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An Empirical Analysis of the Contributions of Information Technologies to the Production Process in Adana, Province of Turkey

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Abstract: To cope with increasing and changing competition environment with globalisation, organisations have to achieve quality. And, it can be argued that information technologies, as an exceptional factor that is able to affect all units and functions of organisations, plays an important role in achieving quality. This study aims at determining the extent to which information technologies and systems are used in production lines for 162 SMEs (Small and Medium Size Enterprises) organisations operating in various sectors in Adana Province. The results obtained from an analysis of the data, collected implementing a survey, employing exploratory factor analysis, indicates that information technologies contribute significantly to TQM (Total Quality Management) and to each dimension of TQM. In addition, empirical results show that information technology does not affect equally all the dimensions of TQM.

Key words: Information technology, total quality management, computer aided design, computer aided manufacturing

INTRODUCTION

Today, the globalisation of markets, in consequence of economic and technological developments, has changed the dimension and the shape of international competition. Rapid developments in information technologies seem to play the most prominent role in this pattern. The Information Technologies (IT), on the one hand, enabled the customers to choose among the goods and services produced in anywhere in the world and to get possession of them quickly, on the other hand, they led the customer expectations about quality to increase. As of now, organisations have to produce a large variety and quantity of goods, which are suitable to the needs of global customer and to the international quality norms, rather than compatible with the local consumer wants and preferences, if they want to be able to compete on the global market. Although the enlargement of markets with globalisation has provided new opportunities for organisations to increase their production and sales, increased competition resulting from ever increasing number of competitors in international markets is becoming a real threat for the firms (Kürsat, 2000).

In the face of rapidly increasing global competition, organisations can only be successful to the extent that they increase their ability to reduce production costs through increasing productivity, to increase their profitability, to satisfy ever increasing expectations of their customers in terms of product quality and reliability, product variety and customer services. To develop these

types of talents, firms must take the quality seriously and embrace it as their management philosophy. In summary, while determining quality level of their goods and services, firms have to utilise Total Quality Management (TQM) instruments and techniques, which highlight the importance of taking advantage of information technologies.

Total Quality Management (TQM) implies the change and the most important key to change is technology. The presence of close association between TQM and IT is also mentioned by a number of researchers (Cortada, 1995). This is because the success of the adopted TQM philosophy is closely related to the use of information systems as well as the eligibility of human factor. The use of IT in production of goods and services is rather important in terms of performance, appraisal, costs and measurement sensitivity, time saving, labour use and so on.

Evaluating the firms in Turkey in these terms, it is fair to say that the current figures are not encouraging. Although TQM is getting popular and there exists successful applications and many more companies are getting ready to use it in Turkey, the level reached so far is far from the desired level in this quality race in which the private sector has taken initiative. When one searches for reasons behind all these, he or she see that the main reasons lie behind TQM and involve technology mismatch, resistance to change, ignorance to development and the needs of the century and the lack of full automation in production. Misperceptions of

management, which do not embrace the concepts of productivity, quality and performance, prevent the Turkish organisations from being global competitors. For this reason, it is vitally important to create hospitable environment and to put carefully planned TQM in effect in all processes of firms. This is the only way to make the Turkish organisations gain the ability to compete at the global level. Stated briefly, the success of the firms in the face of increasing competition in global environment is related to their success in achieving quality and to the extent of the use of information technology.

To establish the exact role of information technology in success of TQM, it is required to determine the extent to which the information technology is used to attain the targets of the TQM. For these reasons, it is important to investigate the role of information technologies in increasing the performance and the competitiveness of the firms and to measure the extent of this effect empirically. To this end, as a first task, the different dimensions of the TQM, the tasks that the information technologies assume in each dimension of the TQM and the channels through which its effects go through needs to be explained.

The information systems and technologies take place in every stages of TQM approach and they appear to be the most effective element in TQM. In terms of the use of information technologies, seven dimensions of the TQM can be established, namely; management's commitment to quality and strategic planning process, information and analysis; customer satisfaction; participation of employees to the quality process; participation of employees to the quality process; increase cooperation with providers; increasing technical capacity, new product design, new process innovations; product design and development of production process quality; the evaluation of quality results. Stated briefly, quality can only be achieved if the top management, which will start and implement the process, supports the process and makes strategic planning to achieve the quality (Garvin, 1991; Ryan, 1996; Dale *et al.*, 1997).

It is not enough for management to define the TQM process clearly; for success, it is a must that the management effectively takes place and contribute in every stage (Thiagarajan and Zairi, 1997). The contribution involves many different aspects such as transferring the quality messages to the workforce and customers, training the top management and the workers and so on. As it seems clear information technologies contribute a lot to this dimension of the TQM and it is really difficult to achieve success without them.

Top management commitment to quality is not adequate alone, for success strategic quality plans have

to be undertaken and managed. Prominent writers of TQM (Deming, 1986; Oakland, 1993), unanimously agree upon the importance of strategic planning because it integrates all quality efforts of a company. Since, planning process involves identifying its customers, prioritising their needs, understanding its employees and becoming committed to quality, preparing strategic plans will make organisations eventually successful in these tasks (Harrington, 1997; Thiagarajan and Zairi, 1997). This is because plan is a whole in where consumer, provider, employees, projects and processes are integrated each other (Zahedi, 1998). Considering the fact that a successful strategic plan needs to be focused on the goal, to be integrated and to be compatible with other plans, an important role that the information technologies play at planning stage will be understood. The preparation and implementation of such a plan, the collection of vast amount of information, the analysis of this information are vital elements of this process and this can only be achieved with the help of well-advanced and integrated information system.

One of the most important indicators of the attainment of quality is customer satisfaction. Customer satisfaction means that customers' needs and wants are satisfied by the goods and services they bought and therefore customer satisfaction can only be achieved if firms identify its customers and their needs very well (Adam *et al.*, 1997; Oakland, 1993). Identification of customers' needs and wants, collection of customers' opinion about the products will help raise the quality of products. In short, for quality, it is necessary to know exactly what really the customer wants. Customers needs and attributes can be determined through the analysis of the data obtained from customer satisfaction surveys. Thereby, it can be possible to satisfy the customer needs and to evaluate, the real or perceived, customer experiences. At this point, information technology plays an important role in ensuring customer participation.

Information technologies enable the best possible way for firms to produce alternative goods and services to satisfy customer needs by facilitating the comparison between product attributes and customers' expectations from that product. For example, a travel company can provide holiday choices compatible with the customers' own needs easily and in a short period of time making use of information technologies. Another example of the use of information technologies in achieving customer satisfaction, which is the hearth of the TQM and requires mass product tailored for an individual, can be given from Japan in where it is widely employed in building prefabricated houses. Seller designs a house in compatible with the request of an individual by bringing the thousands of finished pieces together in computer.

Then, the designed houses are being delivered within 30 to 60 working days to the owners (Kürsat, 2000).

Providing the participation of employees in quality process is very important in success of quality programmes and quality development. The workforce should be given relevant and sufficient training to tackle the problems faced in the process and to do their job efficiently (Flynn *et al.*, 1994; Scully, 1996; Thiagarajan and Zairi, 1997). Workers should be informed about the advantages of high performance at all stages of work, positive effects on other workers, customer satisfaction, minimisation of costs, improving the organisation in economic terms and so on.

Information technologies also play an important role in providing employees' involvement. It will be possible to establish a communication system among employees in an organisation making use of information technologies. In this way, not only managers and workers but also workers among themselves will have a chance of efficient communication. For example, in application of the quality circles, internet groups can be established with the support of information technology (Kürsat, 2000).

The relationships with providers play an important role in successful implementation of TQM (Flynn *et al.*, 1994). This is because, to produce high quality goods and services, all inputs employed in the production process must have a high quality. To clarify the importance of the relationship between firms and providers, the subject can be taken as a value system. As it is well known, in value system, one unit's output is defined as the other unit's input and because of a lack of coordination among these actions, the mismatch occurs between one unit's output and customer's expectations leading to interruptions and a large scale corrective measures. Therefore, the exploitation of this interdependency among the value chains by buyers and the implementation of the TQM successfully depend, to a large extent, on the level of cooperation with providers.

Today, information system is widely used to increase the cooperation with providers. Thereby, integration of organisations with providers and fast and effective exchange of data became possible. Nowadays, firms want to have long-term relationships with a limited number of providers instead of working with too many competitive providers. For example, Ford signs at least a five year contract or for the life time of a model with its providers. In the same way, Xerox reorganised the relationships with its providers within the leadership through quality programme. Benetton is another example, renewed its relationships with providers through information technology webs and BDT/BDM technologies (Kürsat, 2000).

Achieving quality is closely related to the minimisation of the unwanted fluctuations that may occur in the production process such as deviations from the production targets predicted in the strategic plans. To achieve continuous improvement in quality, it is very important for firms to catch up new developments in technology, create new designs, invent new production processes, or make improvements over the old processes (Terziovski *et al.*, 1996). The role information technologies play in this process cannot be disputed.

One of the most important steps in the journey to quality involves product design stage. Increases in design qualities and removal of uncertainties will help to solve many problems faced in the production process. The use of information technologies in design and production processes will increase the quality of product design and production processes. Computer Aided Design (CAD) provided radical improvements in achieving quality in many sectors. The use of CAD ensures higher quality designs by shortening the required time period for a design and speeding the designing process. This, in turn, reduces the number of steps to complete a task reducing the number of possible mistakes in the process. In addition, mistakes can be detected earlier than usual with shortening the process period. In addition to being a design instrument, CAD can be seen as a communication technology which allows the spillover of product information across geographic regions and across sectors (Kürsat, 2000).

CAM (Computer Aided Manufacturing) will also increase the quality by facilitating management, reducing the percentages of defects among finished products. Today, the use of both CAD and CAM together contributes highly to the quality target through reducing costs, increasing productivity and providing flexibility in production and carrying out production up to standards (Mahmut, 1998).

Total quality management philosophy involves continuous improvement at all dimension of TQM as mentioned before and we mentioned different dimensions of TQM. All activities of firms should be measured, then we determine possible problematic areas among the ones mentioned before and sustain continuous improvements. We can achieve this by comparing the performance of organisations directly or compare with the level of performance of organisations believed to implement some of the functions-components of TQM- in the same sectors. In these comparisons, product and services quality, productivity and efficiency level, workforce and customer satisfaction can be taken as criterion.

Information system provides contributions to comparison activities in many respects. For example, many

institutions use internet to search for successful applications of firm and product development.

To summarise, IT affects all units and functions of organisations and it plays a vital role in success of TQM which is one of the must for firms getting ready for global competition. But, it is obvious that IT does not affect each dimension of the TQM at the same level. To determine the full effect of IT in the production process, all explained above should be tested empirically and the extent of this effect, its quality needs to be explored, determined.

MATERIALS AND METHODS

To investigate the extent to which Turkish organisations, implement information systems and TQM and to determine whether information systems have an impact on TQM, the data is obtained from implementing a survey method to managers of 162 companies operating in a various sectors in Adana Province. In preparation of survey questions, the theoretical and empirical literature on the role of information technologies in production process summarised above have widely been utilised. Furthermore, we also carried out interviews with managers to support to clarify the role of TQM in using IT in production lines. The survey questions prepared in this way and implemented to 162 firms actually using IT involve 23 questions. Among these questions the first five of them are about firms attributes and the remaining 18 questions are five point Likert scale and aims to determine the contribution of IT to the quality for organisations. Tables provided in the appendices give a general information and descriptive statistics about the questions used in the data set.

Before presenting the results obtained from the analysis undertaken to determine the extent of the use of IT in production, it is useful to explain the methodology used in selection of instrumental variables. Considering the fact that IT affects TQM through a number of various channels, exploratory factor analysis is employed to find out in which dimensions of the TQM explained by which of the 18 questions in total prepared for exploring the impact of IT.

First, the applications of the Factor analysis (FA) to the data set is examined by employing Kraiser-Meyer-Olkin (0.69) and Barlett tests. The results of these tests turned out to be 0.69 and ($\chi^2 = 562.7$, df. 120, $p = 0.00$) respectively confirming the applicability of factor analysis to the data. The suitability of each of the 18 units to the general structure of the data set subject to empirical analysis is determined evaluating diagonal elements of the

Table 1: Reliability and factor choice

Dimension	No. of items	Alpha	Eigen value	% variance explained by factor 1
Customer satisfaction	4	0.69	2.54	22.50
Management	4	0.66	2.38	11.94
Production process design	3	0.60	1.81	8.91
Product quality	2	0.74	1.94	6.74
Quality results	3	0.51	2.20	9.36

anti-image matrix and those numbers assumed less than 0.50 are eliminated from the data set. Table 1 presents the results obtained from using FA. The first column gives the number of factors selected by FA and corresponds different dimensions of TQM in the second column, the number of questions are given in each dimension involves. In the rest of the columns, corresponding alpha reliability coefficient, Eigen values and percentages of total variance explained in each factor is given.

As a rule of thumb, when the reliability coefficients higher than 0.7, it is concluded that the different measures composing the factor is consistent. However, this coefficient can be taken as 0.6 in exploratory factor analysis. Examination of the Table 1 shows that all the factors except the quality results assumed a value higher than 0.6.

FINDINGS ON THE CONTRIBUTION OF INFORMATION SYSTEM ON QUALITY

Here, finding on the impact of IT on different dimension of TQM obtained from using the instruments explained above, will be provided and evaluated. Above, in each of the questions in the survey explains which dimension of TQM is determined by using exploratory factor analysis. In the light of this information, average of the instruments in each of the dimensions is calculated and presented in Table 2. Keeping in mind the fact that in five point Likert scale, the number 3 implies a moderate effect, the examination of the second column in the Table 2 shows that averages of instruments are quite high. This finding indicates that IT plays an important role in success of each of the dimensions of TQM. Overall average effect of IT, given in the last row, equal 3.92 supporting the claims.

As mentioned before, there is no reason to believe that IT affects different dimensions of TQM at the same extent. We employed ANOVA to test whether there exists differences among the extent of the impact of IT on different dimensions of TQM. The results obtained from the ANOVA ($F_{4,162} = 47.5$), indicates that there is a significant differences among dimensions of TQM in

Table 2: Extent of IT use along the five dimensions of TQM

Dimension	Average	Standard deviation	Min.	Max.
Customer satisfaction	3.89	0.62	1.50	5.00
Management	4.15	0.49	1.75	5.00
Production process design	3.38	0.80	1.00	5.00
Product quality	4.07	0.58	1.50	5.00
Quality results	4.11	0.48	2.67	5.00
Overall IT use in TQM	3.92	0.35	2.62	4.88

terms of IT contributions. In addition, we used Duncan's range test to find out the extent to which dimensions differed from each other. Test results showed that, at 0.05% significance level, while average value of management, product quality, quality results instruments are not statistically significantly different from each other, average values of customer satisfaction, production process innovation are statistically significantly different from each other and from all other instruments.

CONCLUSION

In this study, the importance of information technologies, within the comprehensive framework provided by the TQM, is evaluated and the contributions of IT to production process are attempted to be measured using empirical methods. Examination of the theoretical and empirical literature provided above shows that IT affects all units and functions of firms and it is very useful to examine the channels this effect goes through within embracing framework provided by the TQM. Detailed information on survey, prepared to examine the impact of IT, utilising the information provided above, is provided above and the preliminary analysis of the data set is carried out. In the third section in where an empirical part of this study is given, exploratory factor analysis is employed to examine whether IT contributes to production process and using the instruments obtained from EFA, the hypothesis of the study are tested. Finding of the study shows that IT plays an important role in success of TQM having impact on all dimensions of TQM subject to analysis. However, test results indicate that the effect of IT is not even for all dimensions. Particularly, while IT has a pretty high effect on management, quality results and product quality, its contributions to product design and customer satisfaction is relatively low.

In summary, firms aim to make profits by increasing their competitiveness and need to achieve international competitiveness through achieving quality giving a special attention to IT and TQM, adopting and integrating these technologies into its structure, human responses and achieving integrated processes. For these reasons, IT and TQM should be integrated into the main building

blocks of firms to achieve competitiveness. At the same time, managers should shift the workforce attention to this direction, because IT and TQM are information intensive techniques.

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