PRIORITIZING TOTAL QUALITY MANAGEMENT IMPLEMENTATION CRITERION FOR ENGINEERING EDUCATION: AN ANALYTIC HIERARCHY PROCESS ANALYSIS

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ABSTRACT

Total Quality Management (TQM), which employs a set of criterions and practices for improving organizational performance was developed for industrial purposes and is now attracting the attention of researchers in the field of education. In this paper, TQM implementation criterions were examined for their relative importance for better implementation in engineering education. A decision support method, the Analytic Hierarchy Process (AHP), has been applied to prioritize and rank 13 TQM implementation criterions and 68 sub criterions by calculating their local and global weights. To effectively implement TQM, engineering education institutions (EEIs) should focus on the most important TQM practices such as Resource Management, Student Focus and Service Culture, and address the less important ones at a later stage. By doing so, they would gradually reduce employee resistance to change, especially if positive results are obtained.

Keywords: Total Quality Management (TQM), Engineering Education, Analytic Hierarchy Process (AHP), India.

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1. Introduction

The propagation of higher education institutions has played a vital role in the economic regeneration of the world. In the market oriented environment, higher education is facing ever increasing expectations and pressure from its stakeholders (Sahney, Banwet, and Karunes, 2004). One of the strategies being adopted globally to meet these expectations is focusing on improving the quality of education (Sharma, Moon, and Bae, 2008). Yet, the quality of higher education in many countries falls short of attaining global-level of excellence (Senthilkumar and Arulraj, 2011), and India is no exception.

Indian higher education has witnessed mostly unplanned exponential growth in the past few years which is exerting an intense pressure upon the institutions for survival and success (Umashankar, and Dutta, 2007). Engineering education particularly has witnessed a phenomenal expansion both in terms of growth and diversity; as a result there has been a sharp increase in the number of private colleges as well as universities in India. The number of EEIs in 1990 was 74 with an intake capacity of 5,200, and this has increased to 2,450 and 1,761,976 respectively in 2012 (www.aicte.org, 2012). Due to this explosive growth, the quality issues have been neglected to a great extent. It is imperative to look critically into these issues, so that India will be ready to face challenges in the wake of globalization (Sakthivel and Raju, 2006a).

Indian engineering education has followed some kind of quality evaluations to ensure that it offers high standards of teaching and learning as well as research. The regulators for higher education in India are the University Grants Commission (UGC), the National Board of Accreditation (NBA) and the All India Council of Technical Education (AICTE). The NBA has a well-defined system of evaluating the quality and has the most stringent norms for quality assessment, but NBA accreditation is still optional in India. As a result, many engineering institutes are being run without this accreditation.

From a quality management perspective, the quality assurance methods adopted by these regulatory bodies are weak because they rely on inspection and corrective action. This results in inefficiency because inspection activities are tedious and have a high cost. The TQM philosophy emphasizes prevention and continuous improvement, therefore institutions can improve their effectiveness over time with minimum costs by implementing TQM measures (Kanji, Malek, and Tambi, 1999). TQM is a synthesis of a number of discrete principles requiring all employees at every level of an organization to focus his/her efforts to help improve each activity of the organization (Mehra, Hoffman, and Sirias, 2001).

There are many issues which need to be addressed and prioritized with regards to implementation of a quality programme in engineering education. This paper tries to identify such issues and address them by prioritizing them in terms of their criticality in improving the quality. Talib *et al.* (2011) have also emphasized the need to determine the implementation priority of TQM criterions so as to achieve maximum benefits and desired goals. Therefore, the research is aimed to prioritize the relative importance of TQM criterion and sub criterion for implementation, so that an institute can evaluate their current practices to improve their performance. However, prioritization of the TQM criterion and sub criterion is a complex task as it requires multiple output measurements that match with the multiple objectives of the engineering institution, and also a technique that could provide the correct and required information to the decision makers.

The AHP is one of the most widely used multiple criterion decision making (MCDM) tools which assigns weights to each criterions as per their priority (Vidhya and Kumar, 2006). Therefore the present study uses this approach to determine the relative importance of each criterion in enhancing the quality in engineering education. The major implication of the research will be that EEIs will be able to focus on criterions which have a high priority for improving their quality.

2. Literature review

AHP is a decision-making tool that can help describe the general decision operation by decomposing a complex problem into a multi-level hierarchical structure of objectives, criterion, sub-criterion, and alternatives (Saaty, 1977, 1994, 1996, 2000, and 2010). AHP gives weight and rank to all the criterion and sub-criterion within each level of the hierarchy after decomposing a complex, multi-criterion problem into multiple levels of hierarchy (Saaty, 1990). The AHP approach is a consensus, inclusive based decision without disregarding any opposing views (Yusof and Salleh, 2013). AHP is a theory of measurement through pairwise comparisons and relies on the judgments of experts to derive priority scales (Saaty, 2010). Experts are interviewed and pair-wise comparison judgments are applied to pairs of homogenous criterion, eventually generating the overall priorities for ranking the alternatives (Saaty, 1980). AHP also helps to capture both subjective and objective evaluation measures, providing a useful mechanism for checking the consistency of the evaluation measures and alternatives suggested by the team, thus reducing bias in decision making (Ho, 2008).

The AHP method is extensively used in real life situations, such as maintenance selection problem (Bertolini and Bevilacqua, 2006), higher education (Ho, *et al.*, 2006), optimization of wastewater treatment (Zeng, G., Jiang, Huang, Xu, and Li, 2007), consumer bank selection decisions (Javalgi, Armacost, and Hosseini,1989), measuring performance (Frei and Harker, 1999), allocating resources (Ramanathan, and Ganesh, 1995), new product screening (Calantone, Benedetto, and Schmýdt, 1999), benchmark determination (Partovi, 1994), optimizing distribution networks (Sharma, Moon, and Bae, 2008), choosing the best policy after finding a set of alternatives (Poh, and Ang, 1999), identification of new ventures (Jain, and Nag, 1996), vocational education (Lam, Poon, and Chin, 2008), software development process (Lee, Pham, and Zhang, 1999), service industries (Talib Rahman and Qureshi, 2011; Beshah, and Kitaw, 2013). The literature related to AHP found that researchers widely used priority and ranking for a variety of different applications, and therefore this process was applied in the present study.

TQM is a management approach for improving organizational performance that encompasses a variety of topics both technical and behavioral (Shams-ur, 2004). The subject of TQM has been explored by several researchers and various attributes and measurements for TQM implementation have been suggested. For instance, Deming (1986) prescribed TQM in 14 points, which he claimed to be a set of criterions necessary to remain competitive in providing products and services. Anderson (1994) studied these criterions, and developed a conceptual framework for TQM using seven concepts which includes visionary leadership, internal and external communication, learning, process management, continuous improvement, employee fulfillment, and customer satisfaction. Several studies were conducted to highlight the linkages of TQM with different concepts. Talib, Rahman & Qureshi (2011) identified 17 TQM practices and grouped into three

factor (Strategic factors, Tactical factors and Operational factors) for service industries. Sarathy (2013) determined the important factors that influence the TQM practice in the real estate industry using an AHP 1uestionnaire. Sagar and Tomar (2014) ranked critical success factors of TQM using the AHP.

The existing literature shows that although much empirical research has been conducted which deals with TQM practices, studies exploring TQM concepts in the Indian context and their effects on overall performance in the engineering education sector are rarely seen. It is also evident from the literature that it is a very challenging and complex task to evaluate TQM criterions in a group. In order to bridge this gap, this paper attempts to provide a framework and a system for the educational policy makers and the performance monitoring committee. This framework is for designing standard multiple performance measurement tools based on TQM criterions for evaluating and comparing the performance of EEIs in India.

3. Determining the relative weights of TQM implementation criterions and sub criterions for the engineering education sector

An AHP-based evaluation model was developed for determining the relative weights of TQM implementation criterions. First, TQM implementation criterion and sub -criterion for the engineering education were identified. Then a pair-wise comparison matrix was established by the panel of experts and the eigenvalues of each pair-wise comparison matrix was calculated. Finally, after testing the consistency of each comparison matrix, local and global weights of each criterion and sub-criterion were calculated (Figure 1).

3.1 Identifying the TQM implementation criterion and sub-criterion for engineering education

Engineering education is essential for the improvement of the technical manpower of a country. In India, many technical institutions have ISO9001: 2000 and NBA certification, but at times the quality of education in those institutes is not satisfactory (Sayeda, Rajendran, and Lokachari 2010). A widely accepted view on quality is the degree to which stakeholders' needs and expectations are consistently satisfied. However, formulating a single, comprehensive definition that can integrate the interests of all the customers and stakeholders becomes challenging with the engineering educational system because it has various customers and stakeholders..The "Total Quality Management" philosophy can help build a customer-driven learning organization dedicated to total customer satisfaction through continuous improvement in the effectiveness and efficiency of the organization and its processes within this challenging environment (Choppin, 1995). Many researchers have formulated frameworks for quality improvements (Johnson, 1993; Venkatraman, 2007; Khan and Mahapatra, 2007; Mizikaci, 2007; Srikanthan and Dalrymple, 2003), And these frameworks have been given different names such as Continuous Quality Improvement (CQI), Strategic Quality Management (SQM) or Total Quality Management (TQM). Even though there might be some differences among these approaches, the term TQM is considered to be more general and captures the essence of quality improvement (Venkatraman, 2007). Therefore, implementation of TQM practices in engineering institutions may be integral in helping the students receive a quality education.

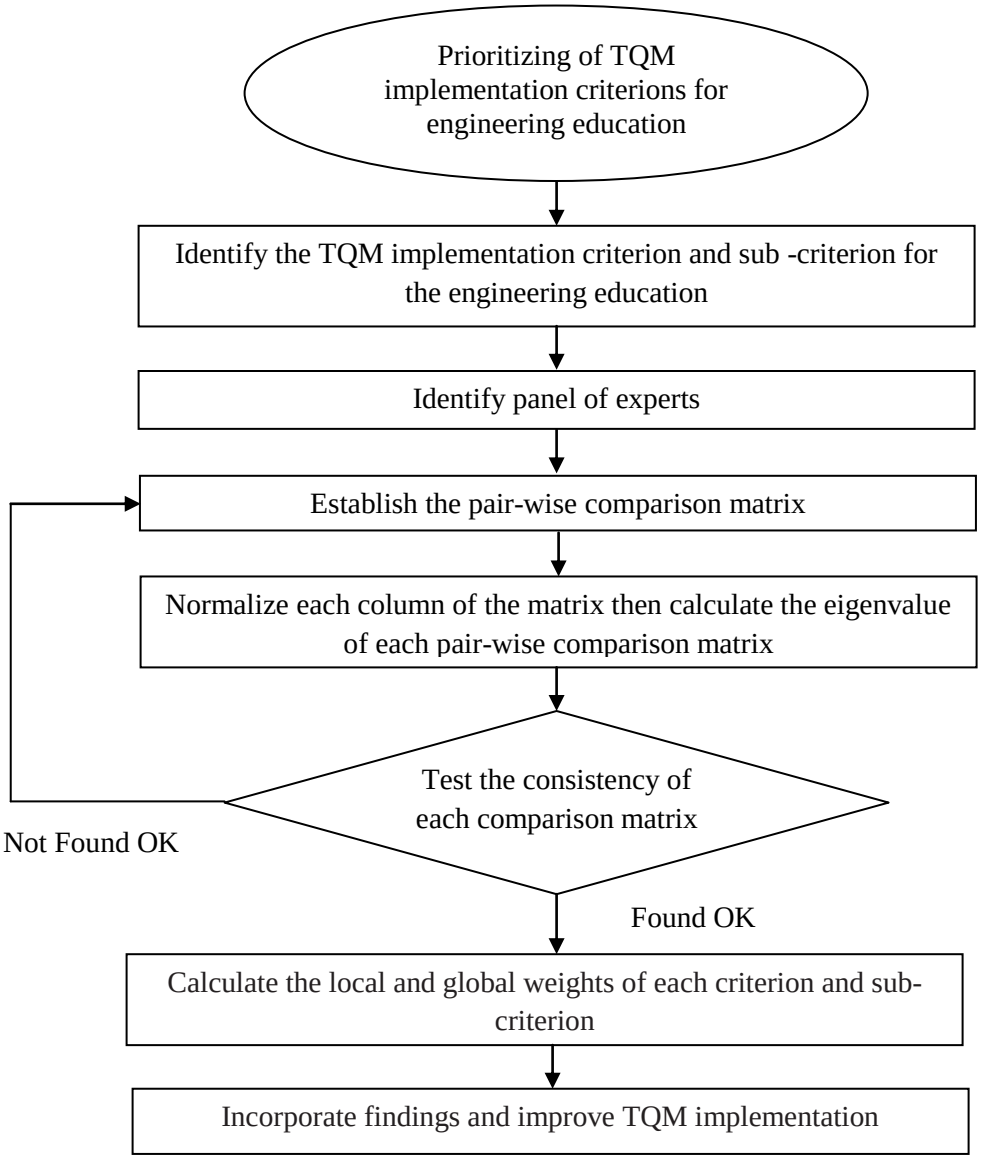

Figure 1. Schematic representation of the methodology

TQM is a set of guiding philosophical criterion and sub criterion that provide a foundation for any continuously improving organization. A literature review helped identity the TQM implementation criterion and sub-criterion for the engineering education sector which have been categorised into 13 major criterion and 68 sub criterion with the use of the Delphi method (Mehta, Verma and Seth, 2013).

3.2 Identifying a panel of experts

A panel of experts in the engineering education sector includes those who have expertise by virtue of having a long association with the system like students, lecturers, professors, director/principals, parents, industrialists and support staff. Heterogeneous groups with widely varying personalities produce more highly acceptable solutions than homogeneous groups (Delbecq, Van and Gustafson, 1975; Rowe, 1994). Researchers have different opinions regarding the appropriate size for a panel of experts; however many researchers (MacCarthy and Atthirawong, 2003; Linstone and Turoff, 1975; Landeta, 1999) have recommended a group size in the range of seven to thirty members. In the present study an expert panel of 26 members was formed which consisted of students (5), lecturers (3), associate professors (3), professors (4), directors/principals (3), parents (3) and industrialists (5).

3.3 Establishing the hierarchy structure for TQM implementation criterion

When dealing with complex issues, it is most effective to organize them in a hierarchical structure. This hierarchical organization and determine of the inter-relationships is difficult. The first step in the process is to set the goal and then define the criterions to achieve this goal with different alternatives (Figure 2). In the present case, the goal is to prioritize TQM implementation criterions for engineering education and rank them by calculating their local and global weights.

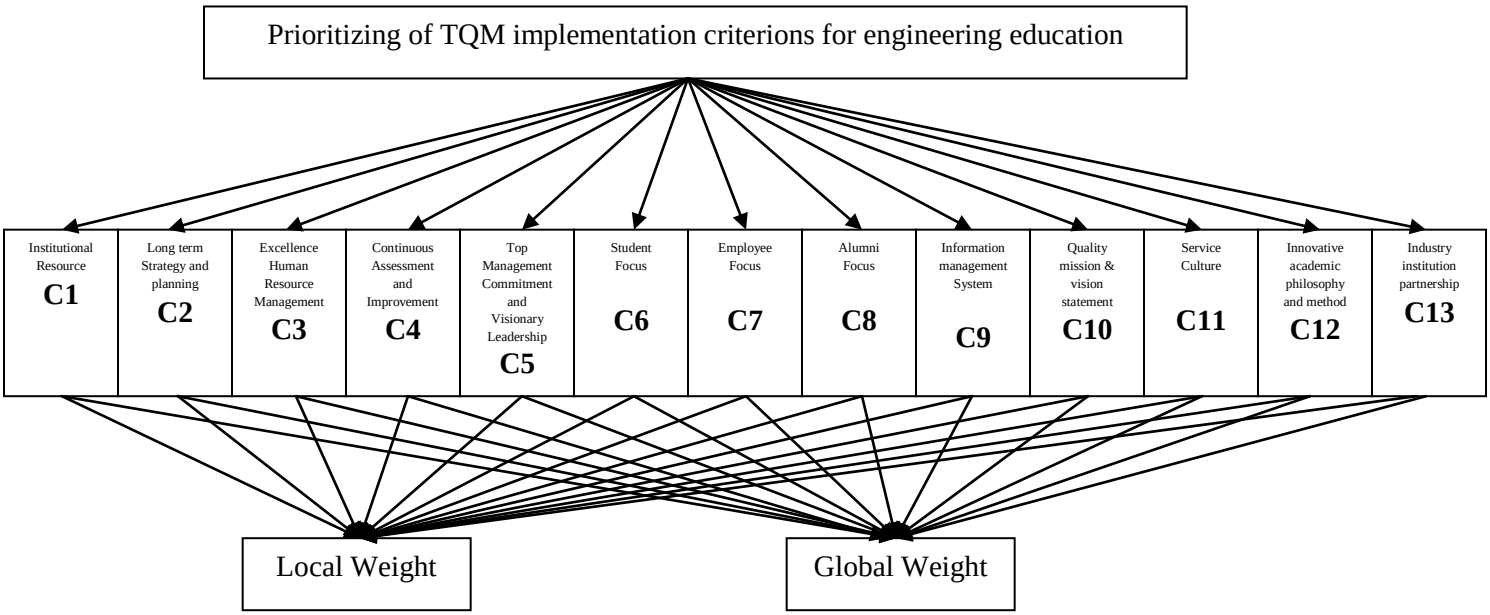

Figure 2. AHP hierarchy

3.4 Establish the pair-wise comparison matrix

In order to determine the importance of specific criterion and sub-criterion, pair-wise comparisons were carried out. The comparison matrix is a square matrix with *n* x *n* dimensions. Pair-wise comparisons are based on the scale of relative importance that assumes values between 1 and 9 (Table 1).

Table 1
Scale of relative importance

Intensity of Relative	Importance	Definition Explanation
1	Equal Importance Level	Two elements have equal importance regarding the element in higher level
3	Week Dominance	Experience or judgment slightly favors one element
5	Strong Dominance	Experience or judgment strongly favors one element
7	Demonstrated	Dominance of one element proved in practice
9	Absolute Dominance	The highest order dominance of one element over another
2,4,6,8	Intermediate Values	Compromise is needed

This scale can be applied to criterion according to the expert panel judgments. Each expert makes a pair-wise comparison of the criterions and assigns them relative scores. Since the values on the diagonal represent the same factor, they become 1. If the

preference is used in favor of the factor in the row when the factor in any row is compared with the factor in the column, a fraction (1/importance value) is preferred (Yaraliodlu, 2001). Table 2 shows the aggregate pair-wise comparison matrix for the thirteen TQM implementation criterions.

Table 2
Establishing a comparison matrix of the TQM implementation criterion

TQM Implementation criterion	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13
C1 Institutional Resource Management	1	2	1	5	6	1/2	3	4	9	7	2	7	8
C2 Long term Strategy and planning	1/2	1	1/2	4	4	1/3	2	3	9	5	1	6	7
C3 Excellence Human Resource Management	1	2	1	5	6	1/2	3	4	9	7	2	7	8
C4 Continuous Assessment and Improvement	1/5	1/4	1/5	1	2	1/5	1/3	1/2	7	2	1/4	3	4
C5 Top Management Commitment and Visionary Leadership	1/6	1/4	1/6	1/2	1	1/6	1/4	1/3	6	2	1/4	3	4
C6 Student Focus	2	3	2	5	6	1	4	5	9	6	3	7	8
C7 Employee Focus	1/3	1/2	1/3	3	4	1/4	1	2	8	5	1/2	6	6
C8 Alumni Focus	1/4	1/3	1/4	2	3	1/5	1/2	1	8	4	1/3	5	6
C9 Information management System	1/9	1/9	1/9	1/7	1/6	1/9	1/8	1/8	1	1/5	1/9	1/5	1/3
C10 Quality mission & vision statement	1/7	1/5	1/7	1/2	1/2	1/6	1/5	1/4	5	1	1/5	2	3
C11 Service Culture	1/2	1	1/2	4	4	1/3	2	3	9	5	1	6	7
C12 Innovative academic philosophy and method	1/7	1/6	1/7	1/3	1/3	1/7	1/6	1/5	5	1/2	1/6	1	3
C13 Industry institution partnership	1/8	1/7	1/8	1/4	1/4	1/8	1/6	1/6	3	1/3	1/7	1/3	1

Similarly, an aggregate pair-wise comparison matrix for the sub-criterion of each thirteen TQM implementation criterion is established.

3.5 Normalizing each column of the matrix and calculating the eigenvalue

To find a normalized matrix, each element of the comparison matrix should be divided with the sum of its column elements. Saaty (1990) suggested that the largest eigenvalue λ_{max} can be calculated by the Equation 1.

$$\lambda_{max} = \sum_{J=1}^{n} a_{ij} \frac{W_j}{W_i} \qquad (1)$$

Where a_{ij} represents a quantified judgment on a pair of elements and W_i and W_j are weights (for i, j =1, 2... n.)

3.6 Testing the consistency of each comparison matrix

To check the consistency of comparison matrix a consistency ratio is defined, which is the ratio between the consistency index (CI) and the random consistency value (RI). The value of the CR should be less than or equal to 0.1 if the order of the matrix is five or more for the comparison matrix values to be consistent (Saaty, 1994).

Whereas on the basis of normalized matrix, CI is calculated using the Equation 2.

$$CI = (\lambda_{max} - N) / (N - 1) \qquad (2)$$

Where N is the order of matrix, the random consistency value (RI) for corresponding N is found from the table of random consistency.

Table 3 shows a normalized matrix with eigenvalues, the consistency index and the consistency ratio of the TQM implementation criterions.

Table 3
Normalized matrix for TQM implementation criterion

TQM Implementation criterion	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13
C1 Institutional Resource Management	.15	.18	.15	.16	.16	.12	.18	.17	.10	.16	.18	.13	.12
C2 Long term Strategy and planning	.08	.09	.08	.13	.11	.08	.12	.13	.10	.11	.09	.11	.11
C3 Excellence Human Resource Management	.15	.18	.15	0.16	0.16	.12	.18	.17	.10	.16	.18	.13	.12
C4 Continuous Assessment and Improvement	.03	.02	.03	.03	.05	.05	.02	.02	.08	.04	.02	.06	.06
C5 Top Management Commitment and Visionary Leadership	.03	.02	.03	.02	.03	.04	.01	.01	.07	.04	.02	.06	.06
C6 Student Focus	.31	.27	.31	.16	0.16	.25	.24	.21	.10	.13	.27	.13	.12
C7 Employee Focus	.05	.05	.05	.10	.11	.06	.06	.08	.09	.11	.05	.11	.09
C8 Alumni Focus	.04	.03	.04	.07	.08	.05	.03	.04	.09	.09	.03	.09	.09
C9 Information management System	.02	.01	.02	.00	.00	.03	.01	.01	.01	.00	.01	.00	.01
C10 Quality mission & vision statement	.02	.02	.02	.02	.01	.04	.01	.01	.06	.02	.02	.04	.05
C11 Service Culture	.08	.09	.08	.13	.11	.08	.12	.13	.10	.11	.09	.11	.11
C12 Innovative academic philosophy and method	.02	.02	.02	.01	.01	.04	.01	.01	.06	.01	.02	.02	.05
C13 Industry institution partnership	.02	.01	.02	.01	.01	.03	.01	.01	.03	.01	.01	.01	.02

λ_{max} = 14.759998, CI = 0.146665, RI = 1.54, CR = 0.095237≤ 0.1

Similarly normalized matrix and eigenvalue are calculated for sub-criterions of each criterion.

3.7 Calculate the local and global weights of each criterion and sub-criterion

Local weight is the weight of the each major criterion and sub criterion with respect to the previous hierarchical level. Global weight is the weight of the each major criterion and sub criterion with respect to the highest hierarchical level (Talib *et al.,* 2011). The global weight of sub criterion is the product of local weight for criterion i to local weight for sub-criterion j with respect to criterion i (Drake, 1998). The 13 TQM implementation criterions have the same local and global weights. The local and global weights calculated for each criterion and sub-criterion are shown in Table 4.

Table 4
Weights and rank of thirteen criterions and sixty - eight sub-criterions

Criterion	**Weights of Criterion**	**Rank of Criterion**	**Sub-Criterion**	**Local**		**Global**	
				Weights of Sub-Criterion	**Rank of Sub-Criterion**	**Weights of Sub-Criterion**	**Rank of Sub-Criterion**
(C1) Resource Management	**0.152**	**II**	C11 Tangible Resource – Essential Infrastructure	**0.5577**	**1**	**0.0850**	**1**
			C12 Tangible Resource – Support services	**0.0417**	**4**	**0.0064**	**40**
			C13 Intangible Resource	**0.1330**	**2**	**0.0203**	**17**
			C14 Financial Resources	**0.2676**	**3**	**0.0408**	**6**
(C2) Long term strategy and planning	**0.103**	**III**	C21 Social Responsibility (SR)	**0.3402**	**1**	**0.0350**	**7**
			C22 Professional Society activities	**0.0449**	**6**	**0.0046**	**46**
			C23 Annual academic calendar	**0.2577**		**0.0265**	**14**
			C24 Promotional policies/procedure	**0.0210**	**7**	**0.0022**	**57**
			C25 Design of course structure based on job requirement	**0.1653**	**3**	**0.0170**	**18**
			C26 Opportunities for campus training and placement	**0.0718**	**5**	**0.0074**	**34**
			C27 Annual budget Utilization	**0.0991**	**4**	**0.0102**	**30**
(C3) Human Resource Management (HRM)	**0.152**	**II**	C31 Teamwork	**0.1878**	**2**	**0.0286**	**9**
			C32 Training	**0.0237**	**5**	**0.0036**	**49**
			C33 Participation and ownership	**0.0862**	**3**	**0.0131**	**24**
			C34 Employee Empowerment	**0.0862**	**3**	**0.0131**	**25**
			C35 Transparency and fairness in recruitment	**0.0428**	**4**	**0.0065**	**38**
			C36 Maintain faculty-student ratio	**0.3856**	**1**	**0.0588**	**4**
			C37 Communication	**0.1878**	**2**	**0.0286**	**10**
(C4) Continuous Assessment and Improvement	**0.040**	**VI**	C41 Continuous Assessment	**0.2964**	**1**	**0.0120**	**27**
			C42 Students' Evaluation	**0.0210**	**5**	**0.0009**	**66**
			C43 Improve overall performance of the faculty, staff and students	**0.0374**	**4**	**0.0015**	**61**
			C44 Update basic resources	**0.0758**	**3**	**0.0031**	**51**
			C45 Comparison of actual with planned performance	**0.1364**	**2**	**0.0055**	**43**
			C46 Continuous Improvement	**0.2964**	**1**	**0.0120**	**28**
			C47 Benchmarking	**0.1364**	**2**	**0.0055**	**44**

Criterion	**Weights of Criterion**	**Rank of Criterion**	**Sub-Criterion**	**Local**		**Global**	
(C5) Top Management Commitment and Visionary Leadership	**0.059**	**IV**	C51 Management commitment	**0.3941**	**1**	**0.0234**	**16**
			C52 Remove barriers to pride of workmanship	**0.0957**	**4**	**0.0057**	**42**
			C53 Strategic planning	**0.2375**	**2**	**0.0141**	**22**
			C54 Annual budget allocation	**0.1539**	**3**	**0.0091**	**31**
			C55 Top Management Learning	**0.0235**	**4**	**0.0014**	**62**
			C56 Top Management Participation	**0.0477**	**5**	**0.0028**	**53**
			C57 Top Management Encouragement	**0.0477**	**5**	**0.0028**	**54**
(C6) Student Focus	**0.206**	**I**	C61Syllabus covered with student satisfaction	**0.3748**	**1**	**0.0772**	**2**
			C62 Extra-curricular and co-curricular activities	**0.1313**	**3**	**0.0271**	**11**
			C63 Academic development	**0.2313**	**2**	**0.0476**	**5**
			C64 Personality development	**0.0714**	**4**	**0.0147**	**19**
			C65 Students Complaint Information	**0.0216**	**6**	**0.0045**	**47**
			C66 Students' feedback	**0.0382**	**5**	**0.0079**	**33**
			C67 Motivational activities	**0.1313**	**3**	**0.0271**	**12**
(C7) Employee Focus	**0.078**	**IV**	C71 Security of job	**0.1867**	**2**	**0.0145**	**20**
			C72 Curriculum development	**0.0259**	**5**	**0.0020**	**58**
			C73 Recognition and Reward	**0.0884**	**3**	**0.0069**	**36**
			C74 Adequate and efficient teaching assistants	**0.0884**	**3**	**0.0069**	**37**
			C75 Effective problem solving	**0.0453**	**4**	**0.0035**	**50**
			C76 Employee feedback	**0.3786**	**1**	**0.0295**	**8**
			C77 In house R&D activity	**0.1867**	**2**	**0.0145**	**21**
(C8) Alumni Focus	**0.034**	**VII**	C81 Alumni feedback	**0.7235**	**1**	**0.0245**	**15**
			C82 Information Circulation	**0.0833**	**3**	**0.0028**	**55**
			C83 Alumni Empowerment	**0.1932**	**2**	**0.0065**	**39**
(C9) Information and Analysis System	**0.010**	**XII**	C91 Data and information of every process are gathered and analyzed	**0.5579**	**1**	**0.0055**	**45**
			C92 Improve and update the information systems	**0.2633**	**2**	**0.0026**	**56**
			C93 Display information which reflect institute image	**0.0569**	**4**	**0.0006**	**67**
			C94 Display information which attract Internal and external stakeholder	**0.1219**	**3**	**0.0012**	**64**

Criterion	**Weights of Criterion**	**Rank of Criterion**	**Sub-Criterion**	**Local**		**Global**	
(C10) Quality mission & vision statement	**0.026**	**VIII**	C101 Vision statement	**0.5059**	**1**	**0.0131**	**26**
			C102 Mission statement	**0.3260**	**2**	**0.0084**	**32**
			C103 Students quality goal	**0.1137**	**3**	**0.0029**	**52**
			C104 Shared quality policy	**0.0543**	**4**	**0.0014**	**63**
(C11) Service Culture	**0.103**	**III**	C111 Friendly atmosphere in campus	**0.6333**	**1**	**0.0651**	**3**
			C112 Internal and external stakeholder pride of workmanship	**0.1062**	**3**	**0.0109**	**29**
			C113 Internal and external stakeholder work together	**0.2605**	**2**	**0.0268**	**13**
(C12) Innovative academic philosophy and method	**0.022**	**IX**	C121 Adopt new academic philosophy	**0.6434**	**1**	**0.0139**	**23**
			C122 Use new and latest technology	**0.2828**	**2**	**0.0061**	**41**
			C123 Right the work first time	**0.0738**	**3**	**0.0016**	**60**
(C13) Industry institution partnership	**0.015**	**X**	C131 Courses/programs partnership	**0.0678**	**4**	**0.0010**	**65**
			C132 Expert/guest lecturers	**0.2602**	**2**	**0.0038**	**48**
			C133 Industry based projects	**0.0348**	**5**	**0.0005**	**68**
			C134 Continuously searching demands of industry	**0.1344**	**3**	**0.0020**	**59**
			C135 Placements partnership	**0.5028**	**1**	**0.0074**	**35**

3.8 Incorporating findings and improving TQM implementation

From the calculations carried out in the step 6, EEIs can prioritize and rank the TQM criterion and sub-criterion and then allocate the resources accordingly to attain the maximum advantages. The use of the AHP has generic applications because its structure and hierarchy can be easily modified to incorporate specific attributes (Banuelas and Antony, 2003). AHP can, therefore, be adopted for prioritizing TQM practices in different service sectors and processes according to the specific objectives set by decision-makers.

4. Results and Discussion

The study identified the priority ranking of the 13 TQM implementation criterion and 68 sub criterion for the EEIs. By understanding their relative importance, EEIs can evaluate their current practices and re-allocate resources and efforts to these criterion and sub criterion to improve their TQM performance.

Table 4 shows the local weights and global weights of 13 TQM implementation criterion and 68 sub criterion that are normalized based on the AHP analysis and ranked accordingly. Implementation criterion "Student Focus (C6)" with a weight of 0.206 is the most important criterion, followed by "Human Resource Management (HRM) (C3)" with a weight of 0.152, and "Service Culture (C11)" and "Long term strategy and planning (C2)" with same a weight of 0.103.

- The top four ranked TQM implementation criterions were "Student Focus (C6)", "Human Resource Management (HRM) (C3)", Service Culture (C11)" and "Long term strategy and planning (C2)". Therefore, the EEIs should focus on student satisfaction as the utmost priority by taking care of syllabus coverage, organizing motivational lectures, emphasizing extra-curricular and co-curricular activities, and seeking student feedback for assessment of syllabus coverage and quality of classroom teaching. Implementation of these practices will result in long term benefits for the EEI and further help in the successful implementation of a TQM programme. Without these practices it will be hard for TQM to be implemented effectively and successfully.

- Human Resource Management (HRM) (C3) was also one of the top most criterions because it focuses on effective utilization of available human resources to improve and enhance the systems. HRM systems will rate the best if the employees are provided proper training and are involved in the decision making process. Along with this, it is also required that a culture of team work is inculcated in the employee's transparency, and fairness in the recruitment process is maintained. Proper faculty-student ratio and communication between faculty and students and between the departments is also important.

- EEIs should develop a long term strategy (C2) in planning for their course structure so that job based courses can be initiated and training provided. Programmes on social responsibility and membership in professional societies will also go a long way in developing a TQM culture in an institute. A proper

service culture (C11) will result in a friendly atmosphere in the institute, helping to provide a synergistic relationship between internal and external stakeholders.

Discussion regarding important sub criterion of each criterion based on its local weight is as follows:

- Sub criterion "Tangible Resource – Essential Infrastructure (C11)" with a weight of 0.5577 for criterion Resource Management (C1) was the highest priority. This emphasized the quality and quantity of the entire physical infrastructure such as buildings with adequate laboratory set-ups, a library with adequate and updated books and technical journals, computing facilities and information systems, and assumes a key role in the teaching-learning processes.

- Sub criterion "Social Responsibility (SR) (C21)" with a weight of 0.3402 for the criterion Long term strategy and planning (C2), plays an important role in grooming the personality of a student and making him a more aware and responsible citizen. The sense of social responsibility can be inculcated in students by organizing welfare activities and general awareness programmes for the surrounding society.

- With respect to the criterion Human Resource Management (HRM) (C3), expert's ranked "Maintain faculty-student ratio (C36)" as the highest sub criterion with a weight of 0.3856. This implied that if the institute maintains a proper faculty ratio, faculty can devote quality time to pedagogic activities such as preparing assignments and lecture notes, conducting regular class tests, lab work etc., separate from other developmental activities related to infrastructure, modernization of labs, setting up of new facilities etc.

- Continuous assessment (C41) plays a significant role in creating and maintaining standards for successful TQM implementation. With a weight of 0.2964, this criterion ranked as the top most sub criterion under Continuous Assessment and Improvement (C4). Therefore, the management should have clear objectives and frame policies to review the existing processes so that the ever changing needs and expectations of the stakeholder can be effectively met.

- Committed support from the top management and their efforts towards never-ending quality improvement efforts leads to better customer service and satisfaction. In the present study, experts were also of the same view as evidenced by ranking the sub criterion "Management commitment (C51)" highest with a weight of 0.3941 for criterion Top Management Commitment and Visionary Leadership (C5). This implied that the commitment of the management is a driving force for the successful implementation of TQM programme in an EEI also.

- Sub criterion "Syllabus covered with students satisfaction (C61)" with a weight of 0.3748 for criterion Student Focus (C6), was most important in the expert's opinion because they believe if management collects regular feedback regarding the syllabus covered and the quality of teaching from the students, it will help in

better analysis of various TQM processes, such as preparing the academic calendar, course curriculum designing, feedback of faculty from students etc.

- Sub criterion "Employee feedback (C76)" with a weight of 0.3786 for criterion Employee Focus (C7), was important because getting employees suggestions for improvements and also understanding their perceptions of the institute is helpful. .

- Sub criterion "Alumni feedback (C81)" with a weight of 0.7235 for criterion Alumni Focus (C8), reflected the importance of alumni and obtaining their feedback regarding the course structure, prevailing market trends and teaching learning methods adopted by the institute. Alumni can also support the institute by arranging campus placements and giving financial support to students and the institutes if required.

- Sub criterion "Data and information of every process are gathered and analyzed (C91)" with a weight of 0.5579 for criterion Information and Analysis System (C9), implied the importance of data collection and its analysis regarding various processes in the institute. This may help management improve TQM practices and frame a long term vision for the institute.

- Sub criterion "Vision statement (C101)" with a weight of 0.5059 for criterion Quality mission & vision statement (C10), showed the management's commitment to long term quality. This commitment helps instill confidence in employees towards management's future plans.

- Sub criterion "Friendly atmosphere in campus (C111)" with a weight of 0.6333 for criterion Service Culture (C11), signified the importance of a good academic environment in the institute. This not only helps to improve the service culture of the institute, but also creates a good impression on the stakeholders.

- Sub criterion "Adopt new academic philosophy (C121)" with a weight of 0.6434 for criterion Innovative academic philosophy and method (C12), focused on the management's commitment to make necessary changes in teaching learning process as per the needs of the stakeholders.

- Sub criterion "Placements partnership (C135)" with a weight of 0.5028 for criterion Industry institution partnership (C13), referred to the interaction of the academia with the corporate bodies, in terms of exchange of ideas, problems and projects for mutual benefit. The management, faculty and students may get to know the demands and requirements of the corporate world which can help them redesign/deliver the course curriculum. This might possibly turn out to be a win-win situation for both because it helps students to discover their interests and capabilities and at the same time helps the corporations find prospective candidates.

The three most important TQM implementation sub criterion with respect to global weights are "Tangible Resource – Essential Infrastructure (C11)" with a weight of 0.0850 for Resource Management (C1), "Syllabus covered with student satisfaction (C61)" with

a weight of 0.0772 for Student Focus (C6), and "Friendly atmosphere in campus (C111)" with a weight of 0.0651 for Service Culture (C11). EEIs should prioritize these criterions for successful implementation of TQM. These criterions indicate that:

- Availability of tangible (like infrastructure) resources in EEIs can improve the overall quality of initiatives supported by top management to develop effective management for availability of resources whenever needed.

- Student satisfaction regarding the quality of teaching affects an institute's performance.

- A positive attitude and organized service culture within the institution can help to achieve total quality education.

5. Implications

From a management perspective, this study offers a number of managerial implications for EEI decision-makers.

- First, the AHP model developed in this research will be very useful to decision-makers in framing guidelines for implementing TQM, and in evaluating the effectiveness of their current TQM practices.

- Second, infrastructural facilities are a pre-condition for an educational institution to carry out its activities smoothly. Continuous support from the top management and their effort towards maintaining sufficient infrastructure leads to better customer service and satisfaction. Thus, this is a driving force for the successful implementation of TQM programme in EEIs.

- Third, the student focus (C6) is crucial in order to obtain the full advantage of TQM. It is the top management's responsibility to collect information (data) regarding students' satisfaction, concerns and issues of their well-being. Management should make attempts to hold meetings with the students and involve them in various academic activities such as course curriculum designing, infrastructural development projects, inviting for sharing knowledge, etc.

6. Conclusions

AHP was used to prioritize TQM implementation criterion and sub criterion for engineering education by identification of their relative importance. A total of 13 TQM implementation criterions and 68 sub criterions were prioritized by calculating their local and global weights. The implementation of the TQM programme requires many changes in institutions, and therefore many people may be reluctant to implement it. The analysis shows that to effectively implement TQM, EEIs should focus on the high priority TQM practices such as Resource Management, Student Focus and Service Culture, and address the less important ones at a later stage. Doing this would gradually reduce employee resistance to change, especially if positive results are generated.

This research study, although exploratory in nature, provides insights into determining the effectiveness of TQM implementation in EEIs; future research could validate the proposed criterion and sub-criterion. Further, a self-assessment system could be developed to evaluate an institute's current performance. This would help to evaluate the strengths and weaknesses of the institute, and provide information to develop appropriate strategies for making improvements. Moreover, the applicability of the results of this study are limited in their scope because this study relies on the judgment of only 26 experts from four EEIs including five experts from industry and all the 26 experts were from a single country.

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