THE DETERMINANTS OF AN IMPORTANT QUALITY DIMENSION ON DESIGN QUALITY

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Abstract
The paper objective is to determine of an important quality dimension on design quality. Study was performed using a self-administered questionnaire survey. This study focused on manufacturing industry in Northern Region Malaysia that has been obtained a quality management system (QMS) certificate registration from registered certification body (CB) such as SIRIM, UL, etc. It was found that quality strategy, leadership for quality, quality technology and tool can be considered as important dimensions towards implementation of design quality. This study contributes to providing important quality dimensions that influence quality performance. The dimensions identify to improve product and process quality in order to increase and or maintain manufacturing competitiveness in market.

Key words: Quality strategy; Leadership quality; Quality technology; Performance.

JEL Classification Codes: M11; L1.

1. Introduction

Many industries nowadays require their suppliers to achieve certain quality standard certification by means of third-party registration in order to fulfill customer's requirements. It's seems to become a norm to certify for a certain quality standard and this serve as a competitive advantage for a company to stay ahead from their competitors and also to sustain in the business market. At the forefront of these efforts have been attempts to improve flexibility and quality, stimulate innovation, and reduce lead times, while simultaneously keeping costs down (Tan et al., 2000). Any company that tries to run its business without a quality system, such as ISO9000, is failing to recognize the importance of quality as a driver to business viability, sustainability and prosperity (McTeer & Dale, 1995).

In the academic literature, empirical research in the area of organizational variables such as the implementation of quality management tools and techniques and the effects on the business performance (Brah & Lim, 2006; Bunny & Dale, 1997), rewards and recognition process and its role for a total quality management based strategy (Allen & Killmann, 2001; London & Higgot, 1997), quality leadership in school and quality communications (Spinks & Wells, 1995; Berry, 1997), quality strategy as a new global competitive strategy and its impact in manufacturing enterprises as well as public sector (Peters, 1996; Leonard & McAdam, 2004; Mehra & Agrawal, 2003; Pun, 2005; Donnelly, 1999; Brown, 1998; Handley, 1995), quality culture in UK industry, Asian companies and schools and its effect on quality performance and management of organization change (Abraham, Fisher & Crawford, 1997; Corbett & Rastrick, 2000; Adebanjo & Kehoe, 1999; Sinclair & Collins, 1994; Berry, 1997; Sohal, 1998) have primarily sought to explain the individual nature of relationship processes and their effect on operating or business performance. As such, these variables were selected and indicated in the framework of this study in order to test on its effectiveness and relationships on quality performance and customer satisfaction of manufacturing industry located in Northern Region, Malaysia.

According to research conducted by Combe and Botschen (2004), quality management is dominated by rational paradigms for the measurement and management of quality, but these paradigms start to "breakdown", when faced with the inherent complexity of managing quality in intensively competitive changing environment. Throughout the 1990s, firms examined and, in many cases, changed their quality focus. Instead of relying on inspecting quality into products, they begin to seek for the room of improvement from organizational variables standpoint and its relationship as well as effects on customer satisfaction.

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It is important to know and understand the organizational variables of quality that can improve the quality performance and customer satisfaction. It cannot be denied that these quality variables such as Leadership for Quality, Quality Culture, Quality Strategy, Quality Technology and Tools, Reward and Recognition, are important in improving the quality performance on Design Quality but there has not been any empirical research looking into this perspective. Therefore, there is a need for research that establishes linkages between the organizational variables of quality and quality performance as well as customer satisfaction. However, the paper objective is to determine of an important quality dimension on design quality.

2. Literature review

According to Johnson (2004), there is several quality standard in which a company can obtain third-party registration. There are the International quality standards, ISO9001:2000 and ISO/TS16949:2002, with the later specifically geared to the automotive industry (Johnson, 2004).

ISO9000 refers to a series of standards for quality management systems, consisting of ISO9000, 9001, 9002, 9003 and 9004, were first issued in 1987 and revised in 1994 by the International Organization for Standardization (ISO) (Tummala & Tang, 1996). The ISO9000 standards are generic in terms of their application, meaning the same standards will apply to service, manufacturing or R&D organizations. They are also generic in terms of the industries they apply to, be it automotive, telecommunications, medical devices or pharmaceutical (Liu, 2008). ISO 9000 describes the guidelines for use of a particular standard whereas ISO9004 describes the guidelines for establishing an internal quality management system within the broad and general context of total quality management (Tummala et al., 1996). The other three standards, ISO9001, 9002 and 9003, are the generic standards containing minimum requirements for establishing and maintaining a documented quality system to instill confidence in customers that the intended products or services meet customer requirements (Tummala et al., 1996). Of the three, ISO9001 is the most comprehensive standard, including all activities in all stages, namely design / development, production, installation and servicing (Tummala et al., 1996). When people say ISO9000, they are referring to the quality management systems (QMS) standards and requirements specified in ISO9001:2000. It is a standard for providing assurance about the ability to satisfy quality requirements and enhance customer satisfaction in supplier-customer relationships (Liu, 2008).

Organizational variables of quality are predictors of successful quality management system implementation and improvements in quality performance in an organization as shown in research conducted by Johnson (2004). As such, the following variables were selected in this study that includes:

Quality Technology / Tools

A research conducted by Brah and Lim (2006) shown that the technology play important and complementing roles in improving the performance. The use of IT is crucial in improving operational, quality and overall business performance. This study shows that high technology firms perform significantly better than low technology peers do. Technology is found dramatically playing a major role in the businesses. While the IT helps to break the internal silos within an organization, it also assists the coordination of activities with the members of the supply chain and the customers (Brah et al., 2006). Perhaps, this contributes to an improved operational and quality performance. Besides, from the empirical evidence provided by the case study on "Analysis of roles of IT on quality management" conducted by Mjema et al. (2005), shows that the use of IT on quality tools such as flow charts, histograms, and Pareto charts for quality control helped to control work process in production and to deliver consistent product quality.

Rewards and Recognition

Reward and recognition systems for individual employees remain one of the controversial areas of quality management (London & Higgot, 1997). An effective reward and recognition process provides a clear and visible statement to all employees of the organizational values and the commitment to employee involvement (London et al, 1997). Alignment of the reward system with organizational strategy helps to determine organizational effectiveness (Allen et al., 2001). The reward system should be aligned to motivate employee performance that is consistent with the firm's strategy, attract and retain people with the knowledge, skills and abilities required to realize the firm's strategic goals, and create a supportive culture and structure (Nadler & Tushman, 1988). Blackburn and Rosen (1993) and Knouse (1995) investigated the HR practices of national, state and local quality award winning

organizations and found that these organizations typically made changes in their reward systems to make them more supportive of a quality-focused strategy (Allen et al., 2001).

Quality Culture

Sinclair and Collins (1994) in their study has defined culture as "the set of habitual and traditional ways of thinking, feeling and reacting that are characteristic of the ways a particular society meets its problems. Culture is not simply an intervening variable, the "layer" between strategy and business results. It explains the nature and contours of the organization and the interaction of people within an organization. In short, for organizations that do not have cultures; they are cultures. Culture can be crafted and manipulated to provide an environment and awareness to employees for continuous improvement on quality performances.

Addressing culture change has not been easy since most people are unclear about exactly what this means and how it should be approached (Smith et al., 1993). Williams et al., (1993), address this problem in the following statement. Despite the growing awareness of cultural issues, comparatively little attention has been paid to the practical, day-to-day processes involved in creating, managing and changing organizational culture. Develin and Partners (1989) cited cultural change and change in management behavior as the key factors to obtaining a successful implementation of Total Quality

Quality Strategy

Quality is a major issue now because there is greater competition than ever before in most markets. The number and capabilities of new entrants into markets has raised competition between new and existing players all of whom have to compete to "world-class" standards. It is argued by Kanter (1996) that the title "world-class" has less to do with being better than competitors are. The term merely denotes the ability to compete at all in global competition. Strategic quality management is not new; the term and concept discussed by Garvin (1988) led to the strategic approach to quality as the fourth era of quality after inspection, statistical quality control and quality assurance (Leonard & McAdam, 2004). This can be used to systematically influence an organization at both strategic and operational levels in an integrated manner (Calingo, 1996). Many boards in organizations do not involve themselves in the strategic direction of quality (Leonard et al., 2004). Even in the situation where there is a "strong strategic intent to promote quality" (Barclay, 1993), this intent is not realized at operational level due to poor communication and policy infrastructure (Leonard et al., 2004).

Leadership for Quality

Leadership is the ability to inspire people or employees in an organization to work together as a team to achieve common objectives. Leaders are people who are able to express themselves fully; they know what they want, why they want it, and more important, how to communicate what they want to others to gain co-operation and support and is the most important part of management (Spinks et al., 1995). In order to master the role of leadership, leaders must strive for attitude modification in their followers to change their mind set. Leadership is the heart and soul of an organization. It is considered to be a concept which describes actions which yield change and improvement, and is associated with the development of community involvement and participation on decision making (Berry, 1997). Leadership is broadly described as a process by which behaviors, values, beliefs and attitudes of members of a group, organization or community are influenced in a way, which promotes collaborative action towards the achievement of shared outcomes (Berry, 1997).

Design Quality

Design quality has been defined as the features, styling and other product attributes that enhance fitness for use or "utility" for the consumer (Fine, 1986). According to Forker et al. (1996), the importance of design quality has been highlighted repeatedly in the quality literature. In this study stated that in recognition of the disproportionate costs incurred at the design stage and the major impact design quality can have on production costs and product quality, much business attention today is focused on improving design quality. Deming's emphasis on continuous improvement of design quality. Juran mentions design quality where the product designs should address the critical few features that capture consumer's needs. Crosby is one of the strongest advocates among the gurus of designing quality into a product. Crosby traces most product quality problems to poor design (Forker et al.,1996). Fynes and Voss (2001) found that design quality has a positive effect on conformance quality because the use of techniques such as design for manufacturing (DFM) and Taguchi methods impact strongly on conformance quality. According to Talha (2004) in his research on the overview of total quality management, companies must first design products to satisfy customers through the quality of design in

order to ensure that performance will achieve customer satisfaction. They must then meet design specifications through conformance to quality (Fynes, Voss & Burca, 2005).

Hypotheses development

Result from an empirical investigation conducted by Rodriguez, et al (2006) on IT use in supporting TQM initiatives, indicated that IT use to support quality data and reporting has a significant impact on quality performance. A Boeing C-17 On Board Inert Gas Generating System (OBIGGS) II improvement project team worked to fix an inert gas generating system that previously needed constant repairs. Team members used several quality tools to identify causes and find solutions. The outcome was a 7400% increase in system reliability and reduced initialization time. They completely redesigned a system that prevents fuel tanks from exploding if struck by enemy gunfire. This group was one of three teams to earn a silver medal in the 2007 International Team Excellence Competition, sponsored by ASQ's Team and Workplace Excellence Forum (Adrian, 2007). As such, the following hypothesis is proposed:

H1 : Variables for quality has positive effect on Design Quality
H1a : Leadership for Quality has positive effect on Design Quality.
H1b : Quality Strategy has positive effect on Design Quality.
H1c : Quality Technology / Tools have positive effect on Design Quality
H1d : Quality Culture has positive effect on Design Quality
H1e : Rewards & Recognition has positive effect on Design Quality

3. Methodology

Population was focused on all the quality standard registered manufacturing firms located in Northern region – Penang, Kedah, Perak and Perlis state, Malaysia. The key informants were quality managers or coordinators directly involved with the implementation of quality management. Study was performed using a self-administered questionnaire survey. Questionnaires were developed based on literature review and consultations from supervisor and lecturers. Likert scales were adopted. Questionnaire was distributed direct and indirectly to respondents through personals approach, mailing or email.

Variables and measurements

Below are the construct measures and their sources that anchored by a strongly agree / disagree 5 point Likert scale. All of them are adapted from the stated sources.

Table 1: Variables and source measurement

Variables	Source (s)
Rewards & Recognitions	Allen & Kilmann (2001)
Quality Technology & Tools	Brah & Lim (2006)
Quality Strategy	Brown (1998); Mehra & Agrawal (2003); Pun (2005)
Quality Culture	Abraham, Fisher & Crawford (1997)
Leadership for Quality	Badri & Selim, Alshare, Grandon, Younis & Abdulla (2006)
Design quality	Fynes, Voss & Burca (2005)

4. Results and analysis

The survey was administered in one phase to 243 ISO certified manufacturing companies in Northern Region, Malaysia. In this phase, a packet containing a questionnaire and a pre-addressed, postage-paid reply envelope was mailed to the respondents. In addition, the respondents were also contacted by email, seeking for their participation in this study. The certified manufacturing companies listed in the Directory of certified products and companies, and accredited laboratories in Malaysia from SIRIM database, all are certified with Quality Management System Standard. The total responses that have been received were 105. After eliminating 20 non-usable responses, 85 usable responses were received. There's no response from 138 manufacturing companies. As a conclusion, the response rate for this study was 47.09%.

Table 2: Analysis of responses

Response	Number
Total for Non-usable Responses	20
Usable Responses	85
Total Responses	105
Non-Response	138
Total Sent	243

The response rate is calculated as = [Number Returned / Number in sample - (Non-usable Responses)] × 100 (De Vaus, 1996).

Figure 1: Response rate formula

The response rate for this study was calculated as
[105 / (243 - 20)] × 100 = 47.09%

Profile of Respondents

Of 105 companies that completed the questionnaire, most of the respondents were aged from 36 to 40 years old (34.1%) follow by 41 to 45 years (27.1%). 68.2% of the survey's respondents were male and 69.4% are Chinese. The presence of a 31.8% of female respondents in the survey was not surprising since key positions in companies are normally male dominated in Malaysia. The questionnaire was answered mostly by Quality Assurance (QA) managers (23.5 %) or by QA Executive (5.9%) and by QA Engineer (4.7%) and remainder by others. 60 percent of the questionnaires were completed by QA department, 8.2 percent by Quality Control (QC) Department, 5.9 percent by Management while the rest by other departments. 65.9% of the respondents were degree holder. Since majority respondents had extensive knowledge in quality management, the problem of survey completion without a sound understanding of the technical matter was avoided. 37.6% having working experience of 11 - 15 years and 25.9% have been worked for 16 - 20 years. Generally, the respondents had considerable years of working experience that enabled them to fully understand their companies and consequently, give reliable answers.

Table 3: Profile of firms / Organizations

Variables	Description	Frequency	Percentage
Primary business	Electrical & Electronics	34	40.0
	Industrial & Engineering	5	5.9
	Chemical	5	5.9
	Plastic	7	8.2
	Apparel	1	1.2
	Others	33	38.8
Number of employees	< 100 employees	18	21.2
	100 ~ 250 employees	20	23.5
	251 ~ 500 employees	11	12.9
	501 ~ 1000 employees	12	14.1
	> 1000 employees	24	28.2
Year of organization in business	5 years or less	3	3.5
	6 ~ 10 years	7	8.2
	11 ~ 15 years	17	20.0
	Above 15 years	58	68.2
ISO9000	Yes	80	94.1
	No	5	5.9
QS9000	Yes	10	11.8
	No	75	88.2
TS16949	Yes	18	21.2
	No	67	78.8
Others	Yes	29	34.1
	No	56	65.9

Factor Analysis

Data collected from survey-based research are constantly being questioned over the quality of their measures. Given that sound theoretical assessment had been considered, statistical procedures to a certain extent can ascertain the validity and reliability of these measures. As the number of variables was large, there was a need to better represent a smaller number of concepts. Thus, factor analysis was performed as it could assist in selecting a representative subset of variables and in a meanwhile retaining their original character.

In this study, four factor analyses were run to verify the postulated dimensionality of the independent, dependent and mediating variables respectively. A forced choice procedure was opted for the number

of extracted factors with VARIMAX rotation on independent variables. It should be noted that all factor analyses were diagnosed to have met their underlying assumptions based on their Kaiser-Meyer-Olkin measure of sampling adequacy, and the diagonals of the anti-image correlation matrix to be above .50. Sufficient unique loadings (for more than 1 extracted factor) and ability for each item to account for a minimum of 50 percent of its variation were conditions set in retaining the items. The analyses provided a clean factor structure with items loading on the appropriate factors. The cut off point of factors loadings for retention is .50 (Hair et al., 2005). All items showed high loadings that are more than .50 and thus, no items were deleted due to low or incorrect loading.

Table 4: Factor Loadings for Independent Variables – Rotated Component Matrix

		Component				
Code	**Leadership for Quality**	LQ	QS	QC	RR	QTT
LQ19	Leaders in my organization create quality strategic directions	**0.77**	0.17	0.23	0.13	0.17
LQ20	Leaders in my organization communicate a clear quality vision	**0.79**	0.26	0.26	0.11	0.14
LQ21	Leaders in my organization set specific action plans for successful implementation of quality strategic objectives	**0.86**	0.19	0.17	0.12	0.22
LQ22	Leaders in my organization show strong commitment to quality policies and strategies	**0.83**	0.28	0.12	0.17	0.09
LQ23	Leaders in my organization guide in setting quality performance expectations	**0.85**	0.20	0.18	0.12	0.21
LQ24	Leaders in my organization create an environment that encourages quality in organization	**0.81**	0.22	0.21	0.00	0.11
LQ25	Leaders in my organization communicate the importance of continuous improvement and quality	**0.83**	0.14	0.26	0.11	0.12
	Quality Strategy					
QS12	There is a quality missions and / or objectives in my organization	-0.01	**0.82**	0.28	0.14	0.11
QS13	Quality missions and / or objectives in my organization is review periodically	0.30	**0.63**	0.11	0.20	0.24
QS14	Manufacturing or production sections in my organization involve actively in achieving quality missions and / or objectives	0.24	**0.85**	-0.01	-0.02	-0.13
QS15	Quality certifications ensure the quality of products of my organization	0.30	**0.71**	0.15	0.11	0.08
QS16	My organization reputation in markets is better compared to those who didn't obtained quality certifications	0.23	**0.69**	0.29	0.04	0.30
QS17	Marketing positions of my organization is better compared to those who didn't obtained quality certifications	0.21	**0.85**	-0.03	0.13	-0.04
QS18	Product and / or service quality of my organization is better compared to those who didn't obtained quality certifications	0.20	**0.78**	0.21	-0.07	0.26
	Quality Culture					
QC5	There is a clear evidence of an executive team sharing and championing a quality vision in my organization	0.30	-0.08	**0.64**	0.22	0.18
QC6	Managers in my organization allocating resources to quality issues	0.18	0.24	**0.61**	-0.13	0.27
QC7	My organization uses of many special words or symbols that emphasize quality *(e.g. teamwork, multitasking, process re-engineering, best practice, benchmarking, etc)*	0.19	0.18	**0.65**	0.00	0.13
QC8	There is a QA personal or QA teams driving the quality spirit in my organization	0.06	0.08	**0.81**	-0.02	0.04
QC9	Meetings are held regularly to communicate the issues related to quality in my organization	0.14	0.05	**0.73**	0.22	0.11
QC10	Managers in my organization visibly supporting the quality through word and action	0.28	0.16	**0.62**	0.28	-0.01
QC11	QA team expect in my organization to act in ways that emphasize quality	0.24	0.22	**0.76**	0.05	-0.09

	Rewards & Recognition					
RR1	My organization provides non-monetary forms of recognition *(e.g. certificated of appreciations, etc)* for staff	0.07	0.02	0.05	**0.78**	0.15
RR2	My organization provides celebrations *(e.g. lunches, dinners, special events, etc)*for staff	0.06	0.05	-0.01	**0.82**	0.25
RR3	My organization provides profit sharing for staff	0.18	0.15	0.07	**0.77**	-0.03
RR4	My organization provides bonus for staff	0.14	0.10	0.25	**0.70**	0.02
	Quality Technology & Tools					
QTT26	My organization is a heavy user of technologies for daily operations *(Internet, emails, scheduling systems, automated tracking systems, warehouse management systems, automated storage and retrieval systems, etc)*	0.18	0.05	0.10	0.07	**0.74**
QTT27	My organization is a heavy user of quality tools in daily operations for decision making *(e.g. Statistical analysis – Pareto charts, control charts, SPC, flowcharting, graphs, histogram, scatter plot, Cause and Effect, FMEA, QFD, Check sheets, mistake proofing, etc)*	0.25	0.20	0.13	0.24	**0.75**
QTT28	My organization is a heavy user of quality tools in analysis for decision making *(Statistical analysis – Pareto charts, control charts, SPC, flowcharting, graphs, histogram, scatter plot, Cause and Effect, FMEA, QFD, Check sheets, mistake proofing, etc)*	0.20	0.13	0.11	0.11	**0.77**
Eigenvalues		10.51	2.79	2.34	2.22	1.57
Percentage variance (69.43%)		37.55	9.96	8.36	7.95	5.60
KMO Measure of Sampling Adequacy		.85				
Bartlett's Test of Sphericity - χ^2 (d.f)		1691.69 (378)				

Reliability Analysis

The remaining items that survived the factor analysis procedure were subjected to reliability analysis. The computation of the Cronbach's Alpha would determine the extent of agreement between respondents for each dimension; such that a higher score would indicate a higher reliability. All the Cronbach Alpha values are above 0.6 implying that the measures of all items are acceptable. The alpha coefficients for all dimensions are reported in the following factor analyses tables.

Table 5: Result of the Reliability Test

Variable	No of Item	Item Dropped	Cronbach's Alpha
Rewards & Recognition	4	-	.81
Quality Culture	7	-	.86
Quality Strategy	7	-	.92
Leadership for Quality	7	-	.96
Quality Technology & Tools	3	-	.77
Design Quality	5	-	.85

Table 6: Result of Regression Analysis for Customer Satisfaction

Variable	**Standardized Coefficients Beta**
Rewards & Recognition	.13
Quality Culture	-.01
Quality Strategy	.24*
Leadership for Quality	.25*
Quality Technology & Tools	.24*
F	11.38***
R^2	0.42
Adjusted R^2	0.38
F^2 Change	11.38***
R^2 Change	0.42

Note: *p<0.05

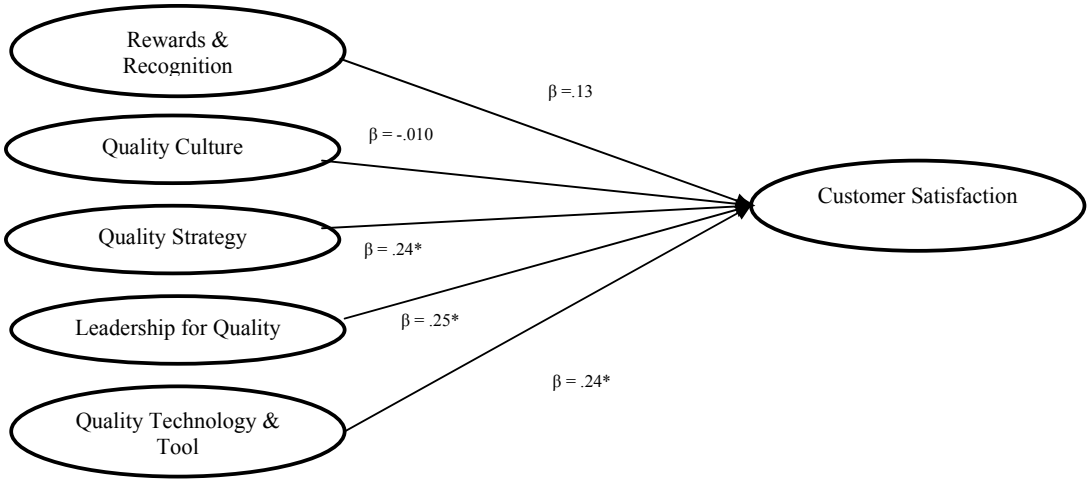

Figure 2: Relationship between Independent variables and dependent variable

From the Figure 2 above, significant relationship exist between Quality strategy ,(Leadership for Quality ,(Quality Technology and Tool and Customer Satisfaction with $p<0.05$. R square indicated 41.9% of independent variables that explained the dependent variable, which is customer satisfaction. Among five independent variables as shown in Figure 3, three show significant relationship with customer satisfaction that serves as dependent variable in this study. They are Quality strategy, Leadership for quality and Quality technology and tool, with $p<0.05$. However, only 41.9% of independent variables explained dependent variable in this model. Based on research conducted by Pun (2005), result shows that manufacturers who can manage strategy formulation and execution effectively with performance measures will find themselves in a more advantages position in comparison to their competitors. Facing the changing demands of business environments, sound strategy formulation helps manufacturing enterprises to compete for survival and growth and thus, lead to customer satisfaction.

According to one of the hypothesis proposed by Bunney et al (1997), top management leadership to be the driver of customer focus and quality focus. The results show positive values of more than 0.5 for all correlations at 0.001 significant levels in this study. This indicates a strong positive correlation between top management leadership, customer focus and quality focus. Meyer and Collier (2001) and Anderson et al (1998) also find strong correlation between leadership and the quality attributes. Both studies identify leadership as an important initiator and driver of the other components; moreover, they are responsible for creating an environment culture of Total Quality Management and accessing the suitability of its implementation (Bunney et al., 1997).

Another finding from Bunney et al (1997) shows technology plays an important role in quality management where high-tech firms generally perform better in quality when compared to low-tech firms and this is one of their hypotheses in the research. Perhaps, use of technology assist operations in many ways, such as, cutting down information and processing lead-time, improve efficiency and minimize errors to the minimum (Bunney et al., 1997). Results support the notion that with the help of technology, it improves business operations, increase the delivery quantity of services or products, provide greater flexibilities to customers and bring about an increase in the productivity of employees. As a result, this leads to customer satisfaction.

5. Limitations of the study

The results of this research are subject to several limitations, which were identified and recognized while conducting this research. Although this research is considered successful in meeting the research objectives, it can be refined and evocative if the following limitations do not occur. First, the target respondents were the QA manager or QA personal that handling quality management system. Some respondents were not from QA department. This may due to the different in organization structure of Manufacturing Firms. Second, the questionnaires were sent to Manufacturing Industry in Northern Region of Malaysia only because majority of the Manufacturing Industry located in this region and it's

served as a good starts for this study. Thus, results will only be applicable within manufacturing firm in Northern Region Malaysia only.

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