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Maha Mohammed Yusr [1]
Sany Sanuri Mohd Mokhtar
Abdul Rahim Othman

THE EFFECT OF TQM PRACTICES ON TECHNOLOGICAL INNOVATION CAPABILITIES: APPLYING ON MALAYSIAN MANUFACTURING SECTOR

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Abstract: *The relationship between TQM practices and innovation performance had drawn the attention of several scholars during last decade, however, this relationship still not clear and inconclusive. Therefore, this study is one of the attempts that aim to clarify the nature of this relationship. Reviewing the past studies reveals that there is somewhat ignoring in examining the indirect relationship between TQM and innovation performance. Thus, to determine and explore the effect of applying TQM practices within the organization on innovation performance, this study is aiming to investigate the relationship between TQM practices and technological innovation capabilities in Malaysian context. The obtained result of SmartPLS statistical analysis confirmed the positive effect of applying TQM practice on technological innovation capabilities. Moreover, the findings also provide an indication regarding the level of occurrence of technological innovation capabilities among Malaysian manufacturing companies. According to the output several recommendations have been highlighted to the managers of the companies.*

Keywords: *Total Quality Management (TQM); Technological innovation capabilities; innovation performance; Partial Least Square PLS*

1. Introduction

Dose TQM's practices influence innovation performance? This question had drawn the attention of several scholars during last decade, however, this relationship still not clear and inconclusive. Therefore, this study is one of the attempts that aim to clarify the nature of this relationship. Reviewing the past studies reveals that there is somewhat ignoring in examining the indirect relationship between TQM and innovation performance. One of logic reasons to justify these inconclusive findings among the previous studies, is that TQM practices and innovation could be related in more complex (indirect) way rather than a simplistic (direct) relationship (Singh and Smith, 2004; Yusr, 2013). Furthermore, in (2003) Prajogo and Sohal recommended investigating the relationship between TQM practices and innovation through another context in order to determine innovation performance. According to literature, more specifically, RBV theory, the organizations can achieve superior performance and competitive

[1] Corresponding author: Maha Mohammed Yusr
email: maha_yusr@yahoo.com

advantage by developing and deploying unique and distinguished organizational resources and capabilities (Barney, 1991; Wernerfelt, 1984).

In this context, Innovation capability basically refers to the firm’s ability to continuously transform knowledge and ideas into new products, processes and systems for the benefit of the organization (Hurley and Hult, 1998; Lawson and Samson, 2001). Furthermore, Innovation capability has been regarded as an organizations’ critical capability that deploys resources with a new capacity to create value (Yang *et al.*, 2009). Moreover, Innovation capabilities has been known as the skills and knowledge needed to effectively absorb, master, and improve existing technologies, and to create new ones (Lall, 1992). Meanwhile, Cavusgil, Calantone and Zhao (2003), Yusr (2013); Yusr *et al.* (2012); and Yusr *et al.* (2013) consider innovation capability as critical antecedents to achieve superior innovation performance, which provides the potential for effective innovation performance. Since, the concept of innovation is captured by innovation capability, as an antecedent of innovation performance, thus, to determine and explore the effect of applying TQM practices within the organization on innovation performance, this study is aiming to investigate the relationship between TQM practices and technological innovation capabilities in Malaysian context. Technological innovation capabilities in the current study are consisting of several capabilities that help and pave the way to achieve high rate of innovation performance. Technological innovation capabilities that have been adopted in this study are formed of learning capability, Research and Developed R&D capability, resource allocation capability, manufacturing capability, marketing capability, organization capability, and strategic planning capability (Yam *et al.*, 2004). Hence, by examining the effect of TQM practices on technological innovation capabilities the first objectives of this study will achieve.

As has mentioned previously, this paper will be applied in Malaysian context more specifically in Malaysian manufacturing companies. Malaysian now has nation goal which is becoming developed country by 2020 (*10th Malaysia Plan*, 2010). For that, many plans have been conducted with numerous procedures and steps to follow the 2020 Vision, and, Innovation Led Economy is the latest plan that cover the period from 2011-2015 (*10th Malaysia Plan*, 2010). Being innovative is a critical requirements to Malaysia, to achieve that, several policy initiatives and institutional have been launched to move Malaysia towards an innovation-led economy (Tuah *et al.*, 2009). However, the occurrence of innovation is still low in Malaysia compare to what should have been based on its level of development (*National Survey of Innovation in Industry, 2000-2001*, 2003). Furthermore, the result of National survey of innovation in the industrial sector, which conducted three surveys to determine the level of innovativeness of Malaysian manufacturing sector for the period from 1990 to 2002, showed that innovation performance of manufacturing sector in Malaysia is low and needs to be reinforced *(National Survey of Innovation in Industry*, 1996; 2001; 2003). Given the above facts related to Malaysia scenario, determining the level of technological innovation capabilities of Malaysian manufacturing companies is represent the second objectives of the current study, which hope to provide clear picture about Malaysian manufacturing capabilities status.

2. Literature Review

Technological innovation capabilities

Technological innovation capabilities have been defined as a set of characteristics of an organization that support and facilitate the innovation output (Burgelman *et al.*, 2004). Developing and enhancing these capabilities can help to enhance the organization performance and lead to build the competitive advantage of the organizations (Yam *et al.*, 2004). Reviewing literature reveals that there are several approaches through which technological innovation capabilities have been discussed, for instant, Christensen (1995) uses asset approach to assess technological innovation capabilities where the main elements were science research asset, product innovation asset, and esthetics design asset. In (1996) Chiesa, Coughlan, and Voss, suggest process approach as suitable approach to determine innovation capabilities. Chiesa *et al.*, (1996) point up the concept of generation capability, process innovation capability, product development capability, technology acquisition capability, leadership capability, resources deployment capability, and capability in effective use of system and tools as the main capabilities that form innovation capability.

Another study was conducted by Burgelman *et al.*, (2004) utilize same approach (e.g. process approach) with different elements to evaluate technological innovation capabilities. Belong this approach, six elements form innovation capabilities which represented by organization’s capability in resources availability and allocation, understanding competitor innovative strategy and market, understanding technological developments relevant to firm, structural and cultural affecting internal innovative activities, and strategic management capability to deal with internal innovative activities. in the same year (2004) Yam *et al*. introduce another paper that addresses innovation capability by using functional approach. Yam and his team introduce several capabilities according to the function bases of each capability, accordingly, learning capability, R&D capability, resources allocation capability, marketing capability, manufacturing capability, organization capability, and strategic planning capability have been considered as the main element to determine innovation capability of the organization.

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The functional approach has been adopted in this research paper for two reasons: First, it is easy to understand, and second, it facilitates the multi-informants approach for the survey. Beside, functional approach has been applied in Asia context specifically in China, which might be suitable to be applied in Malaysian context.

Total Quality Management TQM

In the last two decades, Total Quality Management TQM has been considered as the modern management philosophies and concepts (Prajogo and Hong, 2008). TQM has started in Japan from 1950 onwards. Deming, the founder of TQM, taught top management of Japanese firms how to improve product quality to be more credible (Summers, 2009), which opened the global market in front of the Japanese companies (Gevirtz, 1994). Miller (1996) defines TQM as a “Continuing process where top management makes whatever important steps to enable everyone in the organization in the course of performing all duties to establish and achieve standards which meet or exceed the need and expectations of their customers, both external and internal” (p. 157). In 1997, Forker, Mendez and Hershauer introduced TQM as a complementary system of rules and steps which targets to improve the quality of a organization’s products and services. In the present study, TQM practices are represented by five dimensions (leadership and management commitment; customer focus; people management; processes management; quality data reporting), following several previous studies (Saraph, *et al.*, 1989; Dean and Bowen, 1994; Black and Porter, 1996; Powell, 1995).

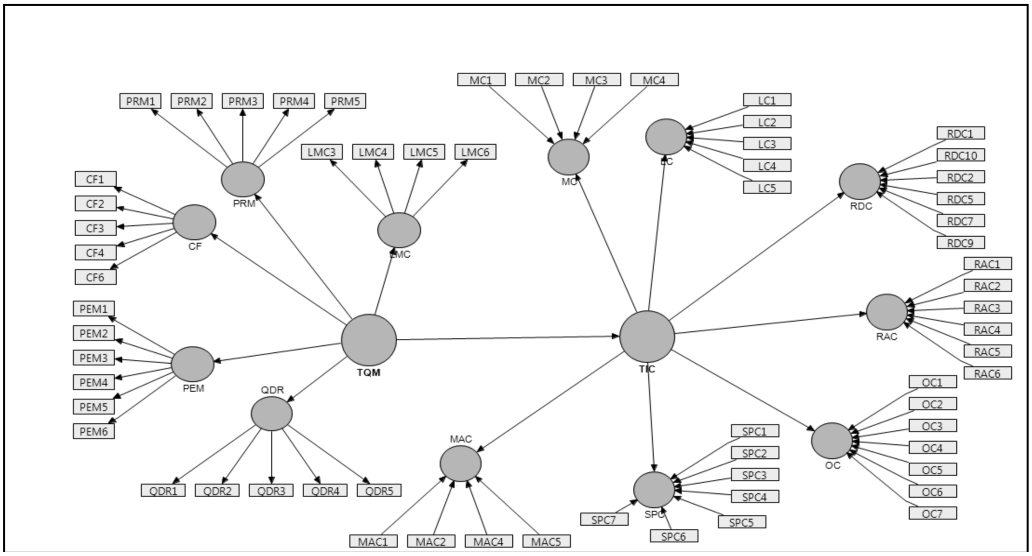
The relationship between TQM practices and innovation capabilities

Applying TQM in the organization provides a good environment and conditions that lead to generate distinctive capabilities in different aspects of the organization (Lorente *et al.*, 1999a; Perdomo-Ortiz *et al.*, 2006; Santos-Vijande and Lez, 2007). Prajogo and Hong (2008) found that TQM practices are effective for building and developing a range of capabilities that go beyond quality. Through top management practice of TQM a suitable environment will be established that encourage the work as one team, trust culture, flow the information, share the knowledge within the organization, which provide on the ends a suitable environment to learn, change and quick response to the surrounding circumstances. In other words, the commitment of the leadership towards quality helps the organization to build a distinctive capability that makes it more flexible to respond to the changing in the environment (Lorente *et al.*, 1999b; Perdomo-Ortiz *et al.*, 2006).

Furthermore, customer focus and supplier quality management have been considered as the window through which the organization look at the outside and get the necessary feedback that related to customers, competitors, which represents the main source that build the Resource and Development R&D capabilities, and, also this kinds of information helps to develop the strategy planning capability. In addition, People management is the processes in which the organization keeps in developing their staff through systematic training programs that provide necessary competences that can be shared within the organization. TQM philosophy emphasizes on equipping the employees in different level with latest knowledge in different fields related to the organizations’ processes, which leads to build and provide the organization with strong basis of skills and innovation capabilities (Jones and Grimshaw, 2012; Perdomo-Ortiz *et al.*, 2006).

Moreover, Process management helps to build the manufacturing capabilities of the organization, where process management practices focus on the continuous improvement and preventing the defect through transforming the data (regarding the performance, technologies, system) between the functional areas during the organization, in other words, the effective process management the effective ability to transform the output of certain department into other department to determine the source of poor performance in the process of producing the product, which in turn, affect positively to build the manufacturing capabilities within the organization. Likewise, quality data reporting, through which the management reviews the processes and evaluate the performance systematically, which help to provide the organization with the capabilities to make a right discussions based on fact (Perdomo-Ortiz *et al.*, 2006). Furthermore, through recording the failure and success experiences learning capabilities of the employees will develop and enhance. Considering the above discussion, applying TQM provides the organizations with capabilities that can be considered as the innovation capabilities (Perdomo-Ortiz *et al.*, 2006; Perdomo-Ortiz, *et al.*, 2009). Based on the pervious discussion the following hypothesis introduced as follows:

H: TQM practices are positively associated with innovation capability.



TQM: *Total Quality Management*; LMC: *Leadership and top Management Commitments*; CF: *Customer Focus*; PEM: *People Management*; PRM: *Processes Management*; QDR: *Quality Data Reporting*; TIC: *Technological Innovation Capabilities*; LC: *Learning Capability*; RDC: *R&D capability*; RAC: *Resources Allocation Capability*; MC: *Manufacturing Capability*; MAC: *Marketing Capability*; OC: *Organizing Capability*; SPC: *Strategic Planning Capability*.

Figure 1. The conceptual framework

3. Research methodology

Measurement

A survey research method has been used by this study to collect the necessary data to evaluate the nature of the relationship shown in the framework above. From the previous related literature the instrument has been adopted (Ahire *et al.*, 1996; Dean and Bowen, 1994; Flynn *et al.*, 1994; Fuentes *et al.*, 2006; Powell, 1995; Prajogo and Sohal, 2006; Rahman and Bullock, 2005; Samson and Terziovski, 1999; Yam *et al.*, 2004). A 7-point Likert scale was utilized for all valid items to ensure a higher degree of statistical variability among the survey answers, while 7 represent strongly agree, and 1 strongly disagree. The respondents were asked to give their views regarding to which extend these items were used in their companies.

Sample and data collection

By using online survey 80-items have been administrated randomly to 500 manufacturing companies listed in Federal Malaysian Manufacturing FMM index (2012), which includes companies from divers industries. Out of 500 distributed questionnaires, 105 were returned, representing a response rate of 21%. Due to the nature of this study, that targets to examine the effect of TQM practices on innovation capabilities, the unit analysis was CEO, manager of quality, manager of factory, or manager of R&D of the companies, where the managers in that positions are more knowledgeable regarding the issue of this paper. 9.5% of the respondents were CEO of the companies, whereas the highest managers of factory were the highest percentage with a rate of 36.2%, followed by managers of R&D with a percentage of 31.4%, while managers of quality represented by 22.9% of total respondents. On the other hand, 22.9% of the companies were electrical & electronic followed by food and beverage companies with a rate of 15.25, then Fabricated metal companies come with percent of 6.7%, while the remain ration distributed among other industries like automobile and motoring products, textile and wearing apparel, chemical products and like. Table (1) below illustrates the summary of the demographic characteristic of the sample.

Table 1. Demographic characteristic of the sample

Demographic characteristic	**Percentage**
Industry	
Electrical & Electronic	22.9%
food and beverage	15.2%
Fabricated metal products	6.7%
Others	55.2%
Total	100 %
Position	
CEO	9.5%
Manager of quality	22.9%
Manager of factory	36.2%
Manager of R&D	31.4%
Total	100.0

Data analysis

For purpose of assessing the model introduced in this study, Structural Equation Model has been run, more specifically, Partial Least Square (PLS-SEM) path modeling. However, to determine the level of innovation capabilities of Malaysian manufacturing Statistical Package of Social Science (SPSS) has been used. PLS-SEM path modeling is analysis technical that focuses on the valuation and analysis of the relationships among the latent variables, what called also, inner model or structural model. However, a block manifest variable is utilized to measure latent variables having every indicator relate with a particular latent variable referred to as an outer relationship or measurement model (Henseler *et al.*, 2009). The two main kinds of outer relationship which are significant to PLS path modeling are the formative and reflective models (Gudergan, *et al.*, 2008). While a formative measurement model has cause–effect relationships between the manifest variables and the latent index (independent causes), a reflective measurement model involves paths from the latent construct to the manifest variables (dependent effects) (Gudergan *et al.*, 2008; Jarvis *et al.*, 2003).

Since the theoretical model in the present study includes both formative and reflective indicators, applying PLS-SEM, among others, was the suitable analysis technique for this study. Further, utilizing PLS has several advantages; first, it is a nonparametric technique and, consequently, does not assume normality of the data; second, it does not require a large sample size as other causal modeling techniques like AMOS (Falk and Miller, 1992; Ruiz, et al., 2008). Thus, SmartPLS version 2.0.M3 was performed in data analysis to assess the measurement and structural models. Although the main objective of the study is to test the relationship between the main constructs, evaluating the measurement model will apply to ensure the validity and reliability of the instrument which implicates the validity of the getting output.

Assessing the measurement model

As mentioned previously, the measurement model encompasses of relations between the constructs and the items operated in their measurements. It should be mentioning that reflective and formative constructs require different treatment while being assessed.

Consequently, the investigation of the correlations or internal consistency of the measuring items of formative constructs is not required, and, vice versa, meaning, examining the internal consistency of the measuring items of reflective construct is required (Mathieson *et al.*, 1996). The evaluation of both set of constructs is discussed individually in the sections below.

Formative construct

TIC construct is a multidimensional indicator (Jarvis *et al.*, 2003) which consists of reflective first order (between the indicators and the dimensions) and formative second order (between the dimensions and the construct). Therefore, TIC construct will be subjected to the two kinds of evaluation to test the validity and reliability of the construct. While the value of the items weights for first order of formative dimensions is examined to determine the relevance and level of contribution of the items to this dimension, the loading of the dimensions for second order of reflective construct is tested. To get the significance of each item, bootstrapping has been run, and it has found that out of 45 items constituting TIC only 23 were significant while the remained items were non-significant. For formative indicators, although there were several items known as insignificant, they should never be discarded simply on the basis of statistical outcome (Jarvis *et al.*, 2003). Jarvis *et al.*, (2003) confirmed that such action may substantially change the content of the formative index. Consequently, the researcher should keep both significant and insignificant formative indicators in the measurement model as long as this is conceptually justified. Since the item has been adopted from the previous studies, and, have been considered as valid indicators of TIC, the current study will keep these insignificant indicators in the measurement model of the present study. A concern with formative measures is the potential of multicollinearity among the items, which could produce unstable estimates (Mathwick *et al.*, 2001). Thus, a collinearity test was carried out. By following Hair, Black, Babin & Anderson (2010) procedure, all tolerance values should exceed 0.1, while Variance Inflation Factors VIF should be lower than 10. The result of multicollinearity for seven formative dimensions shows that all items meet the cut-off threshold for VIF and tolerance. Table (2) shows the highest value of VIF and the lowest value of the tolerance.

Table 2. The result of Multicollinearity of formative dimensions

Dimensions	**Tolerance > 0.1**	**VIF < 10**
Learning capability	4.2	0.23
R&D capability	8.8	0.11
Resource allocation capability	3.6	0.27
Manufacturing capability	5.0	0.19
Marketing capability	3.2	0.31
Organization capability	4.8	0.20
Strategic planning capability	6.6	0.15

Reflective construct

The other constructs in the model were reflective indicators, hence, all items will be subjected to convergent validity the average variances extracted AVE and discriminate validity tests to confirm the validity and reliability of the measurement model for both first and second order constructs. The acceptable threshold for composite reliability and Cronbach's Alpha is 0.7 as suggested by Hair *et al.* (2011), while the AVE should exceed 0.5 (Fornell and Larcker, 1981). SmartPLS result shows that all the items meet the basic requirements, therefore, it can be confidently concluded that the measurement model is valid and reliable. Table (3) bellow illustrates the internal consistency (Cronbach's alpha and composite reliability) and AVE of the first order of TQM construct and second order constructs of TQM and TIC.

Table 3. The reliability and convergent validity of TQM and technological innovation capabilities

		Convergent validity		
Construct	**Items**	**Composite Reliability**	**Cronbach's Alpha**	**Average Variance Extracted AVE**
TQM	**CF**	0.969	0.965	0.547
	LMC			
	PEM			
	PRM			
	QDR			
Technological innovation capabilities	**LC**	0.886	0.965	0.547
	RDC			
	RAC			
	MC			
	MAC			
	OC			
	SPC			

Furthermore, Henseler *et al.*, (2009) and Hair *et al.*, (2011) suggested that the indicators' cross loading should be tested and the loading of each indicator with the respective construct must be higher than the loading with other constructs. For discriminant validity assessment; two conditions should be fulfilled; first, the correlations values of the indicators with its latent variables should be higher than the correlation with other constructs, second, the square root of AVE of the construct should be higher than correlation with another constructs (Fornell and Larcker, 1981). Table (4) depicts the cross loading values of the indicators are higher than the loading with other constructs. The result of discriminant validity also shows that all items fulfill the minimum requirements, as shown in Table (6). Accordingly, it can be concluded that all reflective constructs showed an adequate measurement model.

Table 4. Cross loading of the items

Constructs	TQM	TIC
Leadership and Management Commitments	**0.843**	0.675
Customer Focus	**0.541**	0.310
People Management	**0.907**	0.711
Processes Management	**0.925**	0.714
Quality Data Reporting	**0.904**	0.741
Learning Capability	0.753	**0.856**
Marketing Capability	0.036	**0.096**
Manufacturing Capability	0.605	**0.858**
Organization Capability	0.667	**0.927**
Resource Allocation Capability	0.732	**0.916**
Research and Development capability	0.182	**0.249**
Strategic Planning Capability	0.716	**0.893**

Table 5. T-values result of Items loading

Constructs	Items	Loading	Standard Error	T-Value	P-Value
TQM	**LMC**	0.851	0.035	24.245	0.000
	CF	0.872	0.035	25.176	0.000
	PEM	0.893	0.021	43.503	0.000
	PRM	0.931	0.016	57.958	0.000
	QDR	0.906	0.025	35.878	0.000
TIC	**LC**	0.671	0.132	5.065	0.000
	MC	1.016	0.100	10.204	0.000
	MAC	0.844	0.117	7.235	0.000
	OC	1.008	0.055	18.188	0.000
	RAC	0.890	0.086	10.392	0.000
	RDC	0.692	0.110	6.318	0.000
	SPC	0.811	0.106	7.618	0.000

Table 6. Discriminant validity

Constructs	AVE square root	TIC	TQM
TIC	**0.759**	1	
TQM	**0.832**	0.788237	1

Assessing the structural model

Having established measurement model allows going to the next step which is testing the hypothesized relationship by using PLS algorithm and Bootstrapping algorithm in SmartPLS 2.0. Table (7) below depicts the path coefficient of the hypothesized relationship.

Table 7. Path coefficient of the relationship

Hypothesis	Path Coefficient	Standard Error	T-Value	P-Value	Decision
TQM -> TIC	0.802***	0.046	17.510	0.000	Supported

*** Significant at $p<0.001$

As it is noted from the above Table, the path coefficient of the proposed relationship was significant at level of ($p<0.001$). This output demonstrates the significance role of TQM practices in improving technological innovation capabilities.

Predictive Relevance of the Model

The quality of the structural model can be evaluated by R^2 which indicates the variance in the endogenous variable (e.g., Technological innovation capabilities) that is explained by the exogenous variables (e.g., TQM practices). According to the acquired result the R^2 value was found to be 0.643 indicating that TQM practices can account for 64% of the variance in the technological innovation capabilities. By comparing attained R^2 with criterion suggested by Cohen (1988), where 0.26 substantial, 0.13 moderate and 0.02 weak, it can be stated that R^2 is substantial. Accordingly, the result is demonstrating the substantial role of TQM practices in explaining the technological innovation performance.

Goodness of Fit (GoF) of the Model

To determine the goodness of the model, PLS Structural Equation Modeling has only one measure which was described by Tenenhaus *et al.,* (2005) as the global fit measure (GoF). This measure is the geometric mean of the average variance extracted and the average R^2 for the endogenous variables. GoF is calculated by the following equation:

$$GoF = \sqrt{\bar{R}^{2} \times Average\ Communality\ (\overline{AVE})}$$

$$GoF = \sqrt{0.886 \times 0.577} = 0.715$$

According to the baseline values of GoF suggested by Wetzels, Odekerken-Schröder, and Oppen, (2009) (e.g., small =0.1, medium =0.25, large =0.36), the comparison was made. The results showed that the model goodness of fit measure is large an adequate of global PLS model validity.

To this end, the first objective of this study has been met, and, for the sake of fulfillment the second objective, the present study used SPSS to run the descriptive statistics of availability of each of technological innovation capabilities in Malaysian manufacturing companies. The responses from the survey show that the extent to which the average level of learning capabilities in Malaysian manufacturing companies was slightly higher ($M=4.1$) than the median value of the scale (7-point likert scale), which indicates that those companies have a slightly high level of capabilities in learning and acquiring new knowledge and information. While the average level of organization capabilities and strategic planning capabilities of Malaysian manufacturing companies were moderate with mean value of $M= 4.8$, and, $M=4.9$ respectively, the average level of three capabilities (e.g., Resource allocation capability; Manufacturing capability; Marketing capability) of Malaysian manufacturing companies were slightly low with mean value of $M=3.9$; $M=2.4$ and $M=$

3.4 respectively. The highest average level of Malaysian manufacturing capabilities was Research and Development capabilities with mean value of *M=6.7*. Table (8) below introduces the summary of the descriptive result of the technological innovation capabilities.

Table 8. Descriptive Statistics

Technological innovation capabilities	**N**	**Mean**
Learning capability	105	4.1
Research & Development capability	105	6.7
Resource allocation capability	105	3.9
Manufacturing capability	105	2.4
Marketing capability	105	3.4
Organization capability	105	4.8
Strategic planning capability	105	4.9

4. Discussion and Conclusion

This study is one of the studies that have been conducted to reduce the gap related to the nature of the relationship between TQM practices and innovation performance. To do so, the present paper does not examine the direct relationship between TQM practices and innovation performance. However, this study goes to test the effect of applying TQM practices on technological innovation capabilities, which will help to clarify how and why TQM practices can be good practices for innovation performance. Furthermore, this study response to the recommendation suggested by Singh and Smith (2004), where the authors stated that the relationship between TQM and innovation performance might come in more complex relationship rather that simplistic one.

Therefore, the main objective of this paper was to analyze the influence of applying TQM practices in enhancing technological innovation capabilities in the context of manufacturing sector in Malaysia. The obtained findings of this study have provided empirical support for the major hypothesis proposed in the conceptual model. Therefore, TQM's practices can be considered as the foundation of building technological innovation capabilities in the manufacturing companies in Malaysia, This result also in line with Perdomo-Ortiz *et al.*, (2006) result. By applying TQM practices in the organization several principles will be adopted and diffusion within the organization. Emphasizing on achieving high level of quality performance leads to generates and develops many skills and capabilities in different areas.

Moreover, stressing TQM on people Management as one of the practice of TQM is vital to build technological innovation capabilities. This conclusion is supported by Perdomo-Ortiz et al., (2006) and Perdomo-Ortiz *et al.*, (2009). In addition, Samson and Terziovski (1999) demonstrate that companies with good people management practices seem to be better than non-people management practices to a company's capability. The practices associated with people management promote several aspects which are related to improving and building the capability. For example, TQM stresses in managing people on some aspects such empowerment, training and developing the skills and abilities of the employees through engaging the employees with many training programs, motivating the employees through effective rewards programs, all of these aspects, which people management belong TQM practices concerned about, help to build the technological innovation capability of the organization.

Another TQM's practices which help to improve and enhance the technological innovation capabilities is process management. As has mentioned before, process management practices under TQM concept need a better knowledge of know-how regarding the organizational processes to identify and determine the right solutions to solve the problems. Furthermore, managing the processes helps to establish the documentation of processes, suitable work environment and a culture of preventive maintenance which are considered as significant processes for building technological innovation capabilities of the organization more specifically its helps to enhance the manufacturing capabilities. Transforming the ideas and the output of R&D into manufactured product that can meet the customers need is one of the critical capabilities that could be enhanced by applying TQM practices. Through focusing on customer, as one of TQM practices, the organization will get the substantial and valuable information and knowledge regarding the market and customers references. Such input is considered important to develop R&D capabilities via channeling the research processes towards the explicit and latent need of the customers. Marketing capabilities, on the other hand, will be enhanced also, where focusing on customers helps to build good relationship with the customers, and providing necessary bases to solve and deal with customers' complaints to achieve customer satisfaction (Ooi *et al.*, 2009; Yusr *et al.*, 2012). Furthermore, learning capabilities is one of the capabilities that will be affected positively by implementing TQM practices, where I was found that practicing TQM within organization provides quality culture that pave the way to enhance and learning capabilities, which support the studies done by Martinez-Costa and Jimenez-Jimenez (2008) and Yusr *et al.* (2013). Through improvement continually, solve problems, training group work, communication, encouraging sharing knowledge and many other principles which TQM emphasized on learning capabilities of the companies will be improved.

To accomplish the second objective of this study descriptive analysis was run to determine the average level of each capabilities of innovation is more available within Malaysian manufacturing companies. The obtained output demonstrated that out of seven capabilities of technological innovation capabilities, the average level of three capabilities were low these capabilities represented by resources allocation, manufacturing, and marketing capabilities. Such result somewhat reflect the reality, where The World Bank in its report (2010) mentioned that the upgrading the current product line, and machinery and equipment among Malaysian manufacturing companies declined in the period between 2002 and 2007, which reflected by low average level of occurrence manufacturing and resources allocation capabilities. Based on the attained result that refers to the low average level of incidence of marketing capability among Malaysian manufacturing companies, it could justify the declined of Malaysian export in favor of the countries in the same region (such as Thailand, Philippine, Indonesia, etc.). The result also indicates the occurrence of learning, organization, and strategic planning capabilities among Malaysian manufacturing companies. However, these capabilities are still in its infancy stage. Notably, the highest average level of technological innovation capabilities was in research and development R&D capabilities. This result was not surprising, where the Malaysian government through several economic plans emphasized and focused no developing these capabilities through allocating the necessary budget and paying a lot of attention to build the research and development capabilities of Malaysian nation (*10th Malaysia Plan*, 2010; The World Bank, 2010).

Practical implications and Limitations

Nowadays, innovation has become undeniably as sources of competitive advantage. Therefore, it is important to the companies to seek the ways that help to enhance the innovation performance. Building the necessary capabilities pave the way to achieve high rate of innovation performance. Through this study, the effect of TQM practices on enhancing technological innovation performance has been confirmed, thus, I can be suggested to the companies to apply TQM in proper way through which technological innovation capabilities will be built and enhanced. Furthermore, Malaysian manufacturing companies need to improve and allocate more attention to build their manufacturing capabilities, marketing capabilities, and resources allocation capabilities, while their need to pay more consideration to enhance their learning capabilities, organization capabilities, and strategic planning capabilities.

Although the present study investigates the antecedents' process of innovation performance, there are some limitations which could draw the attention for further studies. Even though this paper targets to introduce a model that helps to improve the innovation performance, innovation performance as dependent variable does not include in the model. Thus, I would be more interesting to examine the effect of TQM practices, technological innovation capabilities on innovation performance in one model to test the effect of all variable on these relationships. Moreover, this study focuses on manufacturing sector in Malaysian context which may affect the generalizability of the results, therefore, it is recommended to re-examine these relationships in other economic sector. Finally, determining the level of technological innovation capabilities in Malaysian manufacturing sector need to conduct another research by government entity that has the ability to do a survey which cover wider respondents over Malaysia.

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Maha Mohammed Yusr
University Utara Malaysia (UUM)
School of Business (SBM)
maha_yusr@yahoo.com

Sany Sanuri Mohd Mokhtar
University Utara Malaysia (UUM)
School of Business (SBM)

Abdul Rahim Othman
University Utara Malaysia (UUM)
School of Business (SBM)

Appendix

Total Quality Management

i) Leadership and management commitment

1. Top management in our company considers quality as their top priority.
2. Senior Managers in our company actively encourage implement a culture of trust.
3. Senior Managers in our company actively encourage involvement and commitment in moving towards 'Best Practice'.
4. Top management in our company considers quality improvement as a way to increase profits.
5. Top management in our company allocates adequate resources towards effort to improve quality.
6. Our company has clear quality goals identified by top management.

ii) Customer focus

1. Our company seriously investigates and fixes all customer complaints.
2. Our company knows our external customers' current and future requirements (both in terms of volume and products characteristics).
3. In our company customers' requirements are effectively distributed throughout the workforce.
4. In our company customers' requirements are effectively understood throughout the workforce.
5. In designing new products our company uses the requirements of domestic customers.
6. Our company regularly measures customer satisfaction.

iii) People management

1. Our company has wide training and development process, including career path planning, for all our employees.
2. Our company has an effective team rewards to motivate the employees.
3. Our company has maintained both top-down' and 'bottom–up' communication processes
4. In our company employees satisfaction is regularly measured.
5. In our company, everyone participates in improving our product (s) /process(es).
6. We believe that all employees take quality as their responsibility.

iv) Process management

1. Preventing defective products from occurring is our strong attitude in our company.
2. The processes for designing new products in our company ensure quality.
3. Our company evaluates and improves business process continuously.
4. Our company has a program to find wasted time in all internal processes.
5. Our company evaluates and improves the individual employee's performance continuously.

v) Quality data reporting

1. The information about the cost to implement quality is available in our company.
2. In our company the data of quality (e g., error rates, defects rates, scrap, defects, etc) is made available to managers and supervisors.
3. Our company uses data of quality as tools to manage quality.
4. Our company uses data of quality to evaluate supervisor performance.
5. Our company uses data of quality to evaluate managerial performance.

Technological Innovation Capabilities

i) Learning capability

1. Our company encourages the discussion among the employees and team learning.
2. Our company offers good learning environment to facilitate innovation.
3. Our company considers employee learning capability as one of the key factors to improve the company's performance.
4. In our company the managers are open to risky projects.
5. Experiences and ideas provided by external sources (e.g., advisors, customers, training companies, etc) are considered a useful instrument for this company's learning.
6. Failures are tolerated within our company.

ii) Research and development R&D capability

1. In our company all functional departments are involved in concept of development of new product (s).
2. In our company all functional departments are involved in screening of new product.
3. Our company has an effective communication among R&D staff.
4. Our company applies advanced designing methods (e.g., concurrent engineering).
5. Our company has a high quality feedback from manufacturing to design and engineering.
6. Our company has a quick feedback from manufacturing to design and engineering.
7. Our company has a good mechanism for transferring technology from basic to new product development.
8. Our company has an appropriate level of investment in new product (s).
9. Our company has an appropriate level of investment in new process (es).
10. Our company has a high percentage of R&D personnel in firm's total employment.

iii) Resource allocation capability

1. Our company plans human resource in phases.
2. Our company selects appropriate personnel in each functional department in innovation process.
3. Our company provides steady capital supplement in innovation activity.
4. Our company fully uses external technologies.
5. Our company understands competitor's core technologies.
6. Our company adapts its technology level in line with changes in external environment.

iv) Manufacturing capability

1. The manufacturing department in our company has a great contribution during the conceptual design stage in innovation process.
2. The manufacturing department in our company has a high ability to transform R&D output into production.
3. Our company effectively applied advanced manufacturing methods.
4. Our company has a high degree of manufacturing cost advantage.

v) Marketing capability

1. Our company has good relationship with major customers.
2. Our company has good knowledge of different market segments.
3. Our company has an effective marketing intelligence system.
4. Our company has high sales-force efficiency.
5. Our company well-maintains brand image.

vi) Organizing capability

1. Our company can flexibly adjust its structure in line with changing in the business environment.
2. Our company can handle multiple innovation projects in parallel.
3. Our company has good coordination among the major functional departments.
4. Our company has good cooperation among the major departments.
5. Our company has good communication with the major suppliers.
6. Our company has good communication with the major customers.
7. Our company has effective mechanisms to track progress of innovation process.

vii) Strategy planning capability

1. Our company has a great extent of contingency planning.
2. Our company is able to identify its internal strengths and weaknesses.
3. Our company is able to identify external opportunities and threats.
4. Our company has a clear goal.
5. Our company has clear plan (with measurable milestones) for our new product(s) and its corresponds processes.
6. Our company is highly adaptive to external environment.
7. Our company is highly responsive to external environment.