TQM principles' application on information systems for empirical goals
A study of Indian organizations

Jamshed Siddiqui
Department of Computer Science, Aligarh Muslim University, Aligarh, India, and

Zillur Rahman
Department of Management Studies, Indian Institute of Technology, Roorkee, India

Abstract

Purpose – The purpose of this paper is to describe a study conducted in Indian companies to evaluate the role of total quality management (TQM) of information systems (IS) in pragmatically realizing organizational goals. As the Indian customer becomes more and more brand savvy – largely owing to the globalization and advertising boom, quality consciousness is doomed to increase and if quality issues in the Indian industry are not addressed in time, competition might lead to its elimination.

Design/methodology/approach – This paper explains TQM philosophy on the basis of principles of top management commitment, customer centric advancements of processes, benchmarking for problem solving, relentless improvement and strengthening the employee base. Data were collected through a questionnaire-based survey of managers. Results were interpreted by multivariate analysis of qualitative responses.

Findings – The paper argues that TQM and IS can be quite fruitful in improving the quality of products and services offered to the end customer. Further it quantifies the extent of top management support for TQM in IS, the extent of benefits realized by TQM, relationship between IS-TQM realized benefits and top management support and relationship between the IS-TQM realized benefits and TQM principles implemented.

Research limitations/implications – Data are opinion-based, hence respondents' bias could not be eliminated and difference of opinion within a firm has not been entertained. Research in the area may build upon these findings to further investigate the implementation of TQM principles specific to conditions of IS in Indian firms.

Originality/value – The paper adds to the knowledge on business in India as the nation invites foreign investment. The paper findings may help management of firms in the process of introducing TQM for IS as a measure to enhanced awareness for quality.

Keywords Total quality management, Information systems, Quality improvement, India

Paper type Research paper

Introduction
Globalization of market economies has urged corporations in all sectors to concentrate on maintaining a sustainable competitive edge. However, sustainable competitive advantages are directly related to the upkeep of quality – of services and production. An effective model of such a vision of success for companies is total quality

management (TQM henceforth), which is a customer centric, set of management policies that deliver quality through statistical control, procedure design, policy deployment and human resource management techniques. As information systems have become an integral part of most organizations not only has TQM fundamentally altered and reshaped the work practices and management thinking of many organizations it has also made new and profound demands on many organizations (Au and Choi, 1999). In fact it gains critical value in IS functions since data on microchips forms the baseline for many managerial decisions, business strategies, policies and mission of an organization.

Rationale

In the present study an attempt has been made to quantify the empirical aspects of TQM for the IS of organizations. Organizations have had unqualified success in pursuing quality management on account of compound focus of programs leading to dilution of results, assuming that action and result come in a package and lack of stepwise appraisal of schemes and achievements. Also it has been felt that IS professionals are still hesitant and apprehensive about adopting TQM in software engineering, as a consequence of a general misunderstanding of its practices and principles (Zadrozny and Tumanic, 1992). Given the long-drawn experience of Indian industry with TQM in the field of IS, this study has tried to evaluate the extent of their relationship in terms of awareness and utility.

TQM – concept and framework

TQM is a management philosophy that makes use of a particular set of principles, practices and techniques to expand business and profits that provides a bypass to enhanced productivity by avoiding rework, rejects, waste, customer complaints and high cost (Deming, 1986). This can be achieved by emphasizing the organization's commitment to quality accruing from the data-driven, problem-solving approaches. Five basic pillars of TQM, as outlined by Anderson *et al.* (1994), Dean and Bowen (1994), Waldman (1994) are:

(1) top management commitment for quality enhancement (Choi and Behling, 1997);

(2) customer centric advancements of processes and building a long-lasting trustworthy relationship between the organization and the customer (Lengnick-Hall, 1996);

(3) relentless development by setting goals and deadlines (Lynch and Werner, 1992);

(4) benchmarking with several specific tools and quality-adding techniques, as mentioned by Hackman and Wageman (1995), Zahedi (1995), Freytag and Hollensen (2001); and

(5) strengthening the employee base by concentrating at any stage of a process on quality (Shrednick, 1992), where customer satisfaction is stationed (Anderson *et al.*, 1994).

TQM vis-à-vis *IS*

While IT is taking care of mundane and routine tasks like data input, computation, measurement, and output, the users can concentrate their effort on fulfilling the more important objective of quality improvement (Ang *et al.*, 2000). Application of the five TQM principles applied to IS helps in decelerating wasteful expenditure in technology for the sake of technology (Ayers, 1993) and some potential and significant benefits (Carroll and Swatman, 1997; Pearson and Ellram, 1995). IT also works as an enabler of the structural adjustments of the organization to TQM changes. In order to circumvent such a problem, organizations considering a TQM program should integrate it within the agenda of their strategic planning efforts where business strategies are simultaneously developed with IT plans (Jabnoun and Sahraoui, 2004).

Top management initiatives can innovate ways of using IS/IT abandoning the stereotype mindset that it is just a tool for performing several tasks faster and cheaper (Reese, 1995) With process development and recognition and celebration of successful achievements so that collective support is rewarded and encouraged, followed by defining needs and expectations and enterprising to deliver to the required standards and finally by maximizing on customer involvement at all stages (Caroll and Swatman, 1997; Stylianou *et al.*, 1997). Live and sound IS is critical to the continuous development so software design may not run in the uncontrolled realms of poorly managed functions (Dawson, 1994). With efficient documenting, analyzing and measuring all activities performed by IS organization, standardization and simplification of processes for limiting variability and being focused on the systematic process and not the end product or the individual performing the act (Kiely, 1993a, b). IS organizations make extensive use of benchmarking in maximizing data center efficiency and cost control (Criner, 1994; Freedman, 1992) evolving such structured yardsticks that measure achievements (Buckler, 1994; Kiely, 1993a, b) *vis-à-vis* competitors. IS employee empowerment starts with a vision and clear goals, ensured management commitment, visible support, willingness to take risk, paying particular attention to managers and supervisors, involving staff in all stages of the project, downward and upward communication, staying tuned to the business, educating and training everyone and developing a reward system for achievements (Shrednick, 1992). Nevertheless managers must remember that most employees do not adapt readily to new things and resist to some extent (Prince, 1993).

Objectives

To defend the given hypothesis based on the philosophy of TQM and its applicability to IS we wish to determine:

- the awareness usage and length of experience of TQM in IS;
- the extent of top management support for TQM in IS;
- the extent of benefits realized by TQM;
- the extent to which the TQM principles are applied to IS;
- relationship between IS-TQM realized benefits and top management support; and
- relationship between the IS-TQM realized benefits and TQM principles implemented.

Study area
After several decades of stiff regulations when the Indian market was liberalized the manufacturing and service industries made a significant contribution to the phenomenal economic growth. However, it has been realized that the market suffered deterioration in some areas due to a lack of competitive sustainability. Furthermore, as the Indian customer becomes more and more brand savvy, quality consciousness is doomed to increase and if quality issues in the Indian industry are not addressed in time, competition might result in elimination. Production is taking a paradigm shift from low cost to high quality. It is time to evaluate the success of TQM adopted in firms for IS.

Methodology
Data collection
We consulted similar studies (Pearson and Ellram, 1995; Ahire *et al.*, 1996; Cheon and Stylianou, 2001) to design a questionnaire that with modifications for Indian firms. The items were written in the form of statements to which opinions were sought upon a seven-point Likert-type scale (ranging form strongly disagree to strongly agree). Data collection was done by mail survey addressed to the top executive In charge of the IS department of 300 Indian companies assumed to be making use of TQM in IS department. The list was procured from the BT-500 list of top Indian companies published by *Business Today*. A follow-up questionnaire was mailed to those who did not respond up to eight weeks and another follow-up was sent after a no-reply for 12 weeks. In total, 134 questionnaires came back with responses and 120 responses (40 percent) were sorted for analysis. The data set was intended to represent a large variance in annual turnovers, worth of assets, IS budgets and the segment of the industry. The respondents represented a wide array of business areas and the firms belonged to different classes such as insurance, banking, software, manufacturers, etc. The received bulk of responses also represented this spectrum chosen for the study.

Data analysis
Usable responses were sorted and non-response bias was checked by comparing the answers provided by the first respondents with those provided by respondents following the second and third mailing (Fowler and Jeffs, 1998). This could be done safely because analysis indicated that there is non-significant difference at $p = 0.05$ among these three groups with respect to their total sales, number of employees, IS budgets and number of IS employees. As an added advantage this lack of non-response bias implies that the results obtained from this study sample can be applied to a larger set of population.

Results
Comprehension level of TQM amongst IS managers
In total, 120 managers who responded to the survey had heard of TQM (Table I). However, their levels of familiarity and awareness varied from 3.3 percent (very little) to 37.5 percent (somewhat). This indicates that a larger portion of the group had quite a fair idea further revealing that their perception about the impact of TQM on IS was also on the positive side, i.e. almost two-thirds of the group believed that TQM contributed positively towards IS improvement.

Comprehension level		Frequency	Total	Percent
Heard of TQM	Yes	120	120	100
	No	0		0
Familiarity with TQM principles	Very much	15	120	12.5
	Much	30		25
	Somewhat	45		37.5
	A little	26		21.66
	Very little	64		3.33
Concept of effect of TQM on IS	Very much	14	120	11.6
	Much	66		55
	Moderate	32		26.6
	A little	8		6.66
	Very little	0		0

Table I.
Comprehension level of TQM amongst IS managers

Length of TQM in IS experience
Responses depict (Table II) all firms were making use of TQM in IS (100 percent), However, a miniscule of them have a long-drawn experience. The largest percentage is of those firms which have been exploiting TQM for more than a year but less than three years.

TQM benefits for IS
Respondents were asked to rate the TQM benefits for IS on a seven point Likert-type scale ranging from disagree to strongly disagree. Factorial analysis was done to extract the most important TQM benefits for the organization and IS. The Chronbach's alpha value for finding internal consistency (reliability) and Kasier-moyer-Olkin (IKMO) value to measure sample adequacy were used. In the initial factor analysis we got 12 factors but by further use of PCA and varimax rotation with Kaiser normalization we got nine factors. Both the tests for reliability and validity for factors were found satisfactory (see Table III).

Most respondents felt that the most desirable benefit of TQM for IS, is increased quality of services and products followed by a greater productivity of IS professionals (see Table IV).

An ANOVA was then performed to determine significant differences between the IS managers' perception of the value of specific TQM concepts in realizing pragmatic organizational goals. Tukey's Honestly Significant Difference (HSD) was then calculated to determine if the most important benefit could be identified. The results indicate that top three benefits were considered most important (see Table V).

Length (year)	Frequency	Percent
Less than 1	39	32.5
1 to 3	52	43.33
3 to 5	25	20.83
Above 5	4	3.33
Total	120	100

Table II.
Length of TQM in IS experience

Factor no.	Factors based on survey results	Cronbach's α	KMO value
1	Cost cutting on maintenance of applications	0.919	0.901
2	Increased IS management control	0.880	0.852
3	Superior quality of services	0.902	0.845
4	Greater customer satisfaction	0.788	0.789
5	Enhanced IS professional productivity	0.724	0.697
6	Slashed time consumption on production	0.696	0.621
7	Improved quality of products delivered	0.574	0.591
8	Optimization of human resource use	0.512	0.575
9	Flexibility in reaching out to customer	0.704	0.534

Table III.
Principal factors of TQM benefits

TQM benefits	Mean	Std dev.
Cost cutting on maintenance of applications	4.6333	1.3014
Increased IS management control	5.2175	1.0041
Superior quality of services	5.3245	1.1147
Greater customer satisfaction	5.2126	1.1834
Enhanced IS professional productivity	5.0999	1.0738
Slashed time consumption on production	4.2133	1.1873
Improved quality of products delivered	5.2526	0.9768
Optimization of human resource use	5.0106	1.1867
Flexibility in reaching out to customer	5.1349	1.2013

Table IV.
Benefits of TQM for IS

TQM benefits	Mean	Organization Tukey's HSD Grouping	t-statistic	Mean	IS function Tukey's HSD Grouping	t-statistic
Cost cutting on maintenance of applications	4.48	1	-4.5^a	5.63	1	-3.8^a
Increased IS management control	4.42	2	-4.2^a	5.21	1	-3.6^a
Superior quality of services	4.23	1	-4.3^a	5.32	1	-5.1^a
Greater customer satisfaction	4.60	3	-5.2^a	5.21	1	-2.9^a
Enhanced IS professional productivity	4.51	1	-3.3^a	5.09	1	-3.8^a
Slashed time consumption on production	4.74	2	-1.9	4.21	3	-4.2^a
Improved quality of products delivered	4.26	1	-5.4^a	5.25	2	-0.6
Optimization of human resource use	4.70	2	-1.7	5.01	4	-0.8
Flexibility in reaching out to customer	4.88	4	-0.6	5.13	2	-1.9
F-statistic		3.95^a			4.02^a	

Notes: [a]Significant at 0.01 level. Rating scale: 1 = Definitely realized; 2 = Realized; 3 = Somewhat realized; 4 = Unsure; 5 = Not realized; 6 = Probably not realized; 7 = Definitely not realized

Table V.
Benefits realized by organization/IS functions

Implemented TQM principles
The most effectively used TQM principles were those of customer centric advancements and employee enrichment by strengthening the employee base (Table VI). However, when implemented to IS other TQM principles also did fairly well.

Relationship between top management and TQM benefits
Relationship analysis was done by subdividing the respondents' opinions into two categories – high for much and very much; and low for little and very little. Subjecting to the test of goodness of fit revealed that there is a significant difference between benefits accrued from TQM through strong management support and those of less management support (see p value in Table VII). Top management commitment to TQM is a decisive factor of TQM benefits for IS.

Implementation of TQM principles and benefits realized
Simple regression analysis was performed to test the significance of the relationship of each TQM principle implemented and TQM benefits realized (see Table VIII). The key motive of each test was to see if the simple linear equation is significant or the observed frequencies are just a matter of chance. Analysis revealed that each equation was significant at 0.05 level, with R^2 ranging from 0.30 to 0.35.

The results of all possible regression analysis show that two independent variables provide the key impressions for TQM benefits of IS organizations – customer centric advancements and support of top management. Successful implementation of TQM principles and realization of benefits relies on these factors of critical value. Hence the null hypothesis that the frequencies of different observations for TQM principle implementation are chance observations and there is no working mechanism behind them is rejected.

Although the individual variables are significant, since there is a serious co-linearity among the independent variables a further multiple regression analysis is performed to

Implemented TQM principles	Mean	Std dev.
Conviction of top management	4.8563	1.1432
Customer centric advancements	5.3675	1.1046
Relentless improvement	4.8823	1.2768
Strengthening of employee base	5.2363	1.1134
Benchmarking	4.7342	1.3391

Table VI.
Degree of implementation success with TQM principles in IS

Variable	Top management support	Mean	T-value	p-value
TQM benefits	High ($n = 70$)	5.6234	3.186	0023
	Low ($n = 50$)	4.1867		

Table VII.
Relationship of top management support and TQM benefits

	TQM benefits realized		
TQM principles implemented	T for H_0: parameter $= 0$	P-value	R^2
Conviction of top management	4.476	0.0001	0.3527
Customer centric advancements	4.378	0.0002	0.3271
Relentless improvement	3.324	0.0005	0.3043
Strengthening of employee base	4.276	0.0002	0.3297
Benchmarking	2.547	0.0328	0.1189

Table VIII.
Relationship between implemented TQM principles and TQM benefits

identify the key exploratory variables among the five factors (see Table IX). Also it has been indicated that biased results from multiple regression analysis begin to creep in at correlations above 0.5 (Cheon and Stylianou, 2001).

Discussion

Research limitations are that results have been promulgated on the basis of opinions expressed by only one individual to whom questionnaire was mailed. Hence it doesn't withstand any difference of opinion between individuals of the same company and multiple opinions. For any questionnaire-based survey it is impossible to completely eliminate respondent bias because data is opinion based and not numerical based. Another limitation is that we assumed at the beginning that respondents have a fair understanding of TQM philosophies and hence we did not include many statements that would test the comprehension level of the respondents about TQM. However, these lacunae in the study leave future ground for explorations and research on the subject.

We may argue based on the findings that in future more and more companies will subscribe to the TQM philosophies. This readiness may be attributed to the benefits of TQM realized by IS functions. It has the capability to entice the primary as well as the secondary customer. In-depth relationship analysis of TQM implementation and TQM benefits revealed commitment and support provided by the top management, as most important. Earlier authors have realized the same and recommended the following practices to be embraced for good commitment to TQM (Cortada, 1995):

- setting strategic visions and conveying them to employees;
- preserving high standards of measurable quality;
- modeling the way to customer end-user focus;
- fostering a world of continuous improvement; and
- empowering the employee base by encouraging teaming, initiatives and individual accomplishments.

Similarly, to assure customer centric advancements to facilitate better TQM, implementation steps have been suggested. Pearson *et al.* (1996a, b) has outlined them as:

- identify the real IS customer;
- understand their expectations; and
- commit to the flagship processes critical to the success in meeting these expectations.

TQM principle	TQM benefit	CTM	CCA	RI	SEB	BM
CTM	0.666[*]					
CCA	0.621[*]	0.410[*]				
RI	0.566[*]	0.669[*]	0.614[*]			
SEB	0.581[*]	0.565[*]	0.675[*]	0.762[*]		
BM	0.403[*]	0.512[*]	0.426[*]	0.573[*]	0.569[*]	

Note: [*]Significant at 0.01 level

Table IX.
Correlations of key
exploratory variables

Since this study was conducted in India when almost the entire market had adopted itself to globalization, it will not be out of place to suggest that the research findings also have global applicability, apart from being of use to the academics and business environment of India. If not to the well-advanced west, at least for neighboring countries such as Pakistan, Bangladesh, Nepal, Maldives, Sri Lanka, Bhutan in the SAFTA (South Asian Free Trade Association) these findings are well applicable because they have a similar cultural and traditional milieu. In an unexaggerated form the applicability may even radiate to the not so far off Middle East and the Polynesia.

Comparing the results with other work we found that Howard and Foster (1999), Hua *et al.* (2000), Rao and Raghunathan (1997) and Sohal (1998) also support the importance of top management commitment for TQM implementation. Palvia *et al.* (2001) also postulate that for evaluation of TQMIS a multidimensional concept of IS quality comprising the characteristics of task, technology, people and organization should be considered along with the differences in assessments of these characteristics according to stakeholder groups, managers, developers and users. Chow and Lui (2003) have also identified nine TQM factors, with top management support being the one with highest Cronbach alpha value, followed by role of IS quality group, training, product service design, supplier quality management, process management, quality information reporting, employee relations and ISF performance. Albeit slight variations these results do not challenge our findings. In an anthropological assessment case of TQM successes it was found by Philip and Mckeown (2004) that the top management ethos to encourage entrepreneurial activity and innovation through an individualist market culture and teamwork helped in business transformation towards competency and quality. While enumerating the critical success factors responsible for initiating quality management in Indian firms, Wali *et al.* (2001) put leadership, creativity and quality strategy on top of the list.

Our results are congruous to Pearson and Ellram (1995) with regard to the extent of TQM awareness amongst IS professionals and TQM benefits for IS functions such as improved customer satisfaction, enhanced quality of products and services delivered to the customer, and increased flexibility in meeting customer demands. However, regarding the perception of implementation of TQM concepts for IS functions, listening to the customer topped the list, followed by employee empowerment, continual development and then top management leadership. Other tools/concepts likely to be implemented are identifying the customer, group decision making, process analysis, benchmarking, statistical process control and concurrent engineering. This is slightly different in order from the results of our study.

Our finding on the correlation of the extent of TQM benefits realized and TQM principles implemented is also supported by Fok *et al.* (2001) as they propose the measure of TQM maturity along the dimensions of TQM program use, perceived influence and TQM understanding and a strong correlation of these factors with TQM concepts. Mjema *et al.* (2005) have also concluded in a survey in Tanzania that the IT and IS generated quality tools such as pareto charts, histograms and flow charts helped to control work process in production and to deliver consistent product quality. Similar results have been reported from Mexico's maquiladoras where use of statistical process control through IS in the implementation of TQM principles has been instrumental in transforming Mexico's manufacturing from being known as a cheap labour provider to a global manufacturing power (Aly and Schloss, 2003). The effective

design of a TQMIS to support the implementation of the TQM program is valuable. Indeed the TQMIS is the main mechanical force for driving the daily operational program. It plays a significant role in supporting and driving a continuous improvement culture (Au and Choi, 1999). Since gathering data and analyzing them are essential for decision making and implementing control, a TQMIS is essential for successful implementation of TQM in an organization. For manufacturers striving to achieve ISO 9000/QS-9000 registration which involves gathering, analyzing and documenting enormous amount of quality-related information, a TQMIS could definitely help in achieving their objectives (Bandyopadhyay, 2003).

Dalgard *et al.* (1998) however, imply that a significant gap remains between the success with TQM for IS in the west and the east. But there too, additional emphasis on top management commitment and employee strengthening by on-the-job training and education is stressed. If the gap is only in the extent of success and adaptability and not regarding a basic philosophy or trend then it is only matter of time when business traditions in the east too will incorporate TQM as an integral element, as in the west.

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Corresponding author
Zillur Rahman can be contacted at: yusuffdm@iitr.ernet.in

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