

Total Quality Management in Engineering Education

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Abstract: - Higher education institutions have been facing challenges for some time and are expected to face more in the future. In the new environment that higher education has entered quality plays an increasingly important role. In the past decade, emphasis on quality improvement has been one of the most characteristic features of higher education in many countries. By now, Total Quality Management has been adopted by many universities and colleges in the higher education world. Engineering education colleges and universities have no alternative but to follow and take advantage of the anticipated benefits that TQM has to offer. This paper reviews the main principles of TQM in higher education, defines the different roles of interested parties in a TQM program and comments on the models and the do's and don'ts when implementing TQM in higher education. Finally, the paper outlines the unique challenges of implementing TQM in engineering education.

Key-Words: - Total Quality Management, Quality, Engineering Education, Higher Education.

1 Introduction

While TQM is generally accepted in industry and service organizations, as a successful managerial strategy, its role in the public sector, especially in higher education, is still controversial. TQM's customer orientation creates problems when applied to universities. This is because of the special nature of many academics whose motivation for work is often independent of market issues.

Although problems exist in TQM in higher education, they have not overshadowed the necessity for change in this area. Financial problems and market pressures, which are challenging many higher education institutions, appear to give the main impetus for change. They leave institutions no alternative but to offer "higher quality at a lower cost" – a primary aim of TQM. As a result, higher education institutions have to develop methods to improve their quality. They have to embrace the concepts of Total Quality Management as a means of continually improving every aspect of their organizations.

There are many definitions or descriptions of Total Quality Management given by the quality gurus, but if we want to refer to one, we could mention the definition of the international quality standard ISO 8402 which states that "TQM is a management approach of an organization, centered on quality, based on the participation of all its members and aiming at long-run success through customer satisfaction, and benefits to all members of the organization and society".

In the past decade, emphasis on quality improvement has been one of the most characteristic features of higher education in many countries. By now, Total Quality Management has been accepted by many universities and colleges in the higher education world, in the USA, in the UK, in Sweden, in India and other countries [1], [2], [3], [11], [12].

The anticipated results are similar to those experienced in the manufacturing or service sector; higher quality services delivered both to internal and external customers, increased customer satisfaction, higher productivity, and improved student/ staff morale.

2 Total Quality Management in Higher Education

The applicability of TQM in higher education has been the debate for many years. While Total Quality Management has been adopted by many organizations world-wide, its implementation in non-profit organizations, such as higher education institutions, presents more challenges and difficulties than those encountered in business organizations. What are the problems of implementing TQM in higher education? Who is the customer? Can we identify the products? Can we specify a customer-driven definition of quality and introduce a management quality culture based on the industrial model in the education environment? What is the role that the students play in their own learning? Can we control and measure processes

related to teaching and learning? These are some of the question elaborated by many researchers in the recent years [1], [4], [5], [6], [12], [13], [14].

TQM models, exist that present answers to the above questions. These models, based on the teachings of quality gurus, generally involve a number of “principles” or “essential” elements such as customer focus, top management’s leadership, employee involvement, measurement, continuous improvement, and several other elements like training, teamwork, quality tools and techniques, which are all required for successful TQM implementation.

As can be seen from many examples of implementing TQM in higher education, in general, the character of implementation is still limited to business-type operations in universities, such as business finance and administrative services [3].

Nevertheless, TQM in Education can be seen by different perspectives and can be applied at three levels:

- The first level is to the administrative and management processes of an educational organization, with benefits in improved efficiency and lower costs.
- The second level is teaching total quality management, the quality philosophy, methods and tools to students.
- The third level is total quality in the learning process. This has to do with a learning philosophy supported by a comprehensive tool kit and driven by students and staff in order to identify, analyze, and remove the barriers to learning.

Implementation of TQM can start at any level and progress further in other levels gradually.

2.1 Main Principles of TQM in Higher Education

As mentioned above the TQM models that exist involve a number of “principles” or “essential” elements [15]. These main “principles” of TQM in higher education are presented in more detail:

- *Focus on the customer.* Among the essential elements of TQM, customer focus is probably the most important, as reflected by the weight assigned to it by various quality award criteria [4]. Customer identification in a higher education institution seems to present more difficulties than are encountered in business organizations. For example in one model interpretation, parents and students could be perceived as external customers to the quality

system, while in another, they might be perceived as internal customers. At the same time parents act as suppliers also, since they supply the system with “products” – their children- who are influenced respectively by the family environment. With the term *Internal Customers*, in a TQM program in an education institution, we refer to the parents, students, faculty, administration and staff of the institution. On the other hand, with the term *External Customers* we refer to society, businesses, future employers, families and other institutions that the student might continue his/her studies, that have an interest in the output of the institutions education process. There are many different interpretations on who the customers are. While most administrators tend to perceive students as the customers, faculty staff resent this metaphor as being too commercial. Students, parents, alumni, employers, society, faculty, staff and local community, seems to be a complete list of the main groups, there is a believe that some of this groups are more like stakeholders than customers and perhaps customers of secondary processes rather than customers of the primary process of education. Overall it is important to note that without a well defined customer and customer focus, quality efforts may easily end up in failure. It is also important to keep in mind, as in every system that is based on the chain of customers-suppliers, that the customers’ needs and expectations are translated to specifications for the suppliers. Therefore, it is worth mentioning that, one of the critical steps in TQM implementation is the step of *customer identification*, where current and potential customers of the organization are determined.

- *Commitment.* Top Management’s leadership and commitment to quality is also one of the essential elements of TQM. Management’s commitment is a prerequisite in order to start any quality initiative. Quality needs a change of culture and given that people resist to changes, management’s commitment is an essential element for success. This commitment to quality has to be proven in practice, top leaders need to “walk the walk and talk the talk” in order to teach by example and direct involvement. Commitment to quality can also be proven by the allocation of sufficient resources and time. By the term resources we refer to people, tools, training and processes that will boost and promote quality. In education institutions the

issue of leadership differs from the typical leadership in a business organization. Presidents, chancellors or deans do not enjoy ultimate authority as the CEOs of business organizations. Depending on the country, the administration and governance of the university might be shared. This leads to diffusion of authority and responsibility, and, as a result the top administration lacks the authority to undertake drastic measures and changes in higher education institutions. University presidents and chancellors, as leaders, can naturally set goals, organizational values and performance expectations. However, since they lack the necessary authority, it is difficult to deploy these values and goals through the layers of the higher education institutions [4].

- *Total involvement.* Another crucial element in TQM in education is the involvement of all interested parties, mentioned above, in the educational reform. Quality is the responsibility of every member of the organization rather than the responsibility of the “administration”, or the equivalent of a quality department in industry. Changes are an outgrowth of faculty involvement rather than those of the university administration. It has to be noted that the involvement of *all* interested parties is a *crucial* element for success.
- *Measurements.* «You cannot improve what you cannot measure». Measurement against defined goals is a very important element for the successful implementation of a TQM program in an educational institution. In order to prove success, an institution must define quality objectives; measure the starting point of the quality effort, and use measurements for proving the attainment of improvements. A possible problem that may appear is to focus on problem solving, without, at the same time, measure the effectiveness of these efforts.
- *Continuous improvement.* Given the principle “Do something tomorrow better than you did it today”, the goal of every TQM effort is continuous improvement. TQM is a continuous, unending process of improvement. The TQM program should be reviewed and evaluated on a regular basis to ensure goals are still focused and objectives are being met. In the continuous improvement process small improvements are important, as well as, great improvements. Faults and problems are opportunities for further improvement and in no case openings for criticism or judgments. In a TQM program

everybody is responsible for preventing and solving problems. TQM is a philosophy of never ending improvements achievable only by people. Furthermore, continuous improvement in academic institutions means exploring the needs and expectations of the institutions’ customer base, re-evaluating the effectiveness of programs and total quality initiatives [13].

2.2 Defining the roles of interested parties

Special attention should be paid to the **students’ role** in a TQM program of an educational institution.

On the one hand, as discussed above in paragraph 2.1., the role of students as *customers* is a debatable issue. On the other hand, others believe that students are more seen as an *active participant* in the learning process rather than a *customer* or a *product*.

In the context of an analogy with a manufacturing organization, higher education institutions produce graduates. Students move through the various courses required for a degree, as raw material flows through the successive stages of a manufacturing process. When they graduate, graduates compete for jobs just as products compete for a market share. Thus, graduates may be interpreted as the *finished product* and that industry-future employers are the customers of higher education institutions. Among service organizations, higher education institutions are probably unique in yielding a production analogy. However students have other roles besides their product roles.

According to M.B.Sirvanci [4], depending on the process under study, students take on one of the following four roles within the higher education institution: (a) *the Product-in-process* role, (b) *the internal customer for facilities* role, (c) *the Laborer in the learning process* role and (d) *the internal customer for the delivery of course material* role. From the multiple role description above, it should be clear why customer identification is a complicated and confusing issue, and a very important step in TQM implementation.

The instructor’s/ lecturer’s role in a TQM program in education is also very important. The lecturer acts as a guide for the team of students. This enables the students to share knowledge and experience among each other and in this way improve their learning output. Another aspect of the lecturers’ role is that of the manager, the facilitator, the one who coordinates the effort of learning. As managers, instructors must create an environment which allows the students, to produce a quality product (themselves). The more traditional role that

“the instructor’s job is to “profess” and the student’s job is to learn” has no place in the TQM philosophy. In a TQM program the instructor must create a classroom situation which facilitates the learning process and in which the instructor takes responsibility for the students’ learning. In a university setting *how* the students are being taught should have a greater emphasis than *what* they are taught. It is important that the education that the students are receiving provides them with the tools necessary to succeed in their jobs, but emphasis should be also paid in that the education that the students receive is presented in a manner so that the students learn and can apply the material in their future working environment. The instructor has to provide frequent feedback to his students regarding their performance

At the same time **the parents’ role** in the educational process is also very important. In TQM philosophy parents are equivalent partners in the educational process. They are also suppliers, as well as customers (members of the society that will take advantage of the outputs of the educational process). Parents should be involved effectively in the partnership educational process. Once more it is very important in a TQM program to identify clearly the role of all interested parties in the system.

2.3 Models for implementing TQM in higher education

For implementing TQM in higher education several models have been developed, based on the above mentioned principles or key elements. Some of these models are based on the TQM principles and essential elements, some on the teachings of the famous quality gurus (such as Deming, Juran and Crosby), and some on the existing criteria of the quality awards, such as the Malcome Baldrige National Quality Award (MBNQA) in the USA, the European Quality Award (EQA) and the Deming Award in Japan.

There are also many examples of TQM models for higher education, which have been used by several US Universities. The examples of the University of Wisconsin-Madison, the Babson College, Fox Valley Technical College, the Harvard University, the Oregon State University, and the Northwest Missouri State University can be found in the paper presented by R.K.Michael et al [5]. Also the implementation examples of two California public higher education systems are presented by N.Aly and J.Akpovi in their paper [3], as well as the implementation of TQM in the University of

Pennsylvania [2]. TQM was first introduced into higher education in the USA, UK institutions has also followed.

Although, many models exist, models should serve as a basic foundation for colleges and universities to follow when they implement TQM in their own institution. The model that will be chosen needs to be tailored to suit the institutions individual needs. In many cases, universities choose a combination of models in order to cover their special needs.

Based on a research conducted by M.S.Owlia and E.M.Aspinwall [11], it can be seen that in the USA, total quality practices seem to be more extensive and more widely accepted than in the UK. This can be explained by the more privatized and market-dominant nature of US higher education, in comparison with the more traditional UK universities, which usually rely on their national and international reputation [11].

2.4 Do’s and Don’ts for a successful implementation

In order to have a successful implementation of a TQM program, there is a list of things to do and problems and pitfalls to take care of and avoid.

The things that one can do, in order to improve success chances are presented below:

- *Leadership.* Top leadership is the driving force behind success. The program leader must teach by example and his direct involvement is a key to the programs success.
- *Commitment to the principles of TQM.* It takes years in order to drive the principles of TQM through to all employees and students; emphasis on training can help. A basic ingredient for the success of the TQM effort is the commitment of the leadership of the academic organization. Top leadership is the driving force behind success.
- *Customer focus.* It is important to clearly identify all customers in the educational quality system and focus on the primary customer of the process in question.
- *Evaluation.* Measurement and evaluation efforts are needed in all aspects of the TQM effort. The introduction of fact-based management and measurement help in convincing about the efficacy of TQM.
- *Resources.* It is very important to allocate sufficient resources and time to the quality effort. Caution has to be given in order not to underestimate the faculty and staff resources required to launch a TQM effort. TQM needs

time, persistence and patience in order to succeed.

- *Training.* As mentioned before training can make a great difference. Training for management and staff, academics and students, in order to understand the philosophy of TQM and acquire the necessary skills for teamworking.
- *Empower.* A TQM program cannot be forced on “employees”. Leadership must convince employees to accept the program and participate voluntarily. Employees must be empowered and willing to follow the TQM program and believe in its necessity. Note that students are also “employees” in a TQM program in education they also need to be empowered and persuaded.
- *Quality Model.* Models are a good starting point, but no model is perfect for every university. The chosen model needs to be tailored to suit the individual needs of the institution.
- *Starting Point.* Starting with a department where success will come more easily and quality improvements will be clearer to present is a good tactic. Usually administration is the first area to be subjected to quality and scientists only join the effort much later. Academia will be easier to follow once success is already proven. Nevertheless, there is a need to achieve faculty commitment to quality.
- *Communication.* The issue of internal communication, but also communication outside the organization to the community, is very important for the success of the TQM effort. The dissemination of information helps getting all interested parties involved in the institutions success.

The things that one can avoid and take care of, so that the whole effort won't end in failure are presented below:

- Believe that TQM is a “quick fix” and anticipate benefits immediately. Impatience leads to disappointment.
- Not exhibit top management's commitment by example.
- Fail to adapt business principles correctly to an academic environment.
- Fail to address organization structure issues that create problems in focusing on a shared mission or common goal.
- Avoid empowering employees because leadership is unwilling to do so.
- Fail to estimate correctly the necessary resources (faculty and staff resources, time and capital).
- Not provide sufficient training and knowledge to all interested parties.

3 Engineering Education: What has TQM to offer?

Engineering institutions as an engineer-producer, just like every other production system, must of course have quality, time and costs under control. TQM has already proved in higher educational institutions that results in improvements in quality of education, lower costs, productivity improvements, increased customer satisfaction and improved student/staff morale. There is no reason why TQM in engineering education won't have the same results. All aspects of TQM discussed above are also applicable in engineering education. Furthermore the need of applying TQM in engineering education is more critical, due to the close relation of engineering to the market-industry needs, where TQM philosophy has entered its maturity phase.

Nowadays, more than ever, engineering students need to be able to effectively make the transition to the work environment, contribute to a project team, work independently, utilize multiple information resources, communicate effectively, value self-renewal, and have a clear perspective about the dynamics of the changing engineering profession in today's society and complex working environment.

According to M.Jaraiedi and D.Ritz [10] students entering engineering, in the US, is on a decline. Engineering education needs to undergo dramatic changes in order to keep up with the changing society and declining student enrollment. The challenge is to prepare engineering students for the industry as well as give them enough background and incentive to pursue graduate studies [10]. In order to move forward and attain a higher level of quality in engineering education, the concept of TQM must be applied. A university, as a service provision organization, provides services not only to students, but also to the companies that hire graduates. It should be stated, that TQM is not a set of rules that, if implemented, will solve all problems. TQM is a philosophy, a way of life, that must be supported at all levels and practiced by all involved in order to succeed.

Applying TQM philosophy, in engineering education can help technical institutions play this role and continuously improve quality in education.

Examples of engineering education institutions that embrace the philosophy of TQM and use its principles and tools in order to identify opportunities to improve the quality of education in engineering college exist in the literature; the example of the College of Engineering at the University of Miami [9], the College of engineering at Virginia Tech [7],

the Royal Institute of Technology in Stockholm, Sweden [8], the West Virginia University [10], a number of engineering institutions in Delhi in India [11] and other.

4 Conclusion

Higher education institutions have been facing challenges for some time and are expected to face more in the future. In the new environment that higher education has entered quality plays an increasingly important role. Feigenbaum [18] believes that “quality of education” is the key factor in “invisible” competition between countries since the quality of products and services is determined by the way that “managers, teachers, workers, engineers, and economists think, act and make decisions about quality. Higher education is being driven towards commercial competition imposed by economic forces [11]. The new situation demands higher quality at lower costs, together with improved efficiency. Despite opinions that regard TQM as “the latest in a series of fads urged on higher education” it seems that there is solid reasoning behind introducing Total Quality philosophy in universities. TQM is seen by many as having enormous potential to respond to the challenges [17].

Finally, having reviewed the literature and examples of TQM implementation in higher education, both in engineering and other institutions, there appears to be no apparent reason for rejecting the applicability of TQM as a general philosophy in higher education. On the contrary TQM can help institutions that wish to increase their efficiency and their commitment to their customers, by creating a quality culture engaging all stakeholders involved.

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