Total Quality Management Practices and Technology Transfer in Malaysian Public University

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Abstract

It is widely accepted that the implementation of Total Quality Management (TQM) as a management philosophy has significantly contributed to good management practice in business organization particularly in the manufacturing and service sectors. The applications of that concepts, techniques and tools have been successfully tailored to non-profit service or government-based organization. In the context of higher education institution, it has been seriously debated by the TQM scholars and academicians on the issue of to what extent TQM can be applied and how relevant its practices are to higher education's core business i.e. teaching and research. Despite having sufficient knowledge and research on TQM implementation in the scope of manufacturing practices and administration-related services, it is hard to find a research on TQM, which focuses on the scope of R&D at a university. This gap has to be filled because the management of research is a critical topic for universities worldwide. For developing countries such as Malaysia the need to have good management practice in R&D is even greater. Without effective research management, the task of becoming significant players in the global knowledge market will become harder. Thus, the first part of this paper will discuss the applicability of TQM and propose a theoretical framework or model of TQM to suit the need of R&D context. The constructs for the TQM framework are based on previous empirical studies and the evaluation criteria of world standard criteria such as MBNQA, EFQM, and QMS ISO 9000. The TQM constructs that will be proposed are leadership, strategic planning, student/stakeholder & industry focus, data & information management, staff management, process & system approach, partnership & resource and continuous improvement. The second part of the paper will discuss the performance indicators of R&D activities particularly in the context of public university. The review of international literatures stressed that the performance of R&D activities have to be measured. The current issue related to research performance

at university is the level the research output that can be transferred to the stakeholders. Therefore, this study will use technology transfer framework to measure research performance such as publication, patents, royalty and Spin-off Company. Finally, this paper will conceptually develop a model that would show the relationship between the TQM practices in the area of research and the level of technology transfer.

***Keywords**: TQM, Technology Transfer, Commercialization, University, Research Management*

1.0 Introduction

It is widely accepted that the implementation of Total Quality Management (TQM) as a management philosophy has significantly contribute to good management practice in business organization particularly in the manufacturing and service sector (Berry, 1997; Elmuti, Kathawala, & Manippallil, 1996; Kanji & Tambi, 1999; Saraph, Benson, & Schroeder, 1989). The applications of that concepts, techniques and tools have been successfully tailored to non-profit services or government-based organizations (Berry, 1997; Winn & Cameron, 1998).

Historically, TQM was started in the industrial sector and the approach is toward tool and techniques such as statistical quality control techniques (Ahire, Golhar, & Waller, 1996; Oakland, 2004; Saraph et al., 1989). In 1980, the approach then was changed to more 'soft' orientation which incorporates the management and human resource dimension (Jablonski, 1992; Oakland, 2004; Richardson, 1996). The current scope of TQM, is the combination of the principles/practices and tools and techniques (Besterfield, Besterfield-Michna, Berterfield, & Besterfield-Scare, 2003). The principles and practices imply the 'soft' dimension of quality management and the tools and techniques reflect the 'hard' dimension of quality management. The scope is consistent with Deming(1982) and Juran(1988) approach in Quality Management.

Compared with manufacturing sector, the implementation of TQM is relatively new in higher education institution(HEI) (Elmuti et al., 1996). In the context of HEI, the reviews of the literature reveal that the scope of studies in TQM implementation can be categorized into three. The first is focusing more on administration (Elmuti et al., 1996; McAdam & Welsh, 2000; Owlia & Aspinwall, 1997). The second is focusing on teaching and learning (Lim, 2003; Owlia & Aspinwall, 1998; Sakthivel, Rajendran, & Raju, 2005; Sakthivel & Raju, 2006). The third is the studies which have a broader scope incorporating the areas of administration, teaching & learning and research (Calvo-Mora, Leal, & Roldan, 2006; Kanji & Tambi, 1999; Winn & Cameron, 1998).

However there is still a lack of research in TQM which focuses directly on the scope of Reseach & Development (R&D) in HEI. Whereas in industries, there are quite a number of studies investigating the applicability of TQM concept and practices in the R&D area (Fisher, Kirk, & Taylor, 1995; Kumar & Boyle, 2001; Ojanen, Piippo, & Tuominen, 2002; Taylor & Pearson, 1994; Wood & McCamey, 1993). Thus, the same kind of study, in a different context, might be appropriate to be conducted. Moreover from literature review it was found that there is a research gap to be filled in developing a total quality management framework for R&D practices in university.

2.0 Critical Factors of TQM in HEI

In the context of HEI, the previous research have shown that the dimensions of the TQM have been modified due to the contextual reason or nature of the organizational environment (Helms, Williams, & Nixon, 2001; Kwan, 1996; Owlia & Aspinwall, 1997). The summary of the TQM dimensions in HEI is shown in Table 1. Referring to that table, we can see that there are different constructs developed by different authors to capture the TQM concept. The differences are due to the different scope of each study. The scope of those studies are teaching & learning based on service quality approach (Kanji, Tambi, & Wallace, 1999; Owlia & Aspinwall, 1998; Sakthivel et al., 2005; Sakthivel & Raju, 2006), administration (Elmuti et al., 1996; Owlia & Aspinwall, 1997) and overall which comprising the issues of administration, teaching & learning, and research(Calvo-Mora et al., 2006; Kanji & Tambi, 1999; Winn & Cameron, 1998). However, none of the studies in Table 1 is focusing on research activities in particular.

The roles of academic staff are not limited to teaching & learning and administrative work only. The uphill task is to contribute to the expansion of new knowledge that will benefit the university, society and the country through R&D. Prestigious university such as Massachusetts Institute of Technology (MIT), Michigan, Stanford, and Harvard are excellence in research and development (R&D) and technology transfer (Feldman & Desrochers, 2003). A study carried out by Middlewood, Coleman and Lumby(1999) found that the research activities have significantly contribute to the professional development of academic staff, improvement of the image, status and rank of the university, increase in job satisfaction and also improve the quality of teaching.

Little has been written about the implementation of TQM in the R&D environment (Dellana & Wiebe, 1992; Kiella & Golhar, 1997). A conceptual paper written by Kiella & Golhar(1997) has suggested the dimensions of TQM in R&D environment, that are (a) Shared vision (b)Top management commitment (c) Integration of process and function (d) Measurement (e) Benchmarking (f) Research manager as facilitator (g)Teamwork (h)Self-directed team (i) Customer satisfaction (j)Recognition, and (k)Rewards. However, all the dimensions developed are suit to manufacturing environment and not empirically tested and validated by actual data. An empirical study done by Kumar and Boyle(2001) has proposed a TQM framework for manufacturing-based R&D environments, that are (a) R&D strategic management (b) R&D quality awareness (c) R&D client focus (d)Research capability assessment, and (e) R&D process management. The adoption of those dimensions in HEI context needs some modification due to contextual factors and thus, it justifies the need to do further research.

The review of the literature in the area of university research management, R&D and technology transfer in university-industry context have found certain themes that would explain the conceptual model for R&D management in HEI based on TQM framework. Based on Dorsamy(1999) works and other literatures related to research management, it is interesting to note that, there is a possibility to see critical factors of research management from TQM perspectives. The themes or issues of R&D management found in the literature are seems similar with TQM dimensions. Thus, the empirical research needs to be carried out.

Critical Factors	Researchers									
	(Owlia & Aspinwall, 1998)	(Owlia & Aspinwall, 1997)	(Sakthivel et al., 2005)	(Elmuti et al., 1996)	(Osseo-Asare & Longbottom, 2002)	(Kanji & Tambi, 1999)	(Kanji, Tambi, & Wallace, 1999)	(Calvo-Mora et al., 2006)	(Sakthivel & Raju, 2006)	(Winn & Cameron, 1998)
Leadership		• Top management commitment	• Top management commitment	• Top management commitment	• Leadership	• Leadership	• Leadership	• Leadership & commitment	• Commitment & Leadership	• Leadership
Strategic Planning		• Strategic Planning		• Clear vision & goal	• Policy & Strategy			• Policy & strategy		• Strategic management
Customer Focus		• Customer focus	• Customer feedback & Improvement	• Customer focus		• Customer focus & satisfaction	• External customer satisfaction		• Customer focus	
Data & Information Management		• Information & analysis		• Communication & feedback		• Management by fact • Measurement			• Communication	• Information & analysis
People/Staff Management	• Competence • Attitudes	• Employee Involvement • Training	• Courtesy	• Responsive • Assurance • Courtesy • Reliability • Teamwork • Empowerment • Assessment • Training • Reward & recognition • Employee involvement.	• People management	• Management by fact • Internal customer • Teamwork • People make Quality	• Internal Customer satisfaction • People management • Teamwork	• People management		• Human Resource Management
Process & System Management	• Contents	• Organization for Quality • Design management. • Process Management	• Course Delivery	• Supporting structure	• Process Management	• Work is process • Prevention	• Prevention • Process improvement	• Process management	• Course Delivery	• Process Management
Partnership & Resources	• Academic Resources	• Supplier management	• Campus facilities		• Resource management		• Measurement of resources	• Partnership & resources	• Campus facilities • Learning Env.	
Continuous Improvement			• Continuous Improvement	• Continuous Improvement		• Continuous Improvement	• Continuous Improvement		• Continuous Improvement	
Measurement / Results				• Customer satisfaction • Productivity • Quality	• People satisfaction • Society • Business	• Business excellence			• Customer satisfaction	• Customer satisfaction • Quality & Operational

Table 1: Summary of the TQM dimension in HEI

3.0 TQM dimensions for R&D practices in university

There are a number of approaches to conceptualize the TQM practices (Oakland, 2004; Roa et al., 1996; Samson & Terziovski, 1999). The first approach is by adopting the concepts and methods suggested by quality gurus such as Deming, Juran, Crosby and Ishikawa. The second approach is using ISO 9000 framework and principles. The third approach is using quality award frameworks such as Malcolm Baldrige National Quality Award (MBNQA) and European Foundation for Quality Management (EFQM). The forth is based empirical evidence or the critical success factor in real practices (Black & Porter, 1996; Samson & Terziovski, 1999).

The thought and ideas of Quality guru (including philosophy, concept, tools and techniques) on quality management practices have been incorporated into ISO and Quality Award Frameworks. Besides, to be more comprehensive in conceptualizing the real practices of TQM, the critical success factors have to be considered too. Therefore the dimensions of TQM framework for this study are based on the combination of those approaches as shown in Figure 1

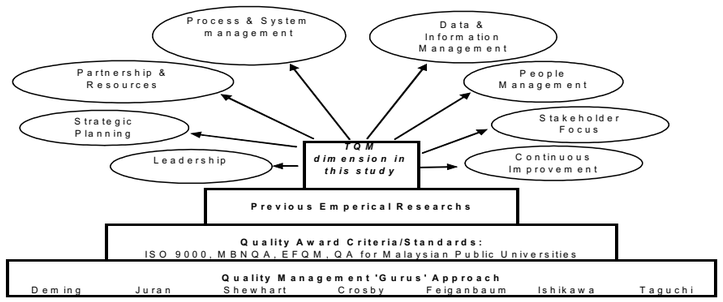

Figure 1: TQM dimensions in this study.

3.1 Leadership

According to Hemlin(2006), senior researchers should manage research by leading co-workers and the research group, as well as leading the research unit or department he/she belong to. Weggeman & Groeneveld(2005) have emphasized that the leader must be more leading than managing. This means motivating and inspiring people to achieve goal and vision, stimulate and facilitate cross-departmental communication, networking and collaboration, encourage researcher to build network and to transfer the knowledge through various medium, welcome creative and entrepreneurial ideas and test those potential, and build good relationship with stakeholder to get more fund. As the research funding becomes scarce and competitive, the leader must be capable enough to deal with funding source (not only limited to government grant but look for alternative resource- such as industry), prioritized research areas and coordinate the research activities(Y. S. Lee, 1996; Scmitdt, Graversen, & Langberg, 2003).

Beside giving the direction, the involvement of the university top management in R&D and technology transfer activities will lead and encourage the relationship between university researchers with the industry (Chang, Chen, Hua, & Yang, 2005). The creation and maintenance of good relationship with the industry will facilitate the process of commercialization (Y. S. Lee, 1996).

Clarke(2002) emphasized that there is a need for science-based organization to promote a participative style of management when dealing with the issue of R&D personnel management. An autocratic style of management is just not effective when an organization requires creativity and dynamic research environment (Clarke, 2002; Scmitdt et al., 2003).

3.2 Strategic Planning

The empirical study reveals that the research organization should have clear strategic planning encompassing planning and coordination activities, formulation of target areas and prioritization of research areas (Scmitdt et al., 2003). The time frame for strategic planning to be effective is often well beyond the typical planning cycle of most organizations and usually beyond the 'annual budget'-time frame (Clarke, 2002). The research activities require long-term planning horizon because it may take a long time to produce results and have to deal with many uncertainties or uncontrolled events. Furthermore, the short-term focus will result in a reduction in funding for long-term research and a concentration on short-term work that was less risky and less innovative (Clarke, 2002). Studies done by Heininger(1988) and Steele(1988) have pointed out that the demand for short-term return on investment have contributed to the decline in technology leadership.

The policy to support research and technology transfer activities have to be flexible. A research done by Santora & Gopalakrisnan(2001) indicates that the more flexible the intellectual property policy, the higher the level of technology transfer. Several studies have found that a sound policy which emphasizes more on intellectual property protection to the university or researcher will have positive impact on the level of technology transfer (Carlsson & Fridh, 2002; Goldfarb & Henrekson, 2003; Quetglas & Grau, 2002; Siegel, Waldman, & Link, 2003). In addition to that, a policy which promotes and encourages entrepreneurship activities will positively contribute to the commercialization effort of university research product(Chang et al., 2005; Muller & Fujiwara, 2002; O'Shea, Allen, O'Gorman, & Roche, 2004).

3.3 Stakeholder Focus

The focus of the research must align with current and future needs, responsive to the stakeholder requirement and alert to external organizational environment(Scmitdt et al., 2003). The stakeholder could be students, university, government and firms. Meanwhile the external environment is the industry or the market. In the context of the university, the research have to positively contribute to the enrichment of student learning(Hemlin, 2006) particularly for post-graduate students or research students. Furthermore, the research has to meet the requirement of the university and the most important thing is meeting the expectation of the financial provider. The financial provider is the real customer and it could be a government, private firm or both(Weggeman & Groeneveld, 2005).

To ensure the research has commercial value, it must have technological advantage and meets the need of the market or the industry. Moreover the clear focus on the expected outcome of the research between researchers and firms is the fundamental issue that must be first addressed to gain common understanding and to avoid conflict before commencing on the commercialization effort. The conflict of interest between researchers and firms must be avoided to ensure technology transfer activities succeed (Liu & Jiang, 2001).

3.4 Data and Information Management

A review of the literature reveals that there are rapid increase in the use of electronic tools, use of data and databases in all research fields. The internet and other electronic media are seen as an important research tool for searching the relevant information. Beside the electronic medium, the physical sources such as journals, books and conference papers were the most important sources for researchers(Houghton, 2005). The university has to provide access to those sources via electronic or printed sources.

Furthermore, the information related to research activities such as expertise, facilities, research-related courses, grant application process and funding must be available, updated and reliable. These would significantly help those who are interested to know more about the process of doing research, the potential research that is available and the key person that is responsible for research management. Therefore, the university or faculty has to ensure that the source and information pertaining to research requirement, and research-related activities are easily accessible, available and reliable.

3.5 People Management

Issue of human resource management and development is crucial in managing university research. The performance appraisal system and the incentives must fully support and motivate the staff to excel in research and technology transfer activities (Birley, 2003; Chang et al., 2005; Franklin, Wright, & Lockett, 2001; Goldfarb & Henrekson, 2003; Houghton, 2005; Logar, Ponzurick, Spears, & France, 2001; Siegel, Waldman, Atwater, & N.Link, 2003). The reward can be in the form of financial or non financial. Non financial reward such as recognition, autonomy and freedom of doing research would motivate the researcher to actively involve in research and technology transfer activities(Clarke, 2002; Liu & Jiang, 2001).

To excel in research, the university must have a recruitment policy that requires the staff to have some degree of research capability, interest, commitment and relevant experiences (Hemlin, 2006). The policy would promote a dynamic research environment (Scmitdt et al., 2003). Meanwhile, training and development exercises are required to produce a mass of good staff in research activities. A study done by DiGregorio and Shane(2003) postulate that the university that have more quality staff, will result in higher level of technology transfer activities.

3.6 Process and System Management

According to Scmitdt et al(2003) a research organization transforms an input (grants, competences) through a process to an outcome (dissertations, publications, patents, rewards) (Scmitdt et al., 2003). This means research as a process approach. Another view is, research is done as a project where it is divided into working stages which means done by sequential processes (Hemlin, 2006). Those views are consistent with system theory that emphasized on the interaction between processes or sub-processes to form working system. To realize the commercialization potential, the research has to go through the right process starting from the project selection, project development and project commercialization (Logar et al., 2001; Siegel, Waldman, Atwater, & Link, 2004). Therefore, all the processes involved have to be managed, planned, monitored and assessed.

To facilitate the process of doing research, Hemlin(2006) stressed that it is important to change and adapt new work design to create autonomous and challenging task. Simple routine tasks and administrative tasks can be executed by other than researchers. It is possible to modularize research tasks into components that can be carried out by others. Beside the work design (at the micro level), the structure and flow of reporting (at the micro level) would influence the research and technology transfer activities. A number of studies reveal that the bureaucratic culture and inflexibility of organization structure would hinder technology transfer activities (Chang et al., 2005; Siegel et al., 2004; Siegel, Waldman, Atwater et al., 2003). Another work by Goldfard and Henrekson(2003) also indicated that the administrative system (centralized vs decentralized) influenced commercialization effort. The decentralized system will allow researchers to have more autonomy and become more responsive to the market needs. Whereas in the centralized system, the decision making about funding, allocation of resources and prioritization of research field become more complicated and usually consume more time to expedite.

3.7 Partnership & Resources

The requirement and encouragement of the stakeholder (the financer) is the prime mover for researchers to collaborate (Houghton, 2005; Scmitdt et al., 2003). In conjunction with that research management practices should promote broad communication and collaboration with colleagues as well as with other people outside academia such as business and public organization (Hemlin, 2006). Houghton(2005) has suggested that university should focus more on multi-discipline research to solve complex problems. The collaboration could be in the form of university-university or university-research institute or university-industry. The collaboration is formed on the 'complementary and sharing basis', to remove the constraint in financial resources, infrastructure as well as the expertise (Scmitdt et al., 2003). Previous studies have proven that the involvement and collaboration with industry will significantly contribute to higher level of technology transfer and commercialization of university research product(Blumenthal, Campbel, Causino, & Louis, 1996; DiGregorio & Shane, 2003; Wright, Vohora, & Lockett, 2004). Beside that, a high level of collaboration will result in joint authorship(Houghton, 2005). Thus, the collaboration across fields or organization is crucial for effective R&D management.

There are several things that must be considered in committing partnership exercise. First is the level of commitment and contribution of firms as a partner to university. This must be clearly communicated,

understand and agreed by all parties involved (Barnes, Pashby, & Gibbons, 2002; Siegel et al., 2004). Second is the assessment of the potential partner by the university(Barnes et al., 2002). Third is the trust between university and industry (Barnes et al., 2002; Santoro & Gopalakrisnan, 2001). Fourth is the project management element. Fifth is the flexible process management to responsed to external changes and the sixth is the spirit of partnership is to complement to each other(Barnes et al., 2002).

Resources and good infrastructure are important to ensure effectiveness of the research activities. The grant to finance the research and commercialization activities would influence the level of technology transfer(Carlsson & Fridh, 2002). Studies by Power and McDougall(2005) and Siegel et at. (2004) reveals that there is a significant positive relationship between R&D expenditure and spin-off activities.

According to Chang et al.(2005) the establishment of infrastructure or office to manage intellectual property issues (invention disclosure, patents, licensing, royalty) and commercialization activity (incubators, spin-off company) will create awareness among academics, and can lead to involvement in the exploitation of research product. Logar et al.(2001) also have mentioned that the main barrier in research commercialization is the failure of university to provide the necessary infrastructures. Hence, the availability of good infrastructure will facilitate the process of technology transfer(Friedman & Silberman, 2003; Logar et al., 2001; Power & McDougall, 2005; Siegel et al., 2004).

3.8 Continuous Improvement

The element of continuous improvement is crossing each of TQM dimensions(Lembaga Akreditasi Negara, 2006). The institution must establish dynamic policy, procedures and mechanisms for regular reviewing and updating of its structure, function, strategies and core activities to assure quality and to rectify deficiency. According to *Lembaga Akreditasi Negara* (2006), or National Accreditation Board, universities as dynamic learning organization need to continually and systematically review and monitor the various issues that would impact on the core activities (Teaching & Learning, as well as research). The various issues include:

- Continuous adaptation of the mission and objectives of the university to suit the current and future needs.
- Modification of the required competencies, recruitment and staffing policy of academic staff and research managers in accordance with current and future needs.
- Review of the assessment approaches and academic staff and research manager performance according to the changes in educational and research objectives.
- Adaptation of post-graduate or doctoral students recruitment policy in relation to research activities.
- Updating of resources and infrastructure of educational and research function.
- Refinement of monitoring the research process and performance
- Continuously building relationships and accommodating the interest of the different group of stakeholders (students, government,industry).

4.0 The Important of Technology Transfer

Technology transfer is important to create economic activities and development, new jobs and new solutions to problems in the society (Carlsson & Fridh, 2002). In most countries such as America, Japan, China and Europe countries, policy makers have urged universities to focus on technology transfer activities to stimulate economic development activities (Fujisue, 1998; Liu & Jiang, 2001; O'Shea et al., 2004). In the long run, the competitiveness of the country will be strengthening through these activities (O'Shea et al., 2004).

According to Carlson and Fridh(2002), technology transfer programs are important to the academic institutions' mission of education, research and public service because they provide:

- A transfer mechanism for important research results to the public.
- Service to faculty and inventors in issues related to industry arrangement and technology transfer activities.
- A method to facilitate and encourage additional industrial research support.
- A source of unrestricted funds for additional research.
- A source of expertise in licensing and industrial contract negotiation.
- A method by which the institution can comply with the requirements of laws.
- A marketing tool to attract students, faculty and external funding.

5.0 Definition of Technology Transfer

The comprehensive definition given by Khalil(2000). According to Khalil (2000) technology can be defined as all the knowledge, products, processes, tools, methods and system employed in the creation of goods or in providing services. Another version, which is more narrower in scope, define technology as the information used to performs some task (Carayannis, Rogers, Kurihara, & Allbrit, 1998).

The transfer of technology means the process that allows the flow of technology from a source to a receiver. The source is referring to the owner of the knowledge, whereas the receiver is the beneficiary of that knowledge (Khalil, 2000). According to Eto, Rogers, Wierengo, and Allbritton(1995), technology transfer is the application of information into use.
In the context of HEI, several authors have defined technology transfer as:

- The knowledge and technology created at university are then transferred into industry to apply the knowledge as products and services (Fujisue, 1998).
- Commercial transfer of scientific knowledge from universities to firms (Siegel, Waldman, Atwater et al., 2003).
- The process whereby invention or intellectual property from academic research is licensed or conveyed through use rights to commercialized (Friedman & Silberman, 2003)
- The transfer of the research result from universities to the commercial sector (Bremer, 1999)
- The transfer of knowledge to the commercial sector through education, publication of research result and consultation activities with industry(Matkin, 1990).

In summary, the technology transfer can be defined as the transfer of knowledge for the purpose of knowledge sharing or commercial application, from the owner of the knowledge (inventor/institution) to

the beneficiary of that knowledge (students, other researchers, academics, public, education institutions, government, firms or industry etc.)

6.0 Technology transfer indicators

The university investment in R&D is for the purpose of creating new knowledge, to solve problems and provide solutions for current or future needs, and to create opportunity for economic and social development. The performances of that investment can be measured using technology transfer indicators i.e. non-financial indicators and financial indicators(Van Looy, Callaert, Debackere, & Verbeek, 2003).

6.1 Conference, seminar and publication

Conference and seminar are the platform to share ideas, knowledge and information among colleague or any party who is interested in that particular field. This is an early step to get attention and build relationship or network with those who are interested (Hsu & Yeo, 1996; J. Lee & Win, 2004). The other mechanisms to share and transfer knowledge is through publication such as journal, book or magazine (Barnes et al., 2002; Carlsson & Fridh, 2002; Hsu & Yeo, 1996; Liu & Jiang, 2001). Meanwhile, numerous research have shown that conference, seminar and publication are the indicators of academic performance (Al-Turki & Duffuaa, 2003; Chen, Gupta, & Hoshower, 2006; Dundar & Lewis, 1998; Gulbrandsen & Smeby, 2005; Kyvik, 1995; Smeby, 2003).

6.2 Consultation and technical services

The output of the research also can be in the form of consultation and technical services and the approach is more toward problem solving (Gulbrandsen & Smeby, 2005; Klofsten & Jones-Evans, 2000; J. Lee & Win, 2004). These services are delivered based on the contract which is simple and specific (J. Lee & Win, 2004). Consultation work is referring to the scientific expertise or the technology that are sold to clients to solve their problem (Klofsten & Jones-Evans, 2000). Studies have shown that consultation works are among the most popular activities for researcher (Gulbrandsen & Smeby, 2005; Klofsten & Jones-Evans, 2000).

6.3 Invention disclosure

Invention disclosure is the first step in commercializing the research output. The researchers or inventors will take this action when they believe that the research output has a commercial value (Stralser, 1998). At this stage, the inventor will forward the written application to the office of technology transfer or research management centre of the university, declaring that the new creation or invention has been produced. Since the invention disclosure is the starting point in commercialization effort, many studies have used invention disclosure as one of the indicators for technology transfer activity(Bercovitz, Feldman, Feller, & Burton, 2001; Carlsson & Fridh, 2002; Rogers, Yin, & Hoffmann, 2000; Stralser, 1998; Thursby & Kemp, 2002).

6.4 Patent

Patent is the protection right given to inventors to stop anyone from making or using the invention without the owner permission(CIPA, 2006; USPTO, 2005). The review of the literatures reveals that there are two types of indicators used in relation to patent. The first is number of patent applied (Feldman & Desrochers, 2003; Rogers et al., 2000; Seashore Louis, Blumenthal, Gluck, & Stoto, 1989; Stralser, 1998; Thursby & Kemp, 2002)and the second one is the number of patent approved and registered (Bercovitz et al., 2001; Carlsson & Fridh, 2002; Gulbrandsen & Smeby, 2005; Klofsten & Jones-Evans, 2000; Shane, 2004; Stralser, 1998; Thursby, Jensen, & Thursby, 2001; Van Looy et al., 2003).

6.5 Licensing

Licensing is an agreement to permit the firms to use the right of intellectual property own by the university (Thursby & Kemp, 2002). Previous studies have used licensing activity as an indicator for technology transfer. Some of them used number of license agreement (Bercovitz et al., 2001; Carlsson & Fridh, 2002; Hsu & Yeo, 1996; Markman, Gianiodis, Phan, & Balkin, 2004; Siegel et al., 2004; Stralser, 1998; Thursby et al., 2001) and some used license that generating income (Bercovitz et al., 2001; Feldman & Desrochers, 2003; Powers, 2000; Rogers et al., 2000; Stralser, 1998)

6.6 Royalty

Royalty is the amount of money received in return of the use of intellectual property right(licensing) (Siegel et al., 2004; Thursby et al., 2001; Thursby & Kemp, 2002). There are a number of studies that used royalty as an indicator of technology transfer (Carlsson & Fridh, 2002; Feldman & Desrochers, 2003; Stralser, 1998; Thursby et al., 2001; Thursby & Kemp, 2002).

6.7 Spin-off Company

Spin-off company is a new company that purposely developed to commercialize the new technology or research result that was created by the inventor or university (Pirnay, Surlemont, & Nlemvo, 2003). Many of the prestigious universities such as John Hopkins University, MIT, Michican University, Stanford University, Harvard University and Columbia University have used spin-off company as a mechanisms to contribute to the economic development(Feldman & Desrochers, 2003). In addition, the other researchers also agreed to use Spin-off Company as an indicator for technology transfer activities(Carlsson & Fridh, 2002; Druilhe & Garnsey, 2004; Fujisue, 1998; Gulbrandsen & Smeby, 2005; Liu & Jiang, 2001; Markman et al., 2004; O'Shea et al., 2004; Pirnay et al., 2003; Siegel et al., 2004).

7.0 Theoretical Framework

Based on the above literature review, a research framework is developed to examine the relationship between TQM practices and organizational performance as depicted in Figure 3. The performance element of TQM focuses on the technology transfer performance. Therefore our hypothesis is that there is a significant positive relationship between TQM dimensions and technology transfer performance.

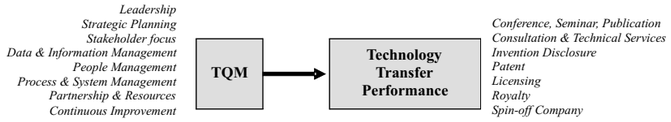

Figure 3: Theoretical Framework

8.0 Conclusion

In conclusion, there is no doubt that the research management and its activities are important to the university, government, industry and society(Carlsson & Fridh, 2002). It is crucial to determine the critical factors that collectively work as a system and produce desired outcome or result. Based on the literatures review, there are eight factors or dimensions that possibly explained the excellence management practices or normally known as TQM. These dimensions are leadership, strategic planning, stakeholder focus, data and information management, people management, process and system management, partnership and resources, and continuous improvement. Since our work is still in the conceptual stage, there is a need to empirically validate the dimensions of TQM in the context of university research activity.

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