# TOTAL QUALITY MANAGEMENT AND INFORMATION TECHNOLOGIES: AN EXAMINATION OF THE ISSUES

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## ABSTRACT

This paper examines the relationship between Information Technologies (IT) and Total Quality Management. The examination is made against a number of dimensions of TQM including customer and supplier relationships, workforce management, process flow management and quality data and reporting. The point is made that the impact of IT on the TQM intervention depends on the type of IT application in terms of its use as an agent to the work process or as an enabling mechanism. The impact of IT on process design and control and what quality professionals need to do to assure quality is also discussed and suggestions made.



Keywords: Information Technologies, Total Quality Management, Dimensions, Application Types.

## INTRODUCTION

Information technology (IT) is increasing in importance for companies and its effects on global trading are becoming widely felt (Mahan and Gotlieb, 1992 Chandler, 1998). It is frequently argued that IT is rapidly becoming the most important factor in increasing productivity and reducing costs (Kagan, 1994; McFarlan, 1984; Parsons, 1983; Weston, 1993), although as writers such as Mahmood and Mann (1993) and Willcocks and Lester (1997) point out, existing studies show contradictory results. Loveman (1994), Powell and Dent-Micallef (1997) and Strassmann (1997) have found that IT had not had a significant effect on productivity or competitive advantage, whereas Kelley (1994) found a positive relationship between programmable automation and productivity.

Various means for improving quality, reducing costs and increasing productivity are being sought and implemented by manufacturers and service providers seeking continuous improvements in business performance. They include total quality management, total productive maintenance, business process re-engineering and management, manufacturing resources planning, just-in-time, and self-directed work teams. Weston (1993) claims that all these interventions rely on IT, since they act as a feedback mechanism to users who are keen to measure productivity and, in addition, they also serve as the means to get rapid and more accurate information, improve communication links, and facilitate the implementation of advanced tools, systems and modelling techniques. IT has evolved from a traditional administrative back-office support orientation towards a more strategic central role within organisations, see Venkatraman et al. (1993) and Boynton et al. (1993). There is little doubt that applications of IT affect all sections and functions of a company, therefore, it is argued that IT also must affect Total Quality Management (TQM).

This paper examines the way in which TQM is influenced by IT, its role in TQM interventions and identifies the key issues which need to be considered by quality professionals.

## THE TQM DIMENSIONS

Before analysing the implication of IT on TQM, it is necessary to define what is meant by the term TQM. Several writers have tried to define the different dimensions that shape TQM, including Ahire et al. (1996), Dale et al. (1994), Flynn et al. (1994) and Saraph et al. (1989), see Table I. Analysis of these dimensions reveals that there are several common dimensions, such as top management support, customer and supplier relationships and employee involvement. From these works and their own research studies the authors have selected ten dimensions of TQM on which to study the impact of IT. These dimensions are given in Table I together with those of the four mentioned studies and are described in brief in Table II.

Take in Table I.

Take in Table II.

| Dimensions selected for study | Dale et al. (1994) | Saraph et al. (1989) | Flynn et al. (1994) | Ahire et al. (1996) |
|---|---|---|---|---|
| Top management support | Commitment and leadership of the chief executive officer<br>Planning and organisation | Role of divisional top management and quality policy | Top management support | Top management commitment |
| Customer relationship | Culture change | -- | Customer involvement | Customer focus |
| Supplier relationship | Culture change | Supplier quality management | Supplier involvement | Supplier quality management |
| Workforce management | Culture change<br>Education and training<br>Teamwork | Training<br>Employee relations | Workforce management | Employee empowerment<br>Employee training |
| Employee attitudes and behaviour | Involvement | -- | Quality improvement rewards | Employee involvement |
| Product design process | -- | Product/service design | Product design | Design quality management |
| Process flow management | Use of tools and techniques | Process management / operating procedures | Process management | SPC usage |
| Quality data and reporting | Measurement and feedback | Quality data and reporting | Feedback | Internal quality information usage |
| Role of the quality department | -- | Role of the quality department | -- | -- |
| Benchmarking | -- | -- | -- | Benchmarking |

**Table I. Total Quality Management.**

| DIMENSIONS | DESCRIPTION |
|---|---|
| TOP MANAGEMENT SUPPORT | **Top management commitment is one of the major determinants of successful TQM implementation. Top management has to be the first in applying and stimulating the TQM approach, and they have to accept the maximum responsibility for the product and service offering. Top management also has to provide the necessary leadership to motivate all employees.** |
| CUSTOMER RELATIONSHIP | **The needs of customers and consumers and their satisfaction have always to be in the mind of all employees. It is necessary to identify these needs and their level of satisfaction.** |
| SUPPLIER RELATIONSHIP | **Quality is a more important factor than price in selecting suppliers. Long-term relationship with suppliers has to be established and the company has to collaborate with suppliers to help improve the quality of products/services.** |
| WORKFORCE MANAGEMENT | **Workforce management has to be guided by the principles of: training, empowerment of workers and teamwork. Adequate plans of personnel recruitment and training have to be implemented and workers need the necessary skills to participate in the improvement process.** |
| EMPLOYEE ATTITUDES AND BEHAVIOUR | **Companies have to stimulate positive work attitudes, including loyalty to the organisation, pride in work, a focus on common organisational goals and the ability to work cross-functionally.** |
| PRODUCT DESIGN PROCESS | **All departments have to participate in the design process and work together to achieve a design that satisfies the requirements of the customer, according to the technical, technological and cost constraints of the company.** |
| PROCESS FLOW MANAGEMENT | **Housekeeping along the lines of the 5S concept. Statistical and nonstatistical improvement instruments should be applied as appropriate. Processes need to be mistake proof. Self inspection undertaken using clear work instructions. The process has to be maintained under statistical control.** |
| QUALITY DATA AND REPORTING | **Quality information has to be readily available and the information should be part of the visible management system. Records about quality indicators have to be kept, including scrap, rework and cost of quality.** |
| ROLE OF THE QUALITY DEPARTMENT | **Quality department need access to top management and autonomy and also has to combine the work of other departments.** |
| BENCHMARKING | **A benchmarking policy for key processes should be in place.** |

**Table II. Dimensions used to analyse the relationship between TQM and IT.**

## THE POTENTIAL ROLE OF IT IN TOTAL QUALITY MANAGEMENT

Some authors consider that IT is an enabler of TQM. For example, Zadrozny and Ferrazzi (1992) claim that the information systems function plays a key role in the TQM initiative through the strategic, human resources, and technology areas. Murray (1991) claims that IT is increasingly being used to measure, understand, and improve an organisation's level of sustainable quality. Clearly, IT can help to facilitate the application of statistical process control (SPC), Design of Experiments, Failure Mode and Effects Analysis (FMEA), and Quality Function Deployment (QFD) and self assessment against a model for Business Excellence. IT can be also vital in the development of real-time collection of data in term of customer satisfaction, internal process controls, critical business systems, and other measurement systems which are necessary to support TQM. Konstadt (1990) argues that sophisticated communications and computational tools and data storage systems are the key to success with TQM. He goes on to make the point that IT can be an enabler in the drive for continuous improvement, even when the basic processes and management worker relationships remain traditional. Moreover, there are those who argue that TQM may be an enabler of the introduction of IT. According to Ayers (1993) applying the principles and practices of TQM to the application of IT promises to decelerate wasteful investments in technology for the sake of technology.

However, it is possible that some of the situations which the introduction of IT generate do not necessarily support the TQM philosophy and its ideals. This is explored by mapping the implications of the introduction and application of IT on each of the ten chosen TQM dimensions.

## MAPPING OF IT ONTO TQM

### Top management support

The support of senior management is necessary both for the success of TQM and the introduction of IT. Zuboff (1983) outlines how the introduction of a new IT intervention may generate some uncertainty within the workforce and how the support of senior management is vital in maintaining the continuous improvement process. On some occasions, the introduction of IT has created problems with the workforce and other members of the staff (Wilson, 1994), so top management has to be very cautious in this task and avoid contradictions between the new IT requirements and the TQM policy being followed at the time. If IT increases management control by top management, this needs to be applied without creating undue stress and concerns.

### Customer relationship

The development of IT may help to improve relationships with customers in several ways. Bar-coding, product recognition systems and electronic point of sales are in wide use and increase the accuracy and speed of sales and lead to improved customer service. IT will also certainly enable organisations to reach customers who are geographically remote (Quelch and Klein, 1996), providing opportunities, in particular, for SMEs. Gilmore and Pine (1997) outlined how customisation is also facilitated by IT. Rathnam et al. (1995) have analysed the utility of IT to increase the coordination amongst customer support teams. Kauffman and Lally (1994) have developed a model to measure the benefits of customer access information technologies.

It is important that organisations understand the speed and extent of the shift to electronic commerce conducted between businesses, homes and countries and start to put into place the means of controlling such invisible processes. For example, companies can offer their products through the Internet, including explanations of the

characteristics of the products, and clients can procure products and services through this means and feedback opinions about the characteristics of the products/services through the e-mail system (some examples can be found in Chandler, 1998). The results of a study by Stone et al. (1996) indicate that in the future, customers will increasingly seek to manage the relationship themselves, using new technologies and that companies need to prepare themselves for this.

Companies can also use these aspects of IT by undertaking customer surveys to obtain relevant and useful information. This information can be saved in electronic databases and be used for mailshots and targeting at specific products. However, this should not replace the actual systems of selling and collecting of customer information. At the present, there are only a minority of the population who have access to the Internet and amongst those who have such systems the capacity of many of hardware systems is not sufficient to support satisfactory use due to problems such as slowness, system compatibility, keeping the data up to date and lack of financial security. Consequently, the use of IT as a marketing system should be considered as a complement to enrich actual systems, and not as a substitute for existing survey methods.

IT can also lead to efficiency in market analysis since the statistical systems required for this are too complex to apply with any degree of efficiency without computer aids. The increase in the capacity of calculation that computers provide should be used in order to develop more complex systems of analysis about consumers needs, expectations and behaviour.

The information about customer needs and competitor's offerings is facilitated by IT. This should be made available for employees within company databases and in this way help to make improved decisions about new products and processes.

Supplier relationship

As is the case with customers, IT systems can help to develop improved communication links with suppliers through systems of electronic data interchange (EDI). The electronical transmission of data can be used to place orders, send product specifications, design details, etc., along with confirmation of invoices and paying for suppliers (Jonscher, 1994). Teague et al. (1997) outline how suppliers can be involved earlier in the design process by the use of IT. In some cases, companies can access the inventory systems of their suppliers and place orders automatically and there can also be access to production scheduling systems. Mukhopadhyay et al. (1995) report the considerable savings achieved by Chrysler using EDI systems between itself and suppliers. The study of Banerjee and Sriram (1995) shows that those organisations that have encouraged their vendors to use EDI appear to have significantly improved organisational efficiencies. The research of Srinivasan et al. (1994) concluded that investments in information technology to support both the sharing of JIT schedules and the establishment of integrated information links are related to significant reduction in the level of shipment discrepancies. Bakos and Brynjolfsson (1993) and Stump and Sriram (1997) argue that IT speeds up of the reduction in the number of suppliers used by an organisation.

Another issue touched upon in the literature is that electronic transactions and their accompanying systems will re-configure how business organisations function and this, in turn, will impact on the development and advancement of TQM. Consequently, the necessary IT interactions between a company and its supplier should be analysed in terms of how they can help the communication process between the parties, including access to databases, systems and the necessary integration and software interfaces.

Workforce management

This is one of the areas in which IT systems have more controversial implications, in paticular, in terms of the changes in the role of shop floor employees and intermediate managers as a consecuence of increased levels of automation. Although some authors (e.g., Business Week, 1984 and Bradley, 1989) claim that the number of levels of organisational hierarchy will decrease with the use of IT, others (Blau et al., 1976 and Pfeffer and Leblebici, 1977) consider that IT may increase the depth of hierarchies by reducing the delays and distortions introduced by the movement of information through the organisation levels. Pinsonneault and Kraemer (1997) found that IT was associated with a decrease in the numbers of middle management in organisations with centralised decision authority but in organisations where decision authority was decentralised they increased. According to writers such as Attewell and Rule (1984), Haug (1977), Wilson (1994) and Zuboff (1982), IT may also reduce job satisfaction and diminish skill requirements by: routinising work, subdividing work into small, highly specialised and repetitive tasks, subjecting humans to machine control, replacing low-level clerical jobs with high-skill professional jobs and automating the more mundane tasks.

From this there are clear arguments both in favour and against IT applications leading to deskilling. Zuboff (1983) and Attewell and Rule (1984) report both sides of this, and it is difficult to determine which view predominates. There are also arguments (e.g., Walton, 1982) both in favour and against the view that IT increases workers' autonomy. These opposing views lie in two possible applications of IT (Eason, 1988). One of them is focused on the use of IT as an agent to control work processes, an argument defended by Beniger (1986) and Wilson (1994). This kind of application leads to deskilling and monitored jobs, with the usual results of higher productivity, increased control and command, and inflexibility. The other view is focused on the use of IT as an

enabling mechanism. In this case, jobs are enriched and job satisfaction increases. The result of this is not necessarily higher productivity (although it would be unlikely to decrease), but it is expected that performance, employee initiative and flexibility will increase. These two kinds of IT implementation are sometimes applied simultaneously in companies, the first type impacts on clerical staff and the second on professional staff.

If the labour required is more intellectual, autonomous and less mechanical controlled as a result of the IT implementation, training become more important, and the content of this should reflect the new knowledge needs. When work becomes more intellectual, the argument put forward by quality management experts is that supervisors should function as coaches rather than giving subordinates' orders. On the other hand, if IT implies less autonomy and intellectual challenging jobs, this conflicts with a number of the TQM principles and practices (e.g. empowerment, trust and discretion, and teamworking, in particular, self managing workgroups). In any case, IT implies a change in the training requirements of the workforce. How organisations plan for this needs to be examined, in particular, the new roles which will be created should be analysed with the aim of deciding if it is necessary to design a new organisation structure.

Employee attitudes and behaviour

When new systems are introduced, based on IT, some organisational restructuring is implied, and the natural resistance of employees to this change may reduce the level of commitment to company goals and objectives. The usual argument that IT applications will lead to a reduction in the number of employees has its protagonists (e.g., Jonscher, 1994 and Brynjolfsson et al., 1994), but there are others (e.g., Osterman, 1986) who claim that this may not be the case. Also, when IT

implementation means deskilling and loss of worker autonomy it is likely that motivation will decrease. Wilson (1994) describes a situation where the conflict between the utilisation of IT and the TQM programme generated some ill-feeling amongst management and staff because the increase of information requirements demanded by top management through the new faster means of communications that IT enabled was contradictory with the demand for improved customer service that TQM implies. On the other hand, when IT is used as an enabler to eliminate boring, dirty and hazardous jobs, job satisfaction increases. In any case, the change in workforce attitudes that may occur after the introduction of IT needs to be considered in order to prevent a decrease in factors such as loyalty to the organisation, pride in work, ability to work with employees from other departments, job satisfaction, and stress.

A positive effect of IT is that they help to share information among different departments and functions. However, the implementation of IT does not mean that people will be more disposed to share information; if they think that they have reasons to believe that this will not be in their best interests then this will not happen. A strong emphasis in the need for the sharing of information should be made if an organisation wishes to make the best use of shared databases.

Product design process

The capacity to innovate increases with the use of IT (Schein, 1994). CAD technologies are a fundamental aid in the design process because, using CAD the design of products, according to consumers' needs, is faster and the innovation can be greater. Moreover, an effective new product design and development process requires information from different departments (production, marketing and R&D) and IT may aid the effective and speedy transmission of this information. Hameri and Nihtila (1997) report a case study in which the design projects involved numerous teams from various

locations. Those Web-based applications in new-product development efforts provided the effective media for communicating and disseminating information.

IT is also useful in Design of Experiments (Mezgar et al., 1997), Failure Mode and Effects Analysis (Webber, 1990) and QFD (Rangaswamy and Lilien, 1997 and Zhang et al. 1996). In all these cases, IT does not change the way to apply these quality tools and techniques, but it helps to facilitate a more complete use of all their possibilities and eases their application.

Process flow management

IT has been found useful in the task of process flow management. They assist the maintenance function through the use of automated systems to detect the need for machine maintenance and diagnose what needs to be done, this can be carried out at allocation remote from the machine (Dilger, 1997; Krouzek, 1987). Automation helps to reduce process variance, because machines usually demonstrate less variability than workers and increases the speed of production processes with a significant quality enhancement (Freund et al., 1997). However, this does not mean that the need for quality management disappears; on the contrary, automated machines only work with quality products (Karatsu, 1988). Both electronic detection and signalling devices also help to reduce process variance. These types of applications lead to the reduction and eventual elimination of a number of inspection type activities (Litsikas, 1997).

SPC may be facilitated, through the automated measurement of product and process parameters and the registration and processing of data (Kendrick, 1995 and Papadakis, 1990). IT can also be useful in bridging the gap between SPC and Statistical Problem Solving (SPS) as described by Layden and Pearson (1992). For example, Gong et al. (1997) proposed a procedure for combining an on-line sensor and a control chart to improve statistical process control decisions.

Those companies involved in a process of quality management systems certification, such as ISO 9000 and QS-9000, now have access to a variety of software to assist them in the process of implementation and self assessment (Ward, 1998).

These three different types of application are a clear indication of the way in which IT can help to improve quality at a shop floor level. On the other hand, automation can imply less flexibility and this is not in line with the TQM principles (Schonberger, 1986).

The design of processes to ensure that outcomes conform to quality requirements is a key issue along with the control of processes in which transactions are conducted on-line. It could be that a new generation of quality control and improvement tools are required in this type of environment. Patterson et al. (1997) provide an example of the need of new quality control and improvement tools created as a consecuence of the use of CNC machinery. In relation to this there is a need to develop appropriate algorithms and software interfaces to evaluate the effects of process interfaces and changes to processes and systems, prior to their implementation.

IT also enables companies to run all their global businesses on one system. They can operate the same processes in every country and have real time data such that executives know the current state of the business anywhere in the world (see, for example, Palvia et al., 1996 and Paxton, 1997).

Quality data and reporting

The use of IT is a fundamental skill to work with data, access to different databases is made easier and the subsequent analysis is faster and more accurate. Organisations have to consider how to apply IT to facilitate the interchange of information between different departments (Lawler, 1991). Some IT applications provide an automated means to gather, record, and act on ideas during meetings of

workgroups (Jackson et al., 1995). Information from newsgroups and listservers provided in the Internet can also be useful aids to improve product quality (Finch and Luebbe, 1997).

The manner in which IT can help in different tasks, such as the determination and use of quality costs, feedback of quality data to employees and managers for problem solving, providing timely quality measurements, and improving the availability of quality-related data is an issue which has started to surface in the literature but needs further explanation.

Role of the quality department

The role of the quality department does not have to change with the introduction of IT. It needs the same autonomy, same access to top management and has to work with other departments in a facilitating role. Nevertheless, its work will be made easier because these technologies assist in the collection and analysis of data and transferring information to other departments. The quality department in conjunction with senior management will be responsible to provide answers to questions which arise from the implementation of IT in a TQM environment.

Benchmarking

IT can aid the Benchmarking process in a number of ways: communication with partners is made easier, identifying best in class companies is facilitated, simulation of performance measures and gap analysis is made available, and the internal communication of data gathered from benchmarking and of the resulting action plans is made faster. All these new possibilities of benchmarking development that IT facilitates should be explored.

## CONCLUSIONS

IT has a key role to play in the process of applying TQM in an organisation and can affect all the ten TQM dimensions identified in this paper. The theme of the relationship between IT and TQM is mainly positive, since IT can act as an enabler of many of the TQM facets. However, the possible problems that they can generate, such as loss of job satisfaction, deskilling workers and reduced process flexibility should be considered and planned.

As IT is being implemented in some companies for the first time, their general impact on TQM has still to be analysed. There are strong indications that relatively few organisations are capable of debating the issues and exploiting the opportunities. Therefore, studying these implications is an important aim of future research and needs to be studied jointly by MIS and quality management specialists. For example, a key challenge facing quality professionals is to develop appropriate process designs and effective process controls in business transactions conducted with digital pieces of data and at the same understand the business risk in these transactions.

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