Int. J Sup. Chain. Mgt Vol. 8, No. 4, August 2019

Quality Management Practices among High Technology Firms: One-way ANOVA Analysis

Mastora Mustafar[#1], Risyawati Mohamed Ismail[#2], Amran Rasli[3], Salmah Omar[#4]
[#]*School of Technology Management and Logistics,*
Universiti Utara Malaysia, 06010 Sintok, Kedah, Malaysia.
[3]*SUMAIT University, Zanzibar, Tanzania*
[1]*mastora@uum.edu.my*
[2]*risyawati@uum.edu.my*
[3]*amran@sumait.ac.tz*
[4]*salmah@uum.edu.my*

***Abstract*— Quality management practices (QMP) are modern approaches used to enhance firm performance. Although there are numerous research findings on quality management practices, the focus of the research is not much on high technology firms. Hence, this study aims to look at the different levels of quality management practices and firm performance in high technology firms based on firm profiles such as firm cluster, firm size and duration of the operation. Data were collected using questionnaires and analyzed using descriptive and inferential analysis. The one-way ANOVA analysis shows that quality management practices among high technology firms were moderate and the results also indicate that there is insufficient evidence to support the existence of differences based on statistical evidence between QMP and firm cluster, firm size, and duration of the operation. This research finding also allows practitioners to gain a deeper knowledge and understanding of the importance QMP and firm performance in the high technology firms.**

***Keywords*—** *Quality management practices, business performance, High Technology Firm*

1. Introduction

Innovation is the commercialization of inventions (1) while commercialization is the process of delivering products or services to consumers. The difficulty faced by most firms is to create innovative products that can be commercialized (1). Most local firms face problems of product acceptance from their own local users. Local R&D results are difficult to commercialize as most users associate locally developed innovative products with poor product quality (2). Researcher agree that although the elements of trust are difficult to change, local R&D based firms need to prove that the products are of high quality by implementing QMP to meet the local or international standards. Hence, quality management in R&D activities should be addressed. Generally, quality management practices are implemented in large firms based on their strengths and resources. According to (3), stated that most small and medium sized firms are slow and often reluctant to adopt quality management practices compared to large manufacturing firms. However, the findings of (4) state that although small-sized firms have weaknesses due to limited markets as well as insufficient resources and expertise in management, they can still gain an edge in innovation and flexibility that will allow smaller firms to effectively implement QMP. Moreover, (4) noted that firm's size is not a barrier to the firm's implementation of QMP effectively and therefore could help to improve the performance of the firm (5). Additionally, (6) found that four critical quality management practices that significantly contribute to firm sustainability performance such as top management support for quality management, design for quality, quality data and reporting, and continuous improvement. Although there are many studies on the relationship between quality management and firm performance (see 7; 6; 8; 9; 10; 11; 12), a few researches are on quality management relationship within the R&D environment (see 13; 14; and 15). Furthermore, there is a gap in this stream of research as most of the past studies was carried out on (1) large-scale firms, and (2) the public sector, especially with regards to the research results of public and university research institutions (16; 17). Hence, the authors seek to investigate whether quality management practices and firm performance have significant differences among high technology firms based on their background.

A robust innovation ecosystem will create stronger co-operation and integration between industry and academia. Research carried out by Higher Education Institutions should be in line with current industrial demands. Poor relations between industry, university and government will result in limitations on research results for institutions to enter the industry, difficulties in getting partners for research collaboration and network mechanism constraints that provide facilities for R&D activities (18; 19). The success of commercialization requires a complete R&D team that is interdependent with one another (20). A complete R&D team comprises representatives of public labs, end users, technology transfer agencies, public and private

finance agencies, and manufacturers using technology in product or process generation and sell them. According to (21), to commercialize R&D results, organizations need to establish relationships between governments and industries in order to create the concept of research contracts. Hence, the Malaysian government has taken proactive steps in the 11th Malaysia Plan by focusing on strengthening the relationship capital by enhancing cooperation among all stakeholders.

At the enterprise level, initiatives such as improving market-based research, enhancing collaboration between researchers and industries, and promoting private investment in research, development and commercialization will be implemented. Improved partnerships between researchers and industry help to craft research that is relevant to the business, while contributing ideas, infrastructure, tools and expertise. In addition, the private sector becomes an active partner by providing funding, expertise and other resources in research, development, commercialization and innovation (R&D&C&I). Additionally, integrated R&D&C&I initiatives will generate higher returns on investment over the long term and stimulate an increase in productivity of the nation (22).

2. Method

This research aims to enhance deep understanding of the relevance of quality management practices and firm performance of high technology firms. The list of high technology firms is derived from a funding providing organization that provides financial assistance and value added services to technology based firms which intends to commercialize technologies from public universities in Malaysia. This research is only focused on firms receiving financial assistance under the 9th Malaysia Plan. Through the list provided, and after being screened, a sample of 138 firms that received funds for commercialization responded to the survey questionnaires. SPSS was used to analyze data collected.

One-way ANOVA tests were used to compare the levels of QMP and firm performance based on the firm profile. One-way ANOVA was used to test the difference of means after confirming the distribution of QMP and firm performance to be considered normal (23). The one-way ANOVA results will show the mean differences for the various groups based on the F test statistic. The F distribution is the probability distribution of variance samples and distribution changes with variation in sample size. The categories selected comparison are firm cluster (Industry Product, Advance Material, Electrical and Electronic, Biotechnology, Waste to wealth, Foods and Others), firm size (small, medium and large) and duration of the operation (less than 3 years, 3 to 9 years and more than 9 years).

The proposed hypotheses are as follows:

H1: There are differences in firm performance based on firm cluster

H2: There are differences in QMP based on firm cluster

H3: There are differences in firm performance based on firm size

H4: There are differences in QMP based on firm size

H5: There are differences in firm performance based on duration of the operation

H6: There are differences in QMP based on duration of the operation

3. Results

One-way ANOVA was used to examine the difference in the level of quality management practices and firm performance based on the firm profile. One-way ANOVA was used as all profile variables such as firm size, firm clusters and duration of the operation used in this research have more than two categories. The one-way ANOVA test results generate descriptive statistics for each variable, Levene Test and ANOVA. The Levene test on variance homogeneity is very important to determine whether a one-way ANOVA test can be used for comparison of each group. This test will identify whether the sample obtained from the population has a uniformity of variance. This is one of the assumptions that need to be met to use a one-way ANOVA test. The assumption of variance homogeneity can be verified when Levene's significant value is greater than 0.05.

The descriptive analysis in Table 1 shows the mean value between 3.830 and 4.110 for firm performance based on the firm cluster. Clusters of other firms such as firms that manufacture more than one industrial products, and medical devices have the highest mean and the clusters of advanced material firms have the lowest mean value. While quality management practices variable based on the firm cluster showed that the cluster of industrial products firms had the highest mean value of 4.439 and the cluster of electrical and electronic firms had the lowest mean value of 3.837.

However, the Levene test results show that homogeneity assumptions are not met for firm performance and QMP, i.e. The Levene test for homogeneity variance is not significant if ($p > 0.05$). As such, the authors believe that the variance of the population for each group is much the same. The Levene test based on the firm cluster shows the

value of p> 0.05, so it is not significant. Therefore, subsequent ANOVA analysis can be implemented on the firm cluster. By using ANOVA, the level of significant can be determined by looking at the F-probability values. If the value of p <0.05, we can reject the null hypothesis, indicating there are difference of the variables based on the firm's profile. The ANOVA results in Table 1 show that the values of *p* are more than 0.05. As such, the authors conclude that there is insufficient evidence to support the difference in levels of firm performance and QMP based on the cluster of firms. Therefore, the proposed hypotheses on the difference of firm performance and QMP based on the firm cluster are not supported.

Table 1: Variance analysis based on firm cluster

Construct	Firm Profile	Descriptive				95% *CI* for min			
		N	Min	SD	SE	Lower	Upper	Mean	Max
Firm Performance	Industry Product	3	4.03	0.05	0.03	3.91	4.15	4.00	4.08
	Advance Material	3	3.83	0.29	0.17	3.11	4.56	3.54	4.12
	Electrical and Electronic	9	4.04	0.48	0.16	3.67	4.40	3.29	4.58
	Biotechnology	11	3.85	0.49	0.15	3.52	4.18	3.33	4.62
	Waste to wealth	5	3.98	0.34	0.15	3.55	4.40	3.62	4.42
	Foods	2	4.02	0.44	0.31	0.05	7.99	3.71	4.33
	Others	25	4.11	0.52	0.10	3.90	4.32	3.17	5.00
	Total	58	4.02	0.46	0.06	3.89	4.14	3.17	5.00
QMP	Industry Product	3	4.36	0.58	0.33	2.93	5.80	3.88	5.00
	Advance Material	3	4.02	0.19	0.11	3.55	4.49	3.90	4.24
	Electrical and Electronic	9	3.81	0.64	0.21	3.32	4.30	2.36	4.51
	Biotechnology	11	3.82	0.55	0.16	3.45	4.18	2.97	4.56
	Waste to wealth	5	3.84	0.43	0.19	3.31	4.38	3.32	4.33
	Foods	2	3.94	0.53	0.38	-0.82	8.71	3.57	4.32
	Others	25	3.99	0.40	0.08	3.82	4.15	3.00	4.56
	Total	58	3.93	0.48	0.06	3.81	4.06	2.36	5.00

Homogeneity Variance Test				
	Statistic Levene	df1	df2	Sig.
Firm Performance	1.69	6	51	0.142
QMP	0.737	6	51	0.622

ANOVA						
		Sum of Sq.	df	Mean Sq	F	Sig.
Firm Performance	Between Groups	0.621	6	0.103	0.5	0.83
	Within Groups	11.451	51	0.225		
	Total	12.072	57			
QMP	Between Groups	0.978	6	0.163	0.7	0.65
	Within Groups	11.909	51	0.234		
	Total	12.887	57			

Next, Table 2 shows the variance analysis results based on firm size. The findings show the means of the firm performance constructs based on firm size is between 3.96 and 4.33. Medium size firm has the highest mean while small size firm has the lowest mean. One-way ANOVA results for quality management practices based on firm size indicate that medium-sized firms have the highest mean of 4.05 as compared to large-sized firms with the lowest mean of 3.68. The ANOVA results of firm performance and QMP based on firm size show *p* values of more than 0.05. Hence, the authors conclude that the statistical evidence does not support the difference between firm performance and quality management practices based on firm size.

Table 2: Variance analysis based on firm size

Construct	Firm Profile	Descriptive				95% CI for mean			
		N	Mean	SD	SE	Lower	Upper	Mean	Max
Firm Performance	Small	47	3.96	0.44	0.06	3.83	4.09	3.17	4.88
	Medium	7	4.33	0.59	0.22	3.79	4.88	3.46	5.00
	Large	4	4.10	0.27	0.14	3.67	4.54	3.75	4.42
	Total	58	4.02	0.46	0.06	3.89	4.14	3.17	5.00
QMP	Small	47	3.94	0.44	0.06	3.81	4.07	2.97	5.00
	Medium	7	4.05	0.40	0.15	3.68	4.42	3.32	4.38
	Large	4	3.68	0.92	0.46	2.22	5.14	2.36	4.36
	Total	58	3.93	0.48	0.06	3.81	4.06	2.36	5.00

Homogeneity Variance Test				
	Statistic Levene	df1	df2	Sig.
Firm Performance	1.93	2	55	0.155
QMP	2.363	2	55	0.104

ANOVA						
		Sum of Sq	Df	Mean Sq	F	Sig.
Firm Performance	Between Groups	0.878	2	0.439	2.157	0.125
	Within Groups	11.194	55	0.204		
	Total	12.072	57			
QMP	Between Groups	0.352	2	0.176	0.772	0.467
	Within Groups	12.535	55	0.228		
	Total	12.887	57			

While Table 3 shows the results of variance analysis based on the firm duration of the operation. The mean of the firm performance based on the firm duration of the operation is between 3.97 and 4.01. Firms with duration of operation of between three to nine years have the highest mean while firms with less than three years of operation have the lowest mean value. One-way ANOVA analysis of quality management practices based on the firm operating duration indicates that firms with periods ranging from three to nine years have the highest mean value of 4.03 while firms with operating periods of less than three years have the lowest mean value (3.57).

The Levene test results based on the firm's duration of the operation showed a value of p> 0.05, so it was not significant. In addition, the one-way ANOVA results for firm performance and QMP based on the duration of the operation show values of p to be more than 0.05, thus Ho cannot be rejected. This explains that there is not enough statistical evidence to support the difference between firm performance and quality management practices over the duration of the operation based.

Table 3: Variance analysis based on duration of the operation

Construct	Firm Profile	Descriptive				95% CI for min			
		N	Min	SD	SE	Lower	Upper	Min	Max
Firm Performance	< 3 years	5	3.97	0.32	0.14	3.57	4.37	3.71	4.46
	3 - 9 years	39	4.02	0.46	0.07	3.87	4.17	3.17	4.88
	> 9 years	14	4.01	0.53	0.14	3.71	4.32	3.33	5.00
	Total	58	4.02	0.46	0.06	3.89	4.14	3.17	5.00
QMP	< 3 years	5	3.57	0.43	0.19	3.04	4.10	3.10	4.24
	3 - 9 years	39	4.03	0.44	0.07	3.88	4.17	2.97	5.00
	> 9 years	14	3.80	0.52	0.14	3.51	4.10	2.36	4.36
	Total	58	3.93	0.48	0.06	3.81	4.06	2.36	5.00

Homogeneity Variance Test

	Statistic Levene	df1	df2	Sig.
Firm Performance	1.023	2	55	0.366
QMP	0.041	2	55	0.959

ANOVA

		Sum of Sq	df	Mean Sq	F	Sig.
Firm Performance	Between Groups	0.014	2	0.007	0.031	0.969
	Within Groups	12.059	55	0.219		
	Total	12.072	57			
QMP	Between Groups	1.245	2	0.622	2.94	0.061
	Within Groups	11.642	55	0.212		
	Total	12.887	57			

4. Conclusion

This study extends the exploration on quality management practices in high technology firms in Malaysia. The findings provide the conclusion that no significant differences were demonstrated in high technology firms based on firm cluster, firm size and duration of the operation. Researchers found that the study on firm size issues shows a range of findings (24). Among them, the study of (25) which states the size of the firm and quality management practices are two factors that have a significant relationship and have an impact on quality performance. This is also supported in the study of (26) which therefore proves that size of the firm affects the implementation of quality. In contrast, the findings of (27) show failure to find evidence of the relationship between firm size and quality management practices. A study by (28) supported the findings by (27) showing no difference in the implementation of quality management practices based on firm size. In addition, (29) in their study also found no significant difference between quality management practices on firm size, industry type, firm ownership and process type. While (30) explains that there is a similarity in quality management practices for large, medium or small firms. Hence, this research findings are consistent with the study of (28) and (30). Similarly, the study by (29) also shows no significant difference between the quality management practice and the firm's performance according to the firm profile. These findings can be rationalized as the respondents in this research have been selected and financially supported by the same agency in granting commercialization funds. In addition to financial assistance, the agency also provides advisory services, infrastructure assistance, and consultation. Further, the role of this agency as a local technology-driven commercialization system has been developed by the government to further enhance the innovation and commercialization of the country. According to (31), their finding shows that Spanish firms' failure rates declined with size and age of firms. The results are similar to the mean growth rate of successful firms. However, for this study, the companies are high technology oriented. Therefor their QMP and performance are not affected by firm profile.

This study only focuses on high technology firms in the 9th Malaysia Plan. As such, the different levels of quality management practices in high technology firms based on firm profiles may differ for different sectors. Therefore, future studies are proposed to focus on large sample sizes. Especially if future researchers want to make a comparison study of the successful implementation of quality management practices in the service and manufacturing sectors. This is because the service sector is seen to be motivated to implement quality management practices (32). Additionally, the service sector is the largest contributor in the national economy (quoted from http://www.statistics.gov.my).

Hence, today, the Malaysian government emphasizes the importance of R&D. Although the percentage of commercialization of R&D revenue was low but the Malaysian government continued to support the country's R&D activities. This effort is translated through the 2015 budget where the Malaysian government has allocated RM290 million for the country's Research and Development. Researchers therefore recommended to the government of the possible rationale for policies to encourage agencies managing financial, infrastructure, technology, and so forth such as MTDC, MiGHT, BiotechCorp to focus on quality management practices during the selection of resources to technology-based companies. In addition, the level of awareness of the company on the availability of facilities provided by the government is also low (33). He added that MTDC for example provides a wide range of facilities especially for commercialization, but this is still a lot of entrepreneurs who are not aware. Therefore, researchers suggest that the government implement awareness programs to guide entrepreneurs,

especially high-tech companies to deal with this problem. Additionally, the government may be able to provide related programs that involve the government, industry, and higher institutions. Finally, it is hoped that these findings will help not only high technology firms, but also organizations or other firms in enhancing opportunities to success. However, quality management practices are not the only way out in the quality problems and the low commercialization of research and development in Malaysia in particular, but rather an approach that may be used to improve firm performance.

References

[1] Walsh, S. T., Kirchhoff, B. A. and Newbert, S. (2002). Differentiating market strategies for disruptive technologies. *IEEE Transactions on Engineering Management*, 49(4), 341–351.

[2] Komo, I. (2006). Ciptaan penyelidik sukar dikomersialkan. Utusan Melayu. Januari 7, 2006.

[3] Sahoo and Yadav (2018). Total Quality Management in Indian Manufacturing SMEs. Procedia Manufacturing 21, 541–548.

[4] Hoang, T.D., Igel, B. and Laosirihongthong, T. (2010). Total quality management (TQM) strategy and organisational characteristics: Evidence from a recent WTO member. Total Quality Management, 21(9), 931–951.

[5] Han, B.S., Chen, S.K. and Ebrahimpour, M. (2007). The Impact of ISO 9000 on TQM and Business Performance. Journal of Business and Economic Studies, 13(2), 1–24.

[6] Nguen, M.H., Phan, A.C., and Matsui, M. (2018). Contribution of Quality Management Practices to Sustainability Performance of Vietnamese Firms. Sustainability. 10, 375. doi:10.3390.

[7] Alghamdi, F. (2018). Total Quality Management and Organizational Performance: A Possible Role of Organizational Culture. International Journal of Business Administration, 9(4), 186-200.

[8] Parast, M.M., Adams, S.G. and Jones, E.C. (2011). Improving operational and business performance in the petroleum industry through quality management. International Journal of Quality & Reliability Management, 28(4), 426–450.

[9] Macinati, M.S. (2008). The relationship between quality management systems and organizational performance in the Italian National Health Service. Health policy, 85(2), 228–41.

[10] Kaynak, H. and Hartley, J.L. (2005). Exploring quality management practices and high-tech firm performance. The Journal of High Technology Management Research, 16(2), 255–272.

[11] Kaynak, H. (2003). The relationship between total quality management practices and their effects on firm performance. Journal of Operations Management, 21(4), 405–435.

[12] Lemak, D.J., Reed, R. and Satish, P.K. (1997). Commitment to total quality management: Is there a relationship with firm performance? Journal of Quality Management, 2(1), 67–86.

[13] Zehir, C., Ertosun, O. G., Zehir, S., and Muceldilli, B. (2012). Total Quality Management Practices' Effects on Quality Performance and Innovative Performance. Procedia- Social and Behavioral Sciences, 41, 273–280.

[14] Jayawarna, D. and Holt, R. (2009). Knowledge and quality management: An R&D perspective. Technovation, 29(11), 775–785.

[15] Ojanen, V., Piippo, P. and Tuominen, M. (2002). Applying quality award criteria in R&D project assessment. International Journal of Production Economics, 80(1), 119–128.

[16] Jusoh, A., Yusoff, R.Z. and Mohtar, S. (2008). Determining TQM practices in university R & D activities using factor analysis: Research experience of Malaysian universities. Jurnal Kemanusiaan, 11, 36–54.

[17] Ramli, M. S., Boer, S.J. and Bruijin, E. J. (2004). Factors for analysing and improving performance of R&D in Malaysia universities. E-Proceedings of: R&D Management Conference, 735-745.

[18] Aton, M.A. (2006). *R&D commersialisation*. New Straits Times. Febuari 20, 2006.

[19] Hii, H.H. and Nordin, A. (2003). *National survey of public research commercialization.* Malaysia: Ministry of Science, Technology and the Environment.

[20] Large, D., Belinko, K. and Kalligatsi, K. (2000). Building successful technology commercialization teams: Pilot empirical support for the theory of cascading commitment. Journal of Technology Transfer, 25, 169-180.

[21] MIMOS (1989). *Penyelidikan dan pembangunan bersepadu di MIMOS: ke arah memajukan industri elektronik negara.* Kuala Lumpur: Institut Sistem Mikroelektronik Malaysia.

[22] Economic Planning Unit (2015). Eleventh Malaysia Plan: 2016-2020. Kuala Lumpur: Percetakan Nasional Malaysia Berhad.

[23] Berenson, M. L., Levine, D. M., and Krehbiel, T. C. (2006). Basic business statistics: concepts and applications. 10th ed. New Jersey: Pearson/ Prentice Hall.

[24] Ragunathan, T.S., Rao, S.S. and Solis, L.E. (1997). A comparative study of quality practices: USA, China and India. Industrial Management & Data Systems, 97(5), 192–200.

[25] Brah, S.A., Tee, S.S.L., and Rao, B.M. (2002). Relationship between TQM and performance of Singapore firms. International Journal of Quality & Reliability Management, 19(4), 356 – 379.

[26] Martinez-Lorente, A., Sanchez-Rodriguez, C. dan Dewhurst, F.W. (2004). The effect of information technologies on TQM: an initial analysis. International Journal of Production Economics, 89(1), 77-93.

[27] Benson, P.G., Saraph, J.V., and Schroeder, G.R. (1991). The effects of organizational context on quality management: An empirical investigation. Marketing Science, 37(9), 1107−1124.

[28] Ahire, S. L., Golhar, D. Y., and Waller, M. A. (1996). Development and Validation of TQM Implementation Constructs. Decision Sciences, 27(27), 23-56.

[29] Zu, X., Zhaou, H., Zhu, X., and Yao, D. (2011). Quality management in China: the effects of firm characteristics and cultural profile. International Journal of Quality & Reliability Management, 28(8), 800–821.

[30] Sila, I. (2007). Examining the effects of contextual factors on TQM and performance through the lens of organizational theories: an empirical study. Journal of Operations Management, 25(1), 83-109.

[31] Daria Ciriaci, Pietro Moncada-Paternò-Castello and Peter Voigt. (2012). Does size or age of innovative firms - Evidence from a panel of innovative Spanish firms - affect their growth persistence? JRC Technical Report. Spain: European Union.

[32] Ebrahimi, M. and Sadeghi, M. (2013). Quality management and performance: An annotated review. *International Journal of Production Research*, 51(18), 5625–5643.

[33] Low, H.H. (2011). Drivers affecting the perception of feasibility towards commercialization of university research and development activities. Doktor Falsafah. Universiti Teknologi Malaysia, Johor.