Freeman, 1991; Denison and Spreitzer, 1991).

exclude high rating at the other end (e.g., external orientation) (McDermott and Stock, 1999). Thus, when using the CVF to assess an organization's culture, researchers can examine the relationships between different culture types and different facets of the construct(s) being studied. A number of empirical studies have adopted the CVF to explore the effect of organizational culture on various operations management practices such as advanced manufacturing technology (McDermott and Stock, 1999; Zammuto and O'Connor, 1992), performance measurement (Henri, 2006); and in particular quality management (Al-khalifa and Aspinwall, 2000; Chang and Wiebe, 1996; Dellana and Hauser, 1999; Jabnoun and Sedrani, 2005; Prajogo and McDermott, 2005; Stock et al., 2007). In the current study, we specifically examine how the degree to which an organization emphasizes each of the four culture types influences its implementation of different TQM/Six Sigma practices.

2.3. Organizational culture and quality management

In the quality management literature, attention to the importance of organization culture has been largely driven by the fact that many firms failed to achieve expected benefits from their TQM implementation because of the ignorance of the cultural factors (Prajogo and McDermott, 2005). Both TQM and Six Sigma entail a radical change in the way that an organization does its business (Rajamanoharan and Collier, 2006; Reger et al., 1994). Employees' attitudes and behaviors are critical for implementing the changes entailed in implementing quality management programs (Van de Wiele et al., 1993). Organizational culture is recognized as having a limiting effect on the effectiveness of quality management implementation. 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 quality management practices (Waldman, 1993). It has been widely agreed that for an organization to realize the value of implementing the TQM practices, it must have a culture that is capable of fully supporting their implementation (Lewis, 1996; Škerlavaj et al., 2007; Sousa-Poza et al., 2001).

The importance of organizational culture is also explicitly addressed in the Six Sigma literature, where culture is seen as influencing the effectiveness of changes required for Six Sigma deployment in an organization. For example, Antony and Banuelas (2002) identified organizational culture as a key ingredient that is essential for successful Six Sigma implementation. And, Breyfogle et al. (2001) suggested that organizations should assess their current culture with tools such as force field analysis to identify the forces that drive the organization toward Six Sigma implementation and those restraining a Six Sigma implementation. Managers should then make strategic plans to enhance the drivers and overcome the restraining forces.

Prior studies have attempted to identify the cultural characteristics conducive to quality management implementation (e.g., Buch and Rivers, 2001; Klein et al., 1995; Zeitz et al., 1997). A majority of prior studies treated quality management as a unidimensional construct and usually focused on the cultural characteristics related to people and flexibility, and overlooked the potential effect of the characteristics about control and standardization on quality management implementation. However, the quality management literature has shown that quality management is a multidimensional construct which encompasses multiple practices. Specifically, some practices are soft or infrastructure practices, such as top management support and workforce management, which emphasize the organizational and people side of quality management and uses a variety of organizational development techniques to facilitate changes; on the other hand, the hard or core practices are more concerned with the methodological and technical side of quality management and focus on using quality management tools and techniques to solve quality problems, including use of quality information, product/service design, and process management (Evans and Lindsay, 1999; Flynn et al., 1995; Wilkinson, 1992). Given the significant distinctions between the various practices encompassed within TQM and Six Sigma, it is very likely that cultural characteristics that support certain practices differ from those cultural characteristics that support other practices.

The need to recognize the multidimensional relationship between organizational culture and quality management has been identified by some researchers (Cameron and Quinn, 1999). As stated by Cameron and Quinn (1999), TQM initiatives failed in many companies because of two major reasons: partial deployment of TQM practices and failure to integrate TQM and culture change. They thus suggested using the CVF model to highlight the comprehensive nature of the TQM factors and ensure they are integrated in a TQM implementation for success. However, large-scale empirical research in this area is sparse. An exception is the recent study by Prajogo and McDermott (2005) who compared a unitarist model which treated TQM as a single construct and a pluralist model which considered TQM with its multidimensional elements, and found that a pluralist model better describes the relationships between cultural types and TQM practices, with different cultures being related to different groups of TQM practices.

This study builds on prior research (e.g., Cameron and Quinn, 1999; Prajogo and McDermott, 2005) by expanding the practices in consideration to include the Six Sigma practices. Furthermore, we develop and propose a set of hypotheses between cultural types and individual TQM/Six Sigma practices so that the results will provide a detailed description of the culture–quality management relationship.

3. Hypothesis development

In this section, we discuss the hypotheses about the relationships between four culture types of CVF and ten TQM/Six Sigma practices.

3.1. Group culture

Emphasizing flexibility and internal integration, the group culture values belonging, trust, and participation, and its strategies are oriented toward developing human relations through cohesiveness, openness, commitment, and attachment (Denison and Spreitzer, 1991). This culture is characterized by teamwork, consensus and participation (Cameron and Quinn, 1999).

In the group culture, the leaders tend to be supportive and participative, encourage empowerment and interaction throughout teamwork, and concern for employees' ideas (Denison and Spreitzer, 1991). This supportive and participative leadership style provides the organization with top management support necessary for its quality improvement, such as committing personal participation in the quality program, developing the cross-functional mechanisms, leadership skills, and team culture necessary for implementing the quality program, creating a climate of open communication about the implementation progress that will enable learning and further change, and investing in training to help employees increase their knowledge, skills and ability (Ahire and O'Shaughnessy, 1998; Beer, 2003; Flynn et al., 1994). It is thus proposed that:

H1a. An organization's emphasis on the group culture will be positively associated with the level of top management support.

An emphasis on the group culture is suggested to enhance the involvement of customers and suppliers in organizational activities (Naor et al., 2008). Customers and suppliers are outside the boundary of the organization, but they are the key parties of the overall supply chain of the products and services delivered to the end users. In quality management, it is essential to maintain close links with customers and suppliers (Dean and Bowen, 1994; Hackman and Wageman, 1995). A close relationship with customers entails a reciprocal involvement with customers regarding quality, including attention to customers for product design and information exchange to obtain the necessary information for identifying their requirements and to obtain reliable, fast feedback on the quality levels of products/services (Flynn et al., 1994; Forza and Flippini, 1998). And, a close relationship with suppliers means selecting suppliers based on quality, requesting supplier certification, involving suppliers in product design and process improvement, exchanging information about supplier quality, and keeping a limited number of suppliers to develop long-term relations based on constructive collaboration (Forza and Flippini, 1998; Kaynak, 2003). Thus, the strong relationships with customers and suppliers are based on commitment, cooperation and communication. For organizations emphasizing the group culture, they would apply its belief in trust, commitment and open communication to their relationship with its customers and suppliers. The following hypotheses are proposed:

H1b. An organization's emphasis on the group culture will be positively associated with the level of customer relationship.

H1c. An organization's emphasis on the group culture will be positively associated with the level of supplier relationship.

A major concern of firms emphasizing the group culture is the development of human potential, teamwork and member commitment as a means to better decisions and overall output (Denison and Spreitzer, 1991). These values are compatible with the implementation of human resource-related practices in TQM and Six Sigma, such as workforce management and Six Sigma role structure. An important assumption underlying quality improvement is that employees should be properly motivated to improve their work because most people are intrinsically motivated to do a good job when working in an environment without fear and coercion (e.g., Detert et al., 2000; Hackman and Wageman, 1995). Successful implementation of TQM and Six Sigma in an organization demands building teamwork within and/or cross functions, providing employees with appropriate training, involving them in decision-making, rewarding them for quality performance, developing Six Sigma specialists to lead the organizational improvement efforts, and establishing the communications to create awareness of organizational goals for quality improvement (Choi, 1995; Daft, 1998; Flynn et al., 1994; Kaynak, 2003; Lee and Choi, 2006; Pande et al., 2002). The group culture's emphasis on cohesion, morale and the long-term benefit of human resources development are consistent with and should facilitate the process of establishing the organizational environment supporting employee learning, collaboration, and involvement for the effective implementation of quality initiatives (Cameron and Quinn, 1999; Detert et al., 2000; Naor et al., 2008; Ouchi, 1981). The above discussion suggests:

H1d. An organization's emphasis on the group culture will be positively associated with the level of workforce management.

H1e. An organization's emphasis on the group culture will be positively associated with the level of Six Sigma role structure.

The teamwork, empowerment, and open communication fostered by the group culture are also expected to facilitate the application of tools and techniques in TQM and Six Sigma for problem solving. The technique-focused practices, such as quality information, product/service design and process management in TQM as well as the use of metrics and structured improvement procedure in Six Sigma, entail the timely sharing of quality data throughout the ranks of the organization to make it available to all employees, cooperation between departments through teamwork to exchange ideas, joint efforts of management and employees in process management activities of preventive maintenance, quality problem identification and solving, and mistake-proof procedures, and effective measurement of process and product performance and

project coordination (Anderson et al., 1994; Breyfogle et al., 2001; Flynn et al., 1994; Kaynak, 2003; Lee and Choi, 2006; Schroeder et al., 2008). Openness in the group culture is consistent with the principle of management by fact in quality management through systematic quality data collection, reporting, analysis and measurement in a problem-solving cycle (Hackman and Wageman, 1995). The group culture, with its focus on participation and empowerment, "helps to equalize people by giving everyone a voice in the product design and process management, as well as responsibility for the results" (Naor et al., 2008, p. 676). Knowing that their ideas and thoughts will be valued by management, employees then will be more willing to make efforts in identifying and solving problems and taking more responsibilities in improvement projects (Antony and Banuelas, 2002; Motwani et al., 2004; Naor et al., 2008). Based on the above discussion, we therefore propose that:

H1f. An organization's emphasis on the group culture will be positively associated with the level of quality information, product/service design and process management.

H1g. An organization's emphasis on the group culture will be positively associated with the level of Six Sigma focus on metrics and structured improvement procedure.

3.2. Developmental culture

The developmental culture emphasizes a high degree of flexibility and change according to the external environment. Organizations emphasizing the developmental culture tend to use such strategies as innovation, resource acquisition, and the development of new market, and foster the activities that delight customers, anticipate customers' needs, and implement creative solutions to problems that produce new customer preferences (Cameron and Quinn, 1999).

The drive for companies to invest in quality improvement is to achieve market advantage. Customers by nature prefer products of higher quality and thus market shares tend to move toward the organizations which can provide high quality products and services (Craig and Douglas, 1982; Jacobson and Aaker, 1987). Efforts in quality improvement are expected to bring in more satisfied customers with greater loyalty and increase sales (Ahire and Dreyfus, 2000; Hendricks and Singhal, 1997; Kaynak, 2003). A central premise of TQM is that customer satisfaction is the most important requirement for long-term business success and the entire organization should focus on customers' needs and expectations (Dean and Bowen, 1994). In order to meet customer and market needs, the organizations must attend to customers for product design and information exchange to obtain the necessary information for identifying their requirements and to obtain reliable, fast feedback on the quality levels of products and services (Flynn et al., 1994; Forza and Flippini, 1998). To do so, organizations need to possess a high level of developmental culture in order to be flexible and to adapt to changing customer demands over time (Naor et al., 2008). In organizations emphasizing the developmental culture, the belief in external adaptation and development of flexibility and diversity would provoke the members' interests in pursuing and understanding customer needs and market requirements. Such organizations tend to build a strong relationship with customers because customer focus is well aware throughout the organization to develop dynamism and readiness to meet new challenges (Al-khalifa and Aspinwall, 2001). It is suggested that:

H2a. An organization's emphasis on the developmental culture will be positively associated with the level of customer relationship.

Organizations with an emphasis on the developmental culture consistently search for new resources and external support for growth (Denison and Spreitzer, 1991). These organizations are more likely to establish cooperative relationships with their key suppliers. The quality of an organization's products is not only determined by the organization's internal processes, but also influenced by the materials and parts provided by the suppliers and their cost and delivery performance (Flynn et al., 1995; Kaynak, 2003). Suppliers play a critical part in assuring the quality of incoming materials and parts as well as contributing to the buying firm's produce/service design and process management projects (Kaynak and Hartley, 2008). Achieving high quality cannot only rely upon internal resources (Robinson and Malhotra, 2005). Strategic partnerships with suppliers enable the organization to bridge boundaries to gain access to valuable specialized capabilities from the suppliers (Holcomb and Hitt, 2007). The above discussion suggests that:

H2b. An organization's emphasis on the developmental culture will be positively associated with the level of supplier relationship.

The developmental culture is characterized by a dynamic, entrepreneurial, and creative workplace and its effective leadership is visionary, innovative and risk-oriented (Cameron and Quinn, 1999). The entrepreneur-type of leadership is coherent with the essence of using Six Sigma role structure to lead the organization's quality improvement initiative through projects. Within the administrative structure of Six Sigma, champions set a rationale and goal for improvement projects that align with business priorities and are accountable to the Six Sigma leadership council for the success of their projects; master black belts communicate with the champion and the leadership council, provide expert advice to improvement teams and help teams promote their successes; black belts are the team leader and responsible for the routine work and results of the projects (Pande et al., 2002). These specialists take more significant individual responsibility in selecting the improvement projects that have potential to bring in significant improvements in quality performance as well as financial and market benefits, planning and monitoring the progress of the projects, and justifying the project outcomes (Breyfogle et al., 2001; Lee and Choi, 2006). To search for new solutions or processes, the Six Sigma specialists are

committed to experimentation and innovation and they have to be open to change in order to transfer the new ideas into ongoing operations (Pande et al., 2002).

Organizations emphasizing the developmental culture support adaptation and innovation activities that may lead to product and service advantage and profitability (Cameron and Quinn, 1999). In these innovative organizations, there is a push for constant, continuous improvement and doing things better, thus they encourage the behavior of constantly studying the processes and products for improvement (Detert et al., 2000). These organizations tend to encourage the development of leaders who are motivated to initiate new improvement projects and provide them necessary resources and responsibilities to execute the projects. This focus on innovation and adaptation also increases the allocation of organizational resources for employee training so as to improve their knowledge and skills to meet the changing requirements of customers (Yeung et al., 1991). Resources for training are critical for the Six Sigma role structure in developing the improvement specialists' expertise (Linderman et al., 2003). The individuality valued within the developmental culture reinforces differentiated training programs used in Six Sigma through which specialists receive different levels of training based on their experience and tasks and are classified with various ranks to recognize their expertise at different levels.

In the developmental culture, people form committees or teams around tasks, which disband as soon as the task is completed, and they reconfigure themselves when new circumstances or tasks arise, and thus power flows from task team to task team depending on what problem is being addressed at the time (Cameron and Quinn, 1999). This approach coincides with the way Six Sigma teams work. Six Sigma teams are formed along the process they are trying to improve and are disbanded after the process improvement is implemented (Schroeder et al., 2008). Both leaders and team members have to adapt quickly to new opportunities. The developmental culture's emphasis on adaptability and individuality is expected to smooth the frequent reconfiguration process of teams (Cameron and Quinn, 1999). Overall, the above discussion suggests that:

H2c. An organization's emphasis on the developmental culture will be positively associated with the level of Six Sigma role structure.

3.3. Rational culture

The rational culture is externally oriented but emphasizes control and stability, with a focus on competitiveness and goal orientation (McDermott and Stock, 1999). Organizations emphasizing on the rational culture encourage competition and the successful achievement of well-defined goals and the strategies often used in those organizations stress efficient planning and control of production to achieve competitive advantages and high productivity (Denison and Spreitzer, 1991).

Research suggests that in order to propel quality improvement initiatives in an organization, its top management must provide vision and goals that direct quality efforts (Ahire and O'Shaughnessy, 1998). Beer (2003) advises that rather than pushing TQM or Six Sigma with only organization-wide top-down training programs, the top management should motivate aspirations for continuous improvement in quality by setting ambitious performance goals for subunit leaders and the means for measuring their attainment and providing personal directive and participation. Top management demonstrates its commitment to the achievement of the quality goals by taking responsibilities for quality and being evaluated based on quality performance (Anderson et al., 1994; Flynn et al., 1994; Kaynak, 2003). As leaders in the goal-oriented rational culture are tough and demanding in achieving competitiveness, they tend to develop clear objectives and aggressive strategies to drive practices and behaviors leading to productivity and profitability (Cameron and Quinn, 1999; Denison and Spreitzer, 1991). This suggests that:

H3a. An organization's emphasis on the rational culture will be positively associated with the level of top management support.

Cameron and Quinn (1999) suggest the creation of partnerships with customers and suppliers as TQM factors compatible with the rational culture. Measuring customer preferences is critical for organizations to achieve competitive position as the organizations emphasizing the rational culture pursue productivity, profit and impact (Denison and Spreitzer, 1991). This requires the organizations to work closely with the customers to understand their needs and expectations so as to better position their products and services in the market (Flynn et al., 1994). More direct contact of organizational members, including line workers, to customers can motivate continuous improvement efforts (Mohrman et al., 1995). Similarly, emphasizing the rational culture, the organizations seek opportunities to collaborate with key suppliers through strategic partnerships to leverage strategic position and improve operating efficiency and productivity (Bowersox et al., 2007). Achieving the improvements necessary to gain competitive advantage requires effectively integrating customers and suppliers into the supply chain (Kaynak and Hartley, 2008; Naor et al., 2008). In sum, the rational culture's focus on the external market and constituencies is expected to support companies to build close relationships with customers and suppliers. The following hypotheses are proposed:

H3b. An organization's emphasis on the rational culture will be positively associated with the level of customer relationship.

H3c. An organization's emphasis on the rational culture will be positively associated with the level of supplier relationship.

Both TQM and Six Sigma use the compensation policies including incentives for group performance, quality-based incentives and compensation based on breadth of skills (Flynn et al., 1995; Henderson and Evans, 2000). Particularly, Six Sigma role structure directly links the incentive

compensation of executives to the achievement of Six Sigma goals and rewards the champions and black belts based on the outcomes of their improvement projects that they are accountable for (Henderson and Evans, 2000). Such incentives and rewards delivered by management are used to increase employee participation in continuous improvement and to enhance employees' ownership in their jobs and quality improvement activities (Ahire et al., 1996; Naor et al., 2008). These performance-contingent compensation policies are compatible with the strategies characterizing the rational culture, which regard incentives as an integral tool used to motivate the workforce to pursue better performance and achieve organizational goals (Naor et al., 2008). This suggests that:

H3d. An organization's emphasis on the rational culture will be positively associated with the level of workforce management.

H3e. An organization's emphasis on the rational culture will be positively associated with the level of Six Sigma role structure.

The three technique-focused TQM practices—quality information, product/service design, and process management—target at improving the quality of a firm's products, services and processes (Flynn et al., 1995; Forza and Flippini, 1998; Kaynak, 2003; Rahman and Bullock, 2005). Systematic collection and analysis of quality data and reporting form the basis for developing appropriate actions for continuous improvement (Flynn et al., 1995; Hackman and Wageman, 1995). Techniques are used in the design stage (e.g., concurrent engineering and component standardization) that enhance the firm's new product development capability in terms of speed and number of components in products, two major outcomes expected from the practice of product/service design (Ahire and Dreyfus, 2000). Process management is a means of optimizing process performance so that production quality can be enhanced in terms of process variability, scraps and reworks, and production costs (Ahire and Dreyfus, 2000). The extensive usage of quality tools and techniques has been shown to result in improved quality performance and higher efficiency and productivity, and in turn better financial and market performance, higher customer satisfaction, and competitive advantage (Flynn et al., 1995; Hendricks and Singhal, 2001; Kaynak, 2003). Since the rational culture values these bottom-line results (Cameron and Quinn, 1999; Quinn and Kimberly, 1984), the implementation of these three TQM practices are supported in the organization emphasizing the rational culture because its managers and employees believe that these are part of the desired organizational goals and their competent performance toward those goals will be rewarded accordingly (Zammuto and Krakower, 1991). It is suggested that:

H3f. An organization's emphasis on the rational culture will be positively associated with the level of quality information, product/service design, and process management.

The rational culture fosters a result-oriented workplace where the major task of management is to drive the organization toward productivity, results and profits (Cameron and Quinn, 1999). The focus on goal achievement and direction fits with the notion of applying Six Sigma structured improvement procedure and Six Sigma metrics to ensure that continuous improvement activities can achieve significant results. Six Sigma projects are planned and executed in a structured manner (e.g., in the format of define-measure-analyze-improve-control (DMAIC) in process improvement or define-measure-analyze-design-verify (DMADV) in product design). The decision about which project is initiated is based on strategic importance rather than convenience (Schroeder et al., 2008). A project's prospective benefits, both in quality improvement and financial returns, have to be clearly defined (Breyfogle et al., 2001; Pande et al., 2002). The guidelines along the DMAIC or DMADV procedures are clearly described and explicit instructions are given to team members in terms of tools to use and tasks to fulfill (Choo et al., 2007; Linderman et al., 2006). The progress of the projects is then closely tracked and recorded to evaluate whether the planned tasks are completed and the anticipated outcomes are achieved (Breyfogle et al., 2001; Pande et al., 2002). In a rational culture environment emphasizing decisiveness, direction, and task fulfillment, effective planning is perceived as an importance criterion of performance (Denison and Spreitzer, 1991), thus employees are acceptable towards the principles of organizing quality improvement activities following the Six Sigma structured procedure such as careful planning of the projects, attaining predetermined objectives step by step and overall at the end of the projects, and instrumental management styles of team leaders, which will ease the process of adopting and using this structured method. Therefore, we propose that:

H3g. An organization's emphasis on the rational culture will be positively associated with the level of Six Sigma structured improvement procedure.

As the rational culture encourages the pursuit and attainment of well-defined objectives oriented toward profitability and competitiveness, it is expected to facilitate the use of Six Sigma metrics in quality improvement. First, a variety of quantitative metrics are used in Six Sigma to evaluate quality performance of products, services and processes, to identify improvement opportunities, and most importantly, to define explicit, challenging goals for improvement projects (Linderman et al., 2003; Schroeder et al., 2008). When team members are motivated by the belief that their performance toward the organizational goals will be rewarded, they will assert more efforts to ensure that each project activity contributes to the common end point and extend their capabilities to new ambitious frontiers (Denison and Spreitzer, 1991; Linderman et al., 2003; Naor et al., 2008; Zammuto and Krakower, 1991). It has been shown that when used appropriately with Six Sigma improvement method and tools, clear goals help to encourage more improvement efforts and increase the improvement

magnitude of Six Sigma projects (Linderman et al., 2006). Second, Six Sigma metrics are customer-oriented and financially bounded with the objective of competitive advantage, which coincides with the external focus of rational culture on achievements such as productivity, results and profits. The customer-oriented metrics are to understand the true customer need, especially the identification of critical-to-quality (CTQ) characteristics, to set project improvement goals and to direct improvement efforts; the financial metrics are to ensure that Six Sigma improvement efforts have measurable financial returns (Schroeder et al., 2008). Analysis and evaluation of improvements based on metrics provides a link between organizational strategy and operational action (Sinclair and Zairi, 1995). Using those Six Sigma metrics in project selection and evaluation helps to connect improvement efforts with observable benefits in customer satisfaction and financial profits. It is suggested that:

H3h. An organization's emphasis on the rational culture will be positively associated with the level of Six Sigma focus on metrics.

3.4. Hierarchical culture

The hierarchical culture has an internal focus and emphasizes control and stability. This culture is characterized by uniformity, internal efficiency, and a close adherence to rules and regulations (McDermott and Stock, 1999). To achieve a high quality level, it is important to have an organizational environment valuing the hierarchical culture in order to support the use of tools in process control and improvement (Cameron and Quinn, 1999). Process management in TQM focuses on improving internal process stability (or to say reducing process variability) through preventive maintenance, production schedules, and statistical process control (Flynn et al., 1994, 1995; Kaynak, 2003). As the hierarchical culture pursues efficiency, stability and error detection and measurement, these process management techniques is more likely to be implemented and maintained in the organization. We then propose that:

H4a. An organization's emphasis on the rational culture will be positively associated with the level of process management.

The hierarchical culture tends to use strategies of clear rules, close control, and routinization, and clear lines of decision-making authority, standardized rules and procedures, and control and accountability mechanisms are valued as the keys to success (Cameron and Freeman, 1991; Cameron and Quinn, 1999; Denison and Spreitzer, 1991). Correspondingly, the Six Sigma structured improvement procedure requires teams to use the formalized problem-solving approach to plan and conduct a project with clear steps, instruction and tools prescribed at each step of the procedure. Schroeder et al. (2008) suggest that from the perspective of the organizational routines theory, this is a metaroutine for changing established routines or for inventing new routines, with an assumption that problem solving can follow predicable steps. The belief underlying the hierarchical culture is that individuals will abide by organizational strategies and polices when roles are formally stated and enforced through rules and regulations (Quinn and Kimberly, 1984). Organizations emphasizing the hierarchical culture are characterized by a formalized and structured place to work where procedures govern what people do (Cameron and Quinn, 1999). In such organizations, employees will feel comfortable about complying with the formal steps of the Six Sigma structured procedure and they will be more willing to follow the rigorous steps and use the prescribed tools. Thus, the concern for predictability, uniformity and formality of rules and procedures inherent in the hierarchical culture is expected to facilitate organizations to put Six Sigma structured improvement procedure in effect. It is then proposed that:

H4b. An organization's emphasis on the rational culture will be positively associated with the level of Six Sigma structured improvement procedure.

4. Research methodology

4.1. Survey instrument

A cross-sectional survey was conducted to investigate TQM/Six Sigma implementation and organizational culture in the US manufacturing industry. The initial survey instrument was developed based on an extensive literature review. The seven TQM practices were measured by validated items from extant TQM empirical studies (e.g., Anderson et al., 1995; Douglas and Judge, 2001; Flynn et al., 1994, 1995; Kaynak, 2003). New measures were developed to evaluate the three Six Sigma practices by reviewing the practitioner publications (e.g., Bhote, 2003; Breyfogle et al., 2001; George, 2003; Pande et al., 2000, 2002) and the academic research (Choo et al., 2004; Linderman et al., 2003; Schroeder, 2000). Items were measured on seven-point Likert scales with end points of "strongly disagree (= 1)" and "strongly agree (= 7)."

Organizational culture was measured using the instrument developed by Quinn and Spreitzer (1991), which contains 16 Likert-scale items, four for each culture type. This culture instrument was designed to evaluate the degree to which an organization emphasizes each of the four culture types in the CVF, and thus is appropriate for examining the relationships between culture types and individual TQM/Six Sigma practices simultaneously. Quinn and Spreitzer (1991) have demonstrated the satisfactory psychometric property of this instrument using multitrait–multimethod (MTMM) analysis and multidimensional scaling. A study by Kalliath et al. (1999), using confirmatory factor analysis (CFA), further verified that this instrument has excellent validity and reliability estimates. The measurement items of culture were evaluated by the seven-point Likert scale with one for not valued at all, four for moderately valued, and seven for highly valued, to assess the degree to which an organization value the relevant cultural characteristics.

To refine the measurement scales, the initial instrument was first reviewed by faculty in operations

management, organizational behavior, and strategic management. Then, the questionnaire was pre-tested by seven quality managers who had 5–20 years of experience in implementing quality management in manufacturing plants. The instrument was evaluated in terms of issues such as how well each scale captured the construct that it intended to measure, whether the wording of each item was clear and understandable, and whether the format was user friendly. Using their feedback, the instrument was revised further to ensure that the questionnaire was comprehensive, understandable and valid from these experts' perspective.

4.2. Sample and data collection

The survey instrument was administered as a web-based format to 878 US manufacturing plants that were selected from the directory of the American Society for Quality (ASQ) and the Thomas Register. Following Dillman's (2000) total design methodology, four rounds of emails with a link to the web survey were sent to the target sample, and responses were received from a total of 226 plants resulting in an overall 26% response rate. The respondents included those in the position of 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 in 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 and 500 workers, 15% of the plants had 501–1000 workers, and 29% of the plants had more than 1000 employees.

To assess the potential of non-response bias, this study tested the difference of the available variables between the early and late respondents (Armstrong and Overton, 1977). 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 group included 65 replies received after the fourth email. The χ^2 tests yielded no statistically significant differences (at 95% significance level) on the demographic variables including the numbers of employees and the types and length of quality management training the respondents received. The *t*-tests indicated no significant differences between the means of two groups in terms of the TQM/Six Sigma 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.

4.3. Analysis and results

4.3.1. Interrater agreement

A second response was obtained from 31 plants that responded to the survey. Interrater agreement was then assessed based on this dual-response sample to determine the "interchangeability" of responses within the same group, that is, it evaluates whether one group member's response is basically identical to another group member's response with regard to the constructs of organizational culture and TQM/Six Sigma practices. The within-group agreement index $r_{wg(j)}$ was used to evaluate interrater agreement. A mean $r_{wg(j)}$ of 0.70 or above is usually accepted as a satisfactory value indicating interrater agreement (James et al., 1993). As shown in Table 1, the $r_{wg(j)}$ value of each factor was greater than 0.70, suggesting the agreement between the raters. In addition, the other interrater agreement measure, the average deviation (AD) index was calculated to assess the average within-group deviation. According to Burke and Dunlap (2002), the upper limit of AD for the seven-point scale like those used in this study is 1.20. The average AD values range from 0.50 to 0.97 (see Table 1), lower than the upper limit, further corroborating the agreement between the respondents. Given the satisfactory interrater agreement and the absence of differences between the plants returning one response versus those returning two responses in terms of the constructs measured, the same pattern of agreement can be assumed to exist in the whole sample. These

Table 1
Descriptive statistics and tests of interrater agreement, unidimensionality, and reliability.

Factor	Mean	S.D.	$r_{wg(j)}$	Average AD	Unidimensionality (CFI)	Composite reliability	
						Cronbach's alpha	Weighted omega
Top management support	5.09	1.55	0.83	0.54	0.98	0.93	0.95
Customer relationship	5.71	1.17	0.87	0.50	0.99	0.80	0.84
Supplier relationship	3.87	1.46	0.81	0.62	0.98	0.83	0.83
Workforce management	4.98	1.38	0.83	0.63	0.94	0.88	0.91
Quality information	5.46	1.47	0.87	0.97	0.98	0.94	0.96
Product/service design	4.67	1.45	0.82	0.67	0.99	0.86	0.87
Process management	5.04	1.19	0.80	0.60	0.93	0.83	0.86
Six Sigma role structure	3.40	1.98	0.89	0.78	0.97	0.96	0.98
Six Sigma structured procedure	4.66	1.80	0.91	0.55	0.99	0.96	0.97
Six Sigma focus on metrics	4.93	1.56	0.87	0.59	0.96	0.96	0.96
Group culture	4.93	1.40	0.77	0.65	0.99	0.95	0.96
Developmental culture	4.92	1.32	0.80	0.60	0.96	0.91	0.92
Rational culture	5.38	1.16	0.87	0.65	0.94	0.90	0.91
Hierarchical culture	4.92	1.09	0.81	0.58	0.99	0.82	0.91

findings strongly support reliability of the measures as the results appear to reflect plants' attributes as opposed to individual idiosyncratic interpretations (Henri, 2006). The dual responses were then averaged for the subsequent analyses.

We also conducted Harmon's one-factor test (Podsakoff et al., 2003) to mitigate the threat of common methods variance (CMV) in the self-reported, single-respondent data set. This test assumes that if a substantial amount of CMV is present, either a single factor will emerge from the unrotated factor analysis or one general factor will account for the majority of the covariance in the independent and dependent variables. The results of Harmon's single-factor test indicated that 14 factors were extracted from the whole set of variables, and when the 10 TQM/Six Sigma factors were each factor analyzed with the culture factors, two factors emerged for each case. Although the above tests do not completely eliminate the possibility of CMV, the results indicate that single-respondent, self-report bias does not appear to be a major problem in this study.

4.3.2. Tests of unidimensionality, reliability, and validity

The measurement items were evaluated for unidimensionality, reliability, convergent and discriminant validity. We assessed unidimensionality first because it helps to reduce the possibility of misspecifications (Gerbing and Anderson, 1988), and the analysis of reliability and construct validity is based on the assumption of unidimensionality (Al-Hawari et al., 2005; Nunnally and Bernstein, 1994). The unidimensionality of each construct was tested using CFA. The software EQS 6.1 was used throughout the study to test the CFA models and later the structural model. As shown in Table 1, all the CFA models had a comparative fit index (CFI) of value higher than 0.90, indicating an adequate model fit and thus satisfactory unidimensionality of the scales (Al-Hawari et al., 2005).

Construct reliability was first estimated with the internal consistency method using Cronbach's alpha. In Table 1, the Cronbach's α values of each scale in this study range from 0.80 to 0.96, above the suggested cut-off value of 0.70 or higher (Nunnally and Bernstein, 1994). In addition, composite reliability of weighted omega was calculated for each scale, since the weighted omega index provides a realistic reliability assessment for latent factors measured by multiple items because it considers that the items may not equally load onto the factor (Bacon et al., 1995), as opposed to Cronbach's alpha, which assumes unit weights for the items and may underestimate the true construct reliability (Bollen, 1989). Coefficient omega gives unequal weights to the items of the factor. As shown in Table 1, the scales had a composite reliability estimate above 0.75, suggesting high construct reliability (Nahm et al., 2004).

Prior to testing the structural model, CFA was performed on the entire set of measurement items simultaneously (Anderson and Gerbing, 1988; Byrne, 1998). The measurement model was assessed by examining the goodness-of-fit indices, factor loadings, standardized residuals, and modification indices. During the process of evaluating the measurement model, several items were deleted iteratively based on the criteria such as large standardized residuals, modification indices, or factor loadings less than 0.50 (Byrne, 1998; Kaynak, 2003; Nahm et al., 2004). Before deleting a particular item, the item and respective construct were evaluated to assure that the loss of the item would not jeopardize the integrity of the construct (Nahm et al., 2004). The retained items are presented in Appendix A. Unidimensionality and composite reliability of the scales were re-assessed and showed satisfactory results.

As recommended, the goodness-of-fit of the measurement model was evaluated using multiple model fit indices, including the ratio of χ^2 to degrees of freedom, comparative fit index (CFI), non-normed fit index (NNFI), standardized root mean square residual (SRMR) and root mean square error of approximation (RMSEA) (Kline, 2004). Based on the criteria for evaluation of model fit suggested by the literature (Byrne, 1998; Hu and Bentler, 1999), the final measurement model had an adequate model-to-data fit: χ^2 per degree of freedom $= 2457.80/1619 = 1.52$, lower than 2; CFI $= 0.91$ and NNFI $= 0.90$, equal or above 0.90; SRMR $= 0.054$, below 0.08; and RMSEA $= 0.048$ with the 90% confidence interval of (0.044, 0.052), below 0.06.

Based on the measurement model, convergent and discriminant validity of the constructs were assessed. A construct's convergent validity is recognized if the items are significantly related to the factor (Nunnally and Bernstein, 1994). Also, a standardized factor loading of 0.50 or higher, ideally 0.70 or higher, provides strong evidence of convergent validity (Hair et al., 2005). In this study, all the items have significant factor loadings, i.e., *t*-values are greater than 1.96 at the significance level of 0.05 (Al-Hawari et al., 2005), and most items have factor loadings greater than 0.70, suggesting adequate convergent validity. Discriminant validity was tested by comparing the χ^2 values between the constrained model that sets the correlation of any two factors at one and the unconstrained model that freely estimates the correlation (Anderson and Gerbing, 1988). A series of χ^2 difference tests were performed for the 10 TQM/Six Sigma factors and four culture factors with the significance α level adjusted to 0.0005 (0.05/91) by dividing α by the number of tests performed (Kaynak and Hartley, 2006). As shown in Table 2, the χ^2 difference tests between all pairs of factors are significant (a significantly lower χ^2 value for the unconstrained model), indicating strong discriminant validity (Hair et al., 2005). Additionally, in Table 2, the correlations between the factors are all lower than their reliability estimates, providing further evidence of discriminant validity (Crocker and Algina, 1986; Ghiselli et al., 1981).

4.3.3. Test of structural model

The SEM technique was utilized to test the proposed relationships between four culture types and 10 TQM/Six Sigma practices. The structural model shows acceptable model fit: χ^2 per degree of freedom $= 2473.48/1634 = 1.51$; CFI $= 0.91$; NNFI $= 0.90$; SRMR $= 0.055$; and RMSEA $= 0.048$ with the 90% confidence interval of (0.044, 0.051). As shown in Fig. 2, most links between the

Table 2
Test results of discriminant validity.

	Factors	1	2	3	4	5	6	7	8	9	10	11	12	13
1	Top management support	–												
2	Customer relationship	0.58[a]	–											
		184.85[b]												
3	Supplier relationship	0.59	0.40	–										
		190.52	226.71											
4	Workforce management	0.77	0.60	0.62	–									
		138.00	156.43	158.91										
5	Quality information	0.61	0.55	0.48	0.70	–								
		507.58	195.05	236.68	249.11									
6	Product/service design	0.67	0.39	0.65	0.68	0.55	–							
		203.78	241.55	135.66	170.65	279.76								
7	Process management	0.71	0.41	0.64	0.77	0.69	0.74	–						
		163.28	229.90	139.95	103.92	184.47	102.57							
8	Six Sigma role structure	0.45	0.18	0.51	0.46	0.33	0.53	0.43	–					
		675.72	286.55	253.76	398.01	1034.16	311.02	335.16						
9	Six Sigma structured procedure	0.60	0.34	0.62	0.63	0.52	0.70	0.59	0.75	–				
		517.16	260.64	193.80	290.54	676.02	196.63	250.17	659.85					
10	Six Sigma focus on metrics	0.69	0.40	0.57	0.65	0.64	0.71	0.68	0.58	0.73	–			
		441.76	246.69	207.19	268.87	545.11	190.58	186.01	641.42	871.00				
11	Group culture	0.67	0.37	0.59	0.66	0.47	0.73	0.69	0.45	0.57	0.70	–		
		456.4	251.8	194.2	248.5	684.7	171.0	175.4	722.8	981.1	568.1			
12	Developmental culture	0.60	0.34	0.49	0.53	0.46	0.66	0.61	0.49	0.57	0.70	0.87	–	
		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	0.66	0.39	0.47	0.63	0.53	0.66	0.63	0.45	0.55	0.71	0.80	0.80	–
		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	0.50	0.34	0.48	0.56	0.45	0.56	0.54	0.38	0.47	0.55	0.62	0.64	0.81
		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

[a] Values represent bivariate correlation for the factors.
[b] Values represent χ^2 differences between each unconstrained model and constrained model.

culture types and TQM/Six Sigma practices are supported. Three culture types—group, developmental, and rational cultures are found to have significant positive effects on different quality management practices, though a few links are not supported. However, it is found that the hierarchical culture has no significant effect on the practices that it was expected to affect. The specifics of these results and their implications are discussed next.

5. Results and discussion

The empirical results of this study reveal that different culture types influence different TQM/Six Sigma practices. The group culture, with its emphasis on commitment and cooperation, is found to be the important culture type for overall TQM/Six Sigma implementation. The model shows that the group culture is significantly related to seven of the 10 practices: top management support, supplier relationship, workforce management, product/service design, process management, Six Sigma structured improvement procedure, and Six Sigma focus on metrics. This finding confirms the importance of group culture for quality management as suggested in prior studies (Naor et al., 2008; Prajogo and McDermott, 2005). Effective implementation of TQM/Six Sigma practices requires 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 developing a group culture, organizations promote participation, trust, and a concern for human development as their core value. In this supportive environment, employees are not only encouraged to participate in continuous improvement teams and are rewarded for their contribution to better quality, but also receive the training and education to be successful in their jobs.

The rational culture is found to have a significant effect on nine of the 10 TQM/Six Sigma practices, including all three Six Sigma practices. The rational culture emphasizes productivity and achievement, with clearly defined objectives for external competitiveness, which is compatible with Six Sigma practices. Efficiency and profit orientation are conducive to the TQM practices that focus on achieving superior quality and competitiveness (Dean and Bowen, 1994). Understanding the customer and developing close relationships with them are key strategies for gaining the competitive advantage that is so ingrained in the rational culture. Gathering and using quality information can also provide the strategic advantage in the external markets that are the focus within a rational culture.

The results show that the developmental culture is significantly related to the implementation of Six Sigma role structure. The individuality valued within this culture supports the approach of Six Sigma that provides training

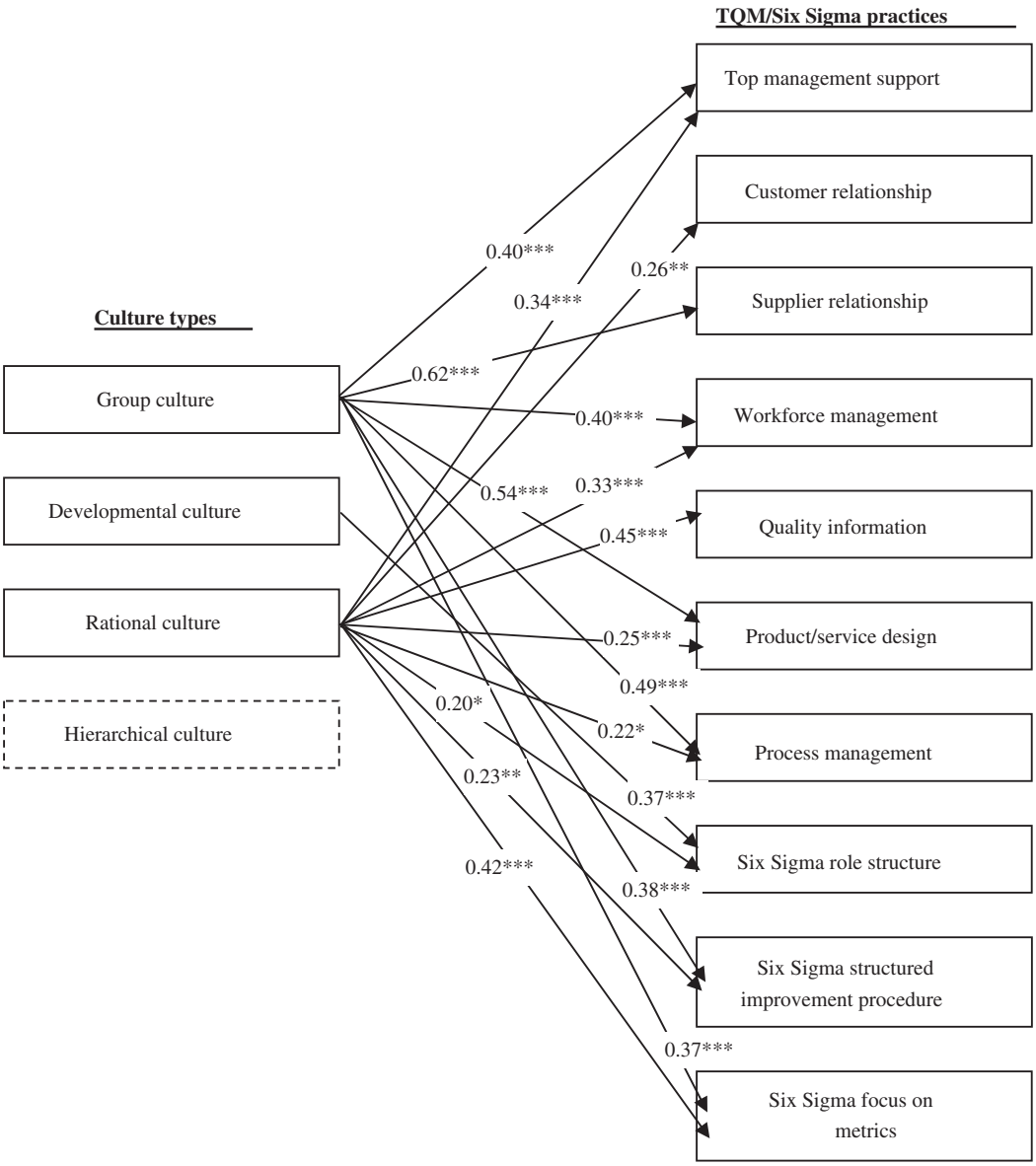

Fig. 2. Structural model of organizational culture and TQM/Six Sigma practices $^{*}p<0.10$, $^{**}p<0.05$, $^{***}p<0.01$.

on an as-needed basis and differentiated by task and assigns different roles and responsibilities to the Six Sigma specialists based on their expertise (Linderman et al., 2003). As the developmental culture exemplifies the tolerance for flexibility by the tendency to shift power from task team to task team depending on what problem is being addressed at the time (Cameron and Quinn, 1999), it may be easier to organize Six Sigma teams based on tasks (Schroeder et al., 2008).

The hierarchical culture has no significant links to either process management or Six Sigma structured improvement procedure as proposed. The lack of significance of hierarchical culture for organizational effectiveness has been noticed in prior studies. For example, Cameron and Freeman (1991) found that the hierarchical culture was not related to any measures of organizational effectiveness in US higher education institutions. Also, Yeung et al. (1991) and Quinn and Spreitzer (1991) found that those organizations that overemphasized the hierarchical culture were the worst performers and their employees reported a low quality of work life. Similarly, the results of this study suggest that compared with other three CVF culture types, the hierarchical culture is the least influential for implementing TQM/Six Sigma practices.

We also look into what culture type(s) are suitable for each practice. The results of this study show that each TQM/Six Sigma practice is compatible with one or two

culture types. For example, top management support, i.e., participation in quality improvement activities and setting strategic goals for quality improvement, can be sustained in an organizational environment emphasizing both the group and rational cultures where managers are participative and emphasize goal setting and achievement.

While the establishment of close relationships with customers and suppliers was expected to be supported by the group, development, and rational cultures, the results show a link between customer relationships and only the rational culture, whereas supplier relationship was facilitated by the group culture only. Building close contacts with customers is aimed to provide managers and employees a better understanding of customer needs and expectations in order to assess current quality level, control quality conformance, and set goals for future improvement (Flynn et al., 1994; Hackman and Wageman, 1995). This objective is more compatible with the rational culture's values of control and probability achievement than the group culture's values of cooperation or the developmental culture's focus on innovation. On the other hand, the exclusive significant effect of group culture on supplier relationship indicates the importance of trust and commitment for supplier management. As suggested in the supply chain management literature, effective supply chain collaboration requires adaptation to a collaborative culture that entails external and internal trust, mutuality of benefits, information exchange, and openness and communication (Barratt, 2004). The finding of significance of group culture for supplier relationship in this study highlights the importance of the external trust toward suppliers and internal cooperation with employees for ensuring continuous, effective supplier collaboration. This result also corroborates the observations by Polychronakis and Syntetos (2007) in a cross-nation multi-case study. They found that in the British organizations featured with flatter hierarchies, collectivism, and democratic leadership styles, there was a strong move towards purchasing consortia for collaborative advantage and companies tended to use collaborative approach coupled with the appropriate top-management support and allocation of responsibilities and ownership of the process at the employee level, which had resulted in service level agreements that facilitate continuous improvement.

The results suggest that two human-focused practices in TQM and Six Sigma are supported by different culture types, indicating their slightly different focuses. The traditional TQM practice of workforce management involves various organizational development techniques to encourage employee involvement and motivation. In this study, this practice is found to be supported by the group and rational cultures whose core values are consistent with the application of the organizational development techniques such as investment in employee training and education, employee involvement and participation, and the performance-based policy of rewards and compensation. On the other hand, the Six Sigma role structure practice is considered as a leadership development mechanism (Schroeder et al., 2005) which develops a group of quality leaders in the organization's continuous improvement efforts with the responsibilities of taking the initiative to identify improvement projects of promising outcomes as well as leading the project execution to accomplish the target goals. These leadership skills are expected to be nurtured in the environment that values innovative- and entrepreneurial-behaviors and achievement of goals.

The TQM core practice of quality information is supported by the rational culture, whereas product/service design and process management are supported by the rational culture as well as the group culture. Similarly, the two technique-focused practices in Six Sigma—Six Sigma structured improvement procedure and Six Sigma focus on metrics—are found to be supported by both the group and rational cultures. These results indicate the importance of rational culture for regulating the use of quality management tools and techniques for achieving higher quality level in organizations, but also the necessity of the group culture for maintaining a teamwork atmosphere in the organization to support the cooperation between departments particularly required in product design and process improvement projects. This finding is analogous to the dual focus of operations management in today's industry, which stresses control and flexibility simultaneously (Douglas and Judge, 2001). As suggested by Shea and Howell (1998), 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 at the same time encouraging the use of a systematic standardized problem-solving approach to use quality tools to control its systems and processes.

This study reveals the differential effects of culture types on the implementation of TQM and Six Sigma practices. The findings substantiate the importance of building a cultural environment to support the comprehensive implementation of various practices to increase the possibility of success with quality management initiatives (e.g., Cameron and Quinn, 1999; Prajogo and McDermott, 2005). A fully functioning quality management system is a holistic, integrated system, which encompasses multiple practices that address different aspects of the organization in order to establish and sustain continuous improvement within the organization (Flynn et al., 1994, 1995; Kaynak, 2003; Yeung et al., 2005). The different practices are driven by and reflect multiple dimensions of organizational culture (Prajogo and McDermott, 2005). As recognized in the literature (e.g., Cameron and Freeman, 1991; Quinn and Spreitzer, 1991; Smart and St. John, 1996; Wilkins and Ouchi, 1983; Yeung et al., 1991), the unique advantage of different culture types for organizational performance indicates that emphasis on one single culture type is not the best for the overall organizational effectiveness. The results of this study suggest that in order to obtain full benefits from implementing multiple TQM and Six Sigma practices, it is important to develop not only flexibility- and people-oriented culture values (i.e., the group culture and the developmental culture) but also control- and external-

oriented values (i.e., the rational culture). Organizations need to support and engage their employees in quality improvement activities and to emphasize productivity and achievement of goals as a result (Cameron and Quinn, 1999).

6. Conclusions

While culture is recognized as critical for quality management, few studies have systematically examined the relationships between different culture types and individual practices. This study sought to provide a better understanding of the culture–quality management relationship through a comprehensive assessment of the links between different culture types and TQM/Six Sigma practices. Six Sigma provides new structure and methods to complement TQM in continuous improvement (Revere and Black, 2003; Schroeder et al., 2008; Yang, 2004; Zu et al., 2008). This study extended previous studies of culture and quality management by including the Six Sigma practices as well as the traditional TQM practices in the analysis, which helps to advance our knowledge of the influence of organizational culture on contemporary quality management practices. The theoretical constructs and measurement scale developed in this study may assist future researchers who wish to simultaneously measure TQM and Six Sigma and address their distinctions in relationships with other variables.

This study has important implications for management practices. Based on the results of this study, different culture types affect different practices. Before adopting TQM/Six Sigma initiatives, managers need to be aware of the cultural values emphasized in their organization so that the multiple TQM/Six Sigma practices can be effectively implemented in the organization. The findings of this study provide the managers some guidelines to design their policies or adjust their systems to better adopt different TQM/Six Sigma practices. Managers would be prudent to assess their company's current cultural values and develop necessary action plans and policies to create a supportive cultural environment to ensure that multiple TQM/Six Sigma practices will be successfully implemented. For instance, it may be easier for an organization emphasizing the developmental culture values to establish the Six Sigma role structure to encourage intra-organization entrepreneurial behaviors through leadership in quality improvement; and when organizations put an emphasis on the core values of rational culture such as goal achievement and direction, the use of core TQM and Six Sigma practices can be facilitated to ensure consistent and effective application of tools and techniques for quality improvement.

This study is subject to the potential threat of common method variance problem because a majority of the self-reported perceptual data used in this study was collected from single respondent. We collected dual responses from 31 plants, and the analysis of that data set showed satisfactory inter-rater agreements. Also, the Harmon's one-factor test results of the single-response data set indicate that common method bias does not appear to be a major problem, though we acknowledge that the statistical analyses do not completely eliminate the possibility of this problem.

A number of directions for future research emerge from this study. This study focuses on examining the relationships between culture types and quality management practices. However, as mentioned earlier, few organizations are featured by only one culture type, rather they have a culture profile consisting of different culture types. More research is needed to investigate how an organization's culture profile influences the pattern of TQM/Six Sigma implementation as well as the resulting effect on organizational performance. Also, the implications of this research suggest the necessity of building a comprehensive culture environment that may reflect multiple and competing types (e.g., the group culture and the rational culture). Future research must investigate the viability of effectively achieving balance among different culture types in one organization and to provide an understanding of the complexities of maintaining the balance. Moreover, 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, as Prajogo and McDermott (2005) and Zeitz et al. (1997) did, that organizational culture influences the quality management implementation. When an organization starts to adopt a quality management program, whether and how its existing culture can support this quality management program is important. However, we acknowledge the potential reciprocal nature—that with continuously implementing the quality management 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. Future research is desired that employs a longitudinal approach to explore the causal direction and possible reciprocal relationships between TQM/Six Sigma implementation and organizational culture.

Appendix. Description of the constructs and measurement scales

The items marked with * were retained after testing the measurement models. The first value in parenthesis for each retained item indicates the standardized factor loading. The second value is the *t*-value.

Construct	Description	Measurement scale
Top management support	Top management accepts responsibility for quality and is evaluated based on quality performance. Top management participates in quality improvement efforts and makes strategies and goals for quality improvement.	1. *Our plant's top management (i.e. top executives and major department heads) assumes responsibility for quality performance (0.90, 16.66). 2. *Our plant's top management provides personal leadership for quality products and quality improvement (0.93, 18.39). 3. *Our plant's top management is evaluated for quality performance (0.85, 15.28). 4. *Major department heads within our plant participate in the quality improvement process (0.85, 15.20). 5. Quality issues are reviewed in our plant's management meetings. 6. Our plant's top management has objectives for quality performance.
Customer relationship	Customer needs and expectations are assessed. Customers are involved in quality improvement projects. Customer satisfaction is measured. There is a close contact with key customers.	1. *We frequently are in close contact with our customers (0.81, 10.37). 2. *Our customers give us feedback on quality and delivery performance (0.79, 8.54). 3. Our plant measures our external customers' satisfaction (customers outside the plant). 4. We use customer requirements as the basis for quality. 5. *Our employees know who our customers are (0.67, 9.52). 6. *Our customers visit our plant (0.62, 9.30).
Supplier relationship	A small number of suppliers are used. Suppliers are involved in product development and quality improvement projects. Suppliers are evaluated based on quality. The organization provides suppliers training and technical assistance.	1. We strive to establish long-term relationships with suppliers. 2. We rely on a small number of high quality suppliers. 3. *Our suppliers are actively involved in our product design/redesign process (0.67, 11.34). 4. *Our suppliers are evaluated according to quality, delivery performance, and price, in that order (0.76, 14.41). 5. *Our plant has a thorough supplier rating system (0.80, 15.87). 6. *Our suppliers are involved in our quality training (0.71, 12.67). 7. We provide technical assistance to our suppliers.
Workforce management	Employees are involved in quality decisions. Employees are evaluated based on their quality performance and their contributions to quality are recognized and rewarded. Managers encourage team working. There is training on QM for managers and employees.	1. *Our plant forms teams to solve problems (0.75, 11.44). 2. Our plant gives feedback to employees on their quality performance. 3. *Our employees are recognized for superior quality improvement (0.73, 12.83). 4. Hourly/non-supervisory employees are involved in quality decisions. 5. Supervisors encourage the persons who work for them to work as a team. 6. *Quality-related training is given to hourly workers in our plant (0.87, 15.79). 7. *Quality-related training is given to managers and supervisors in our plant (0.87, 15.55). 8. Training is given in the "total quality concept" (i.e. philosophy of company-wide responsibility for quality) in our plant. 9. Training is given in the basic statistical techniques (such as histogram and control charts) in our plant.
Quality information	Quality data are available to managers and employees. There is an effort to collect timely quality data. Quality data are used for improvement.	1. *Quality data (error rates, defect rates, scrap, defects, cost of quality, etc.) are available in our plant (0.93, 12.87). 2. *Quality data are available to managers, supervisors, and engineers (0.96, 12.55).

		3. *Quality data are available to hourly/non-supervisory workers (0.85, 16.15). 4. *Quality data are timely (0.83, 14.13). 5. Quality data are used as tools to manage quality. 6. Quality data are used to evaluate supervisory and managerial performance.
Product/service design	There is thorough review before production. Design teams involve people from different functions such as manufacturing, marketing, and purchasing departments. Simplified design and standardization are encouraged for manufacturability.	1. *Our plant conducts a thorough review of new product/service design before the product/service is produced (0.80, 13.73).
		2. Multiple departments (such as marketing, manufacturing, and purchasing) coordinate in the product/service development process. 3. Manufacturing and quality people are involved in the product/service development process. 4. *Quality of new products/services is emphasized in relation to cost or schedule objectives (0.83, 16.51). 5. *We design for manufacturability (0.76, 14.01). 6. *We make an effort, in the design process, to list only the specifications which are clearly needed (0.72, 11.24).
Process management	There is an emphasis on mistake-proof process design. There is consistent use of statistical process control and preventive maintenance. Managers and employees make efforts to maintain clean shop floors and meet schedules.	1. Processes in our plant are designed to be "mistake-proof" to minimize the chances of errors.
		2. *We dedicate a portion of every day solely to maintenance (0.64, 10.49). 3. *We usually meet the production schedule every day (0.66, 9.67). 4. Production is stopped immediately for quality problems. 5. *Our plant conducts preventive equipment maintenance (0.78, 12.21). 6. *Clear work or process instructions are given to employees (0.82, 13.33). 7. *Our plant's shop floors are well organized and clean (0.64, 8.36). 8. A large number of the equipment or processes on the shop floor are currently under statistical process control. 9. We make extensive use of statistical techniques to reduce variance in processes.
Six Sigma role structure	The organization uses a group of improvement specialists who are developed through Six Sigma training and certification programs. The improvement specialists are classified with different ranks based on their expertise. The specialists are assigned with specific leadership roles and responsibilities in improvement teams.	1. *We employ a black/green belt role structure (or equivalent structure) for continuous improvement (0.97, 33.54).
		2. *We use a black/green belt role structure (or equivalent structure) to prepare and deploy individual employees for continuous improvement programs (0.98, 35.09). 3. In our plant, members of a quality improvement team have their roles and responsibilities specifically identified. 4. *The black/green belt role structure (or equivalent structure) helps our plant to recognize the depth of employees' training and experience (0.87, 21.185). 5. *In our plant, an employee's role in the black/green structure (or equivalent structure) is considered when making compensation and promotion decisions (0.83, 18.135). 6. Our plant uses differentiated training so that employees who have different roles in the black/green belt role structure (or equivalent structure) can obtain the necessary knowledge and skills to fulfill their job responsibilities.
Six Sigma structured improvement procedure	There is an emphasis on following a standardized procedure in planning and conducting improvement projects. Teams apply the appropriate QM tools and techniques as prescribed in each step of the structured procedure.	1. In our plant, continuous improvement projects are conducted by following a formalized procedure (such as DMAIC—Define, Measure, Analyze, Improve and Control).
		2. *We use a structured approach to manage quality improvement activities (0.92, 20.58). 3. *We have a formal planning process to decide the major quality improvement projects (0.94, 21.09). 4. *All improvement projects are reviewed regularly during the process (0.95, 21.91). 5. *We keep records about how each continuous improvement project is conducted (0.93, 20.45).

		6. In our plant, the product design process follows a formalized procedure.
Six Sigma focus on metrics	Quantitative metrics are used to measure process performance and product quality performance, and to set improvement goals. Business-level performance measures and customer expectations are integrated with process-level performance measures.	1. *Our plant sets strategic goals for quality improvement in order to improve plant financial performance (0.85, 16.06).
		2. *Our plant has a comprehensive goal-setting process for quality (0.89, 18.96). 3. *Quality goals are clearly communicated to employees in our plant (0.91, 19.83). 4. In our plant, quality goals are challenging. 5. *In our plant, quality goals are clear and specific (0.91, 17.88). 6. *Our plant translates customers' needs and expectation into quality goals (0.88, 17.33). 7. We make an effort to determine the appropriate measures for each quality improvement project. 8. *In our plant, measures for quality performance are connected with the plant's strategic quality goals (0.91, 19.93). 9. The expected financial benefits of a quality improvement project are identified during the project planning phase. 10. Financial performance (e.g. cost savings, sales) is part of the criteria for evaluating the outcomes of quality improvements in our plant. 11. We assess the performance of core processes against customers' requirements. 12. *The measures for quality performance are connected with critical-to-quality (CTQ) characteristics (0.71, 13.90). 13. *Our plant systematically uses a set of measures (such as defects per million opportunities, sigma level, process capability indices, defects per unit, and yield) to evaluate process improvements (0.79, $t = 17.15$).
Organizational culture	Group culture	1. *Participation, open discussion (0.90, 17.85).
		2. *Empowerment of employees to act (0.91, 19.47). 3. *Assessing employee concerns and ideas (0.94, 19.09). 4. *Human relations, teamwork, cohesion (0.91, 18.48).
	Developmental culture	1. *Flexibility, decentralization (0.75, 12.83). 2. *Expansion, growth, and development (0.93, 13.96). 3. *Innovation and change (0.90, 16.92). 4. *Creative problem solving processes (0.90, 13.76).
	Rational culture	1. *Task focus, accomplishment, goal achievement (0.81, 10.50). 2. *Direction, objective setting, goal clarity (0.92, 15.74). 3. *Efficiency, productivity, profitability (0.79, 9.14). 4. *Outcome excellence, quality (0.83, 11.89).
	Hierarchical culture	1. *Control, centralization (0.35, 4.23). 2. *Routinization, formalization and structure (0.77, 10.82). 3. *Stability, continuity, order (0.91, 15.45). 4. *Predictable performance outcomes (0.89, 13.88).

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