

Investigating the Role of Integrity between Total Quality Management and Technology Management in Determining the Quality and Innovation Functions: A Study About Productive Companies in Kerman Province, South-East Iran

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Abstract— The current paper is prepared based on a descriptive study and through it, the integrity between total quality management (TQM) and technology, research and development (TIM), along the prediction of organization's functions in quality and innovation field, are examined. This investigation shows the relationship between TQM and TIM with focusing on two important issues: first, the integrity between TQM and TIM is focused via studying the gap between these two important sections, which are separated in organizations and have different duty descriptions. Second, the impacts of integrity between TQM and TIM on function indices of quality and innovation, which are the first and most important resources in taking competitive advantages for organizations, are examined. The required information for this study is collected from 148 managers of productive companies with more than 500 personnel, in Kerman province, and the constitutive equations model technique is used to analyze the collected information. The results show that: TQM has strong predictive power for qualitative functions of organization but it has not any clear and significant relationship with innovation functions. TIM also has predictive power for qualitative functions of organization but its intensity is lower than TQM. However, TIM has a stronger relationship for predicting the innovation functions of organization than TQM. Finally, TQM and TIM have a correlation with each other. The most important result obtained from the current study is that technology, research and development management is a suitable resource for applying along with and in accordance with TQM which the result of this cooperation is improvement of qualitative functions, and with higher importance, is support of innovation functions in organizations.

Index Terms— Quality, Management, Innovation Functions, Total Quality Management, Total Innovation Management, Technology Innovation Management, Innovation, Kerman Province, Productive Companies, Production Engineering

1 INTRODUCTION

Benner and Tushman [1-16] stated that organizations should be tried to equalize the considering to quality and research issues and should taking them into account, co-equally, in their general strategies [17, 19, 20, 23]. They argued that the availability of qualitative facilities in organization is a basic necessity toward the support of organization's resources to reach a higher level of efficiency and productivity [17, 18]. However, availability of innovation facilities in organization is related to potential capacities for creativity and innovation, developing the staff's skills and ability to using new resources in organization [19]. They concluded that integrating these two issues (quality and innovation) has many effects in supporting the competitive position of organization and it can be predisposed for stability in future functions of organization [20].

The current study is based on the mention issue and studies and examines the role of integrity between total quality man-

agement and technology management in determining the functions of quality and innovation in organization. The necessity for such study can be seen from various aspects; an era in which complicated environment is creating around the organizations, an environment in which the pressure imparted to organization for according with variable and various conditions is increasing, also as the possibility of accurate predicting the demands in markets becoming more difficult, the necessity and importance of the current study becomes more clear because it is a strong relation with these issues [21, 22]. Bolwijn and Kumpe [23-27], based on their studies, concluded that by forming competitive and complex environments, only organizations with ability to support multi-dimension, complicated functions in quality and innovation issues will be able to compete in such environments [28-30]. Quality was one of the most important resources for taking competitive advantage by organizations during 1980 and 1990, especially when the American companies were lost a great part of their contribution to market in competition with Japanese companies [24]. Similarly, innovation also was known as one of the most important resources for organization to taking competitive advantage during a period of time [31-35]. The results obtained by various studies show that companies which considered, specifically, innovation issue are able to significantly increase

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their contribution to market and their profit [29]. Engendering the competitive strategies with complicated dimensions and structure lead organizations to provide and use various resources for performing their activities [36-39]. It is even possible that these resources have been against the environment and nature of organization [40]. The study about the integrity between TQM and R&D is important in setting a relationship between quality management and technology management parts of organization [41]. There are numerous studies about the organization in which, TQM is performed [42]. The results of these studies show that a correct setting of TQM has numerous advantages, in various aspects, for organizations [41]. TQM is an inspiring resource in organization and it is able to affect various parts of organization and competitive functions and in addition to quality aspects, it can improve the situation of organization in the field of innovation aspects [42, 43]. However, there is another approach which claims that the discussed issue is against the necessities of innovation concept. Since TQM is fundamentally related to the concepts of quality control, which its framework is opposed to innovation [44]. This issue is discussed by Prajogo and Sohal [45]. We confute by such discussions to examine and evaluate the effects of TQM on innovation functions in some organizations [46-51]. Evaluating the effects of TQM on innovation functions is also important from innovation point of view [52, 53]. It can be useful for developing the management activities in organization and at the other hand; an important resource in defining and supporting the innovation functions of organization is used [46].

The current research is more focused on the fact that TQM is a set of certain and accepted management principles which is suitable to use in studies about the principles of innovation. Moreover, the results of the current study will be added to literature of the research since this issue is not considered in the country till now. The most of researches performed up to now evaluate the compatibility of TQM with other management activities to define various functions. Evaluating the integrity between TQM and R&D is of critical importance due to its especial consideration to innovation issue.

In the current study, effects of convergence of TQM and technology and research and development management on determining the functions of quality and innovation are evaluated and examined using a descriptive method [54, 55]. Technology is considered in the current research as a theoretical and practical knowledge, skill or tool which is more suitably used for developing the products or services [56-68]. Technology, research and development management includes responsibility about the creating, buying, propagating and developing the technology to help human activities for providing demands of customers [71]. Iansiti [68] demonstrated through its studies that the developing of technology can be lead to create added value in organization only by converging to other systems presented in organization [69-71]. He defines the concept of convergence of technology as below: convergence of research part and productive – executive part of organization. In several other studies, the convergence of marketing and research and development was investigated to define and produce new successful products [72-79]. Reaching to this convergence can be lead to increase in learning power of

organization and also, through supporting the innovation, it can be predisposed the increasing of competitive power of organization in business world [80]. The convergence of TQM and technology, research and development management was firstly introduced by Benner and Tushman [81-86]. They studied and demonstrated that there are relationships between TQM and availability of research facilities in organization; especially, in relation to process management and focus on customer [87, 88]. They argued that process management is concentrated on development, progress and improvement in organization and it works through preserving new professional skills which are applicable in all activities of organization using available facilities [89]. This issue has a strong relationship with principle of focus on customer (customer-orienting) in which organization is focused on increasing the perception power of customers and trying to satisfy their demands [90]. They concluded that organizations should be moved toward the producing products with appropriate quality so that it becomes able to satisfy demands of customers. In addition, Benner and Tushman [91-96] demonstrated that TQM cannot be considered as an obstacle for emerging the innovation [91, 92]. However, they more focused on applicable innovations leading to new, high quality product than innovations leading to fundamental researches [93, 94]. It means that organizations need to supplement TQM process and other organizational resources, especially, innovation and research processes [95, 96].

In the current research, the relationship between TQM and technology, research and development management is studied to support innovation functions of organization. The reason is that technology, research and development management is one the main resources for reaching to high levels of creative functions in organizations. Here, this question may be raised that how TQM can converge to technology management and research and development management? Literature review shows that discussions about technology, research and development management have been specifically considered in TQM literature [90-100]. The techniques and tools such as statistical process control (SPC), heptagonal tools of quality control, quality function deployment (QFD) and failure mode and effect analysis (FMEA) can be mentioned among those discussions [95]. Heatheto and some researchers [90] emphasized on presence of a positive relationship between TQM and advance manufacturing technologies (AMT) in their studies. Zairi [100] proposed that integrity between TQM and AMT can guide organizations toward development and improvement of conditions for a world class competition which is based on the presence of innovation in organization. They argued that TQM has more important role in companies which use strategies such as producing diverse products in competitive environments than companies which use defensive strategies and have much more focus on reducing the costs and or increasing the productive capacity. Beforehand, issues of technology, research and development management have been not any position in TQM literature. None of TQM pioneers such as Deming, Juran or Krasby have been considered the role of research and development in concepts of quality management, even when they argued about quality in concepts such as production. But recent researches showed that TQM can be an

important issue in the field of research and development [93]. Some studies, however, evaluated the applicability of TQM in research and development environments. May and Pearson [91] studied about the acceptability of TQM among structures of research and development in England companies. Another study performed by Miller [92] which studied the viewpoints of 45 research and development managers. The results of that study showed that there is not dependency between TQM and research and development activities in organization, however, TQM has an important role in efficient performing of research and development management activities in organization, if TQM correctly set in organization. Brennan [100] argued in their researches that in many organizations, it thinks that integrity between TQM and research and development is not possible. He mentioned this issue as an important challenge which organization should be counteracted this belief. This issue can be based on conventional thought of contrast of productivity and research concepts. For instance, the philosophy of focus on customer, as one the important principles of TQM, has a key role in aligning of move of company toward market and do this work by emphasizing to understanding and meeting the demands of customers and by correct doing of the work, it can cause to significant growth in productivity of organization. At the other hand, research and development is focused on producing the products with high added value and do this work through developing the potential markets [96]. Moreover, research and development can be used as a tool to move along the offensive strategy which tends to attack toward competitors and cause to increase in contribution to market and or open a path to new markets for products of company by doing this work. It is clear that reaching to such an offensive and strong starts is related to innovation in organization [99]. In this section, major questions of the current study are raised:

First; despite its importance in process of organization activities, the convergence between TQM and technology, research and development management have been less considered. Therefore, investigating about this issue needs to comprehensive studies.

Second; studying about integrity between TQM and technology, research and development management in literature shows a difference in consideration to issues of TQM and research and development by organizations. If research facilities and quality are presented in organizations, quality and research have the primary and secondary importance, respectively, in many organizations. Study about this issue can guide us toward the first question of the current research that if TQM can be converged to technology, research and development management as organizational resources. Are organizations able to perform TQM activities along with research and development management activities? Difference between directions of TQM and technology, research and development management has significant impact on definition of various types of function scales in organization.

In the current study, only quality and innovation functions are studied. Initially, impacts of TQM on quality function and impacts of research and development management on innovation function are investigated. Then, effect of TQM on innovation functions and effects of research and development man-

agement on quality functions are studied. These issues raised another question of the current research that if TQM is related to qualitative functions of organization and if technology, research and development management also has this relation with innovation functions? Two above mentioned research questions demonstrate the difference of directions of TQM and technology, research and development management and question about their impacts on quality and innovation functions and guide us toward the next question that what are the impacts of integrity between these two resources on the quality and innovation functions of organization.

2 THEORETICAL FRAMEWORK OF RESEARCH

Subject of the current study is, at first, evaluating the convergence between TQM and technology, research and development management and then, studying the impact of the convergence on the quality and innovation functions in organization. Therefore, and for better understanding of subject, two above mention questions are more developed in a research framework. This framework depicts a simple linear model of relationship between dependent and independent variables. Activities of company, as independent variables, consist of two regions. The first region, TQM activities, has six variables: leadership, strategic programming, focus on customer, information and its analysis, management of people and management of processes. The second region of organizational activities is total innovation management (TIM) and has two sets of activities: technology management and research and development management. Another section consists of three indices of function, as dependence variable, which includes quality function, innovation of process and innovation function.

3 RESEARCH METHOD

The current research is applicable from classification based on target and is correlation from classification based on method points of view. In addition, field method is used to collect information and data. The tool of data collecting is questionnaire. The main part of questionnaire used in the current study includes theoretical questions. By designing 50 questions in this questionnaire, it is tried to collect and analyze viewpoints of statistical population about variables of the problem. LIKERT scale is used in this study. The sampling process in the current research is purposeful sampling. Statistical population of the current study is a set of productive companies with more than 500 personnel in Kerman province. The reason is that the major activity of the study is evaluating the relationship between research and development unit and quality control unit and such units are only presented in large productive companies. Considering the discovering studies of researcher, it is identified that at least 30 productive companies with more than 500 personnel are active in Kerman province. The rule for determining the sample volume in constitutive equations models is $5q \leq n \leq 15q$ where, n is the number of questions in questionnaire for collecting information. As 50 questions are used in questionnaire of the current study, number of sample volume is $250 \leq n \leq 750$. The questionnaires are distributed to 280 managers in statistical population which 160

questionnaires were given back to researcher. Among these, 148 questionnaires are acceptable.

4 RESEARCH VARIABLES

The tool which is generalized in this study has two important sections. The first section includes six indices to measure TQM activities while it has two indices of technology, research and development management. The second section consists of three indices to measure three types of functions which are including quality function, innovation function and innovation of process function.

5 TQM INDICES

Various scales are proposed to assess TQM by researchers which most of these scales are supplemented each other. In the current study, the scale proposed by Samson and Terziofsky [27] is used as main core of TQM indices. This scale is the basis of Malcolm and Baldrige international quality award (MBNQA) and its criteria are including six criteria to evaluate organizational activities. These criteria are: leadership, strategic programming, focus on customer, information and its analysis, management of processes and management of people. Choosing this scale is due to some reasons. The first is that the thought presented by Samson and Terziofsky [27] is the basis of MBNQA. This scale is accepted and adopted by numerous evaluators and is of ability to separate concepts and activities of TQM. The second is that the criteria of MBNQA can be used to assess the productive companies considered in this study [12].

6 TECHNOLOGY MANAGEMENT INDICES

Morita and Flynn [23] proposed a model for evaluating technology management which is the scale used in the current study. The structure of the model is based on technological compatibilities and it emphasizes on compatibility of behaviors with processes and technological opportunities. Its indices are leadership margin of technology in industry, predicting the potential of new technologies, using long time programs for developing the technological facilities and continuous assessing of future technologies.

7 RESULTS AND DISCUSSION

7.1 Research and Development Indices

Research and development indices are specified in study performed by Gupta et al. [16]. Their proposed model is focused on two major aspects of process of research and development management: facilities and communications. A scale for measuring the research and development activities in company including facilities for correct operating and steering of innovation and being at the state of the art of research is defined. Regarding this issue, level of risk and income are usually evaluated in research and development projects. In the field of communications, this tool evaluates the extension of convergence between research and development activities and other business strategies in other organizational units of company.

7.2 Measuring the Quality Function

In the current study, the quality function is measured by various factors. These factors are based on study of Grandzol and Gershon [17] in which the effects of various functions on TQM are measured. Accordingly, the assessment indices of quality function are reliability, function, efficiency, stability and harmony in characteristics. This scale has a strong credit and stability due to the results of performed studies.

7.3 Measuring the Innovation Function

To assess the various aspects of innovation function, comprehensively, a structure for measuring the innovation function and process is proposed in the current study that its major criteria have been examined and confirmed in studies performed by Avlonitis et al. [5], Deshpande et al. [14] and Subramanian and Nilakanta [28]. These criteria are including number of innovations, speed of innovation, and level of innovation (new technological aspects) and coming to market as first. These four innovation characteristics are used in two major spaces named as innovation function and innovation process. The innovation function is related to proposing productive thoughts or creating some 100% new things in which changes in represented product or service by organization is shown. While the innovation process shows the changes in producing method of products or services of organization through benchmarking from a developed innovation in another place.

7.4 Justifiability and Stability of Information Collecting Tool

The questionnaire used in this study given to 20 professionals of statistical population. After receiving their feedbacks, applying reformations and customization, the questionnaire is distributed to statistical population. To assess the stability of questionnaire, Cronbach's alpha method is used which is one of the methods to calculate reliability and credit of questionnaire [2]. Since the questionnaire is designed as LIKERT scale and, in fact, is an attitude survey type of questionnaire, the most relevant method to calculate credit factor is calculating Cronbach's alpha factor. The Cronbach's alpha results for questionnaire distributed to 40 professionals of statistical population shows a number as high as 0.7, which is presented by Nonali (Cronbach's alpha=0.88).

8 CONCLUSION

The current study obtains two results from studying the integrity between TQM and TIM for determining the organizational functions. The convergence between TQM and TIM is aligned to the results of studies obtained from other issues. These studies stated that organizations can accord TQM with their other resources so that improve their ability in innovation. At the other hand, TQM and TIM have different roles in recognizing the quality and innovation functions. From theoretical

point of view, convergence between TQM and TIM supports the synergy resulted from cooperation of productivity and research facilities. Using the arguments of this study, two arguments can be proposed about the convergence between productivity (quality) and research (innovation) issues. First is that the principle of customer satisfaction is focused on meeting the current demands of customer. According to this philosophy, organization should meet the demands of market through deploying the research and development activities. Second is that the continuous improvement, which is one of the basic principles of quality control, is emphasized on control and continuous improvement and can be positively related to technology management, which is mainly based on fundamental innovations. A review on MBNQA criteria confirms the idea of integrating the quality and innovation issues. Newly, MBNQA criteria were fundamentally changed. One of the central indices that is proposed in new versions is related to the concept of innovation management. The index is stated that innovation will become limited to R & D departments soon. In addition, organizations should be managed so that innovation becomes a part of their daily activities and an important part of their culture. This study reveals that TQM is related to technology and R & D and both are key prerequisites of innovation function. Although it is possible that quality management may not directly result to innovation, organizations should have facilities to exert quality management before start of acting in the field of innovation management. It should be noted that TQM has not strong effect on innovation function. From conventional point of view, it is expected that the power of quality function is based on setting of TQM principles. It confirms the theory that the predictive power of quality functions which is described by means of TIM is less than that is predicted by means of TQM. The findings of the current study about representing a better understanding of relationship between TQM activities and quality function also confirm this viewpoint. The findings show the presence of meaningful relationships between three variables of organizational function. This study obtains an approach about that how the support of a special type of function can affects other functions. From theoretical point of view, this argument is of importance since although arguments related to TQM (which are described by Deming, Juran and Krasby) do not specifically introduce the relationship of total quality management for producing the innovation, these arguments emphasize on importance of continuous improvement of products quality to meet the demands of customers. Therefore, improving the quality of products can be led to developing new products and their introducing to market. From innovation point of view, innovation production should not ignore important aspects of quality. As a result, innovation should play its role in supporting different aspects of quality. However, accurate study of this field shows that there is a fundamental difference between these two approaches especially from strategic point

of view. Innovation producing management is obviously different from quality control, which is emphasized on pursuit of accordance of products with special characteristics. The relationship between quality and innovation of product is better described by assimilating the intermediate role of innovation of process. It means that the quality of product can indirectly affects the innovation function of product through innovation of process. Although TQM has not a direct effect on innovation functions, it has indirect effect on innovation functions through producing high quality products. As described in section of data analysis, innovation of process has meaningful relationships with quality and innovation of product. An acceptable deduction from these findings is that innovation of process can be considered as the second target with both TQM and TIM. In special cases, resources should reach to satisfying levels of standards of quality and it can be gained through continuous improvement of current processes. In this situation, it is not important how many of resources are used for doing the work, but the target should be gained through resetting of processes and reaching to higher levels of innovation. Moreover, the presence of positive relationship between innovations of product and process shows that the strategy of supporting innovation of product and developing its diversity is frequently led to adopt innovation in processes.

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