Priority in TQM Process Using AHP Technique – A Case Study of an EPC Organization

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Abstract

A collection of tasks undertaken by various departments in an organization and the collective outcome is considered management and some management methods have more merit than others. Total Quality Management (TQM) aims to increase the quality of overall management techniques to enhance an organization's quality and performance. This study aims at prioritizing TQM of a selected Engineering, Procurement and Construction (EPC) organization which is further enhanced by incorporating Deming's 14 Points of Management. This effort was assisted by the use of the Analytical Hierarchical Process (AHP) technique to get the best results which will enable top level management to make informed decisions on where and how improvements need to be made. The discoveries of this study have ascertained that the selected EPC organization (Company P) does in fact prioritize TQM with importance given to quality, client satisfaction, employer-employee relationships as well as supplier-purchaser relationships with minor areas that need improvement. The results concluded from the AHP technique made it possible to provide recommendations to the organization as well as determine that Deming's 14 Points of Management with the use of this technique will greatly benefit other organizations to completely prioritize the TQM.

Keywords

Total Quality Management (TQM), Analytical Hierarchical Process (AHP) and Deming's 14 Points of Management.

1. Introduction

First introduced in the U. S. Markets after the Second World War, Total Quality Management (TQM) represents a playbook of philosophies, principles and practices that guides one towards the management of quality as well as the quality of management (Brah et al. 2002). TQM claims outstanding results in this field compared to other methods with its common themes and definitions being constant need for improvement, customer prioritization, employee empowerment and higher-level managerial involvement (Yazdani et al. 2014). With the help of Dr Deming's

philosophy paired with TQM, organizations can work towards achieving a total quality environment to work in (Peterson 1999).

However, the successful implementation of TQM is usually hindered by lack of strategic planning, organizational cohesion, insufficient incentives, cultural and communication barriers, improper distribution of workload and the lack of urgency in accomplishing a common objective (Rouse 2020). This culminated with the lack of understanding for pre-existing systems and Standard Operating Procedures (SOP) contributes to the unsuccessful implementation of TQM (Mosadeghrad 2006). TQM is known to succeed only if it is implemented as a major and long-term paradigm shift rather than a fast solution which takes into account the organization's size, the nature of services and characteristics of the industry they belong to.

1.1 Objectives

The objectives of this research are to investigate the application of Analytic Hierarchy Process (AHP) technique in prioritizing TQM process as outlined in Dr Edward Deming's 14 Points of Management, to acquire primary and/or secondary data from an EPC organization for the TQM elements as well as to prioritize the obtained data using the AHP technique and propose recommendations.

2. Literature Review

Quality is a fundamental instrument which allows for the basic properties of any product or service offered to be compared with similar products or services of its kind. It primarily refers to the arrangement of innate properties of an item that permits fulfilling expressed or inferred needs. Furthermore, the perception of a customer influences the quality of a product or service offered, whereby the customer acknowledges the ability of the specific product or service to have met his or her needs (Wicks and Roethlein 2009). Quality is accomplished by following a strict and consistent regime to achieve certain standards that can help in ensuring the uniformity of a product or service (Watt 2016). In summation, quality is the outcome, the attributes of a product and the stamp of authentication that an organization has satisfied all the requirements of its shareholders, management and stakeholders. Besides that, customer needs are a fundamental ideal behind all the definitions of quality.

TQM can be viewed as an approach that is directed at satisfying customers, empowering employees, achieving higher revenues and reducing costs (Juran 1995). It is a blueprint employed by management to implant a high level of consciousness towards quality. It is a way to engage the entire organization from the highest level of management to lowest level employee to strive towards common goals through continuous improvement. TQM utilizes data, strategies and effective means of communication to incorporate quality discipline into the principles and philosophies of an organization.

When combining Management and Total Quality, one can expect the attributes of Management being planning, directing, organizing, controlling and assuring to compliment Total Quality which is the quality of returns to fulfil the requirements of its stakeholders and the quality of a product or service offered to its customers or clients. To be successfully implemented, TQM requires continuous long-term efforts instead of being implemented as a one-off process. This can only be achieved through constant managerial involvement and evolvement via up to date training and technical understanding, work skills ratings, diversity of responsibilities, proper recognition of achievements, constant communication between all levels of the organization culminated with the use of the latest technology and equipment as a team (Nasim 2018).

That being said, the Deming Management Method involves the theoretical essence of a system of organization that nurtures cooperation and learning. Dr W. Edwards Deming's methods promote the implementation of practicing process management in an organization. This enables continuous improvement to happen with processes, services, products and employee fulfilment, all this being critical factors of customer satisfaction and an organization's survival. According to Deming, quality management is based on the foundation that variation should be reduced in products as well as services to boost the median.

Deming was able to improve his philosophy on management by observing the way the Japanese incorporated their teachings on quality control in line with the pre-existing Japanese Culture to construct an economic legacy that was prodigious (Best and Nuehauser 2005). In 1986, 14 principles of TQM were introduced by Deming which is now known as the 14 Points of Management. According to Rungtusanatham et al. (2003), these 14 points ought to be a

remedy for what they call the "seven deadly diseases" of management and will aid organizations overcome obstacles that hinder the production and delivery of high-quality products or services.

Deming's theory includes commitment by top management, the minimization of mass inspections by using techniques of statistical control, improvement of the work environment which can be achieved through training and education, elimination of fear as well as non-reliance of numerical quotas amongst others (Agrawal and Nishant 2019). There are some noticeable differences between Deming's Management Methods and TQM. The comparison between Deming's practices and principles with TQM can be seen in Table 1 below:

Table 1. Comparison of the Deming approach vs TQM

THE DEMING APPROACH	TOTAL QUALITY MANAGEMENT
Represents a single philosophy used entirely or not at all.	Represents a general philosophy and can be tailored to situations with various methods of implementation.
Successful implementation requires long-term commitment and is the management's responsibility. However, if management's commitment starts to wane, the organization should not hesitate to drop a client.	Successful implementation requires long-term commitment and is the management's responsibility. Many would not be eager to let go of an ongoing effort.
Requires constancy of purpose.	Can adapt itself to situations and realities of the environment implemented in.
Emphasizes nothing less than overall transformation.	Emphasizes reductions in cycle times and improvements of processes.

With the help of Dr Deming's philosophy paired with Total Quality Management, organizations can work towards achieving a total quality environment to work in. This will entail detailed research and understanding of an organisation, full understanding, and commitment to change, and full implementation and total practice of the changes recommended by all levels of the organisation and their supporting entities such as suppliers etc. All though this may seem like a lot of work at the onset, the result will definitely bring about a more efficient and effective way of managing an organisation which will lead to greater success.

To aid this research, the AHP Technique was adapted. Saaty (1986) stated that AHP was a set of axioms that delimits the scope of the problem environment carefully. It is based on a well-defined mathematical structure with consistent matrices and its associated eigen vectors ability to generate correct or true and approximate weights (Saaty 1994).

This method utilizes the comparison of criteria or alternatives in respect to criterion within a natural and pairwise mode. To accomplish this, AHP uses a central scale of absolute numbers that have been used prior in practice and is justified through physical and theoretical studies as well as experiments. The central scales are known to capture individual preferences with respect to qualitative and quantitative attributes better than any other scale (Saaty 1980, 1994).

The scale converts the preferences of individuals into ratio scale weights that can be integrated into a linear additive weight for each input. The resulting linear additive weight can be used to provide comparison and to rank the alternatives available and thus assisting the decision-making process. The AHP is considered to be a descriptive and prescriptive method of decision making as it naturally resolves a multicriteria decision problem.

3. Methodology

Figure 1 below depicts the process flow that was exercised to gather and analyze data for the purpose of this research. The main objectives of the research, which was to prioritize TQM practices with the culmination of Deming's 14 Points of Management, was clearly defined based on the EPC Organization selected. Once the

objectives were defined it was further dissected into the relevant Main Criteria and Sub-criteria which is then structured into a hierarchy for analysis at successive levels using the AHP Technique.

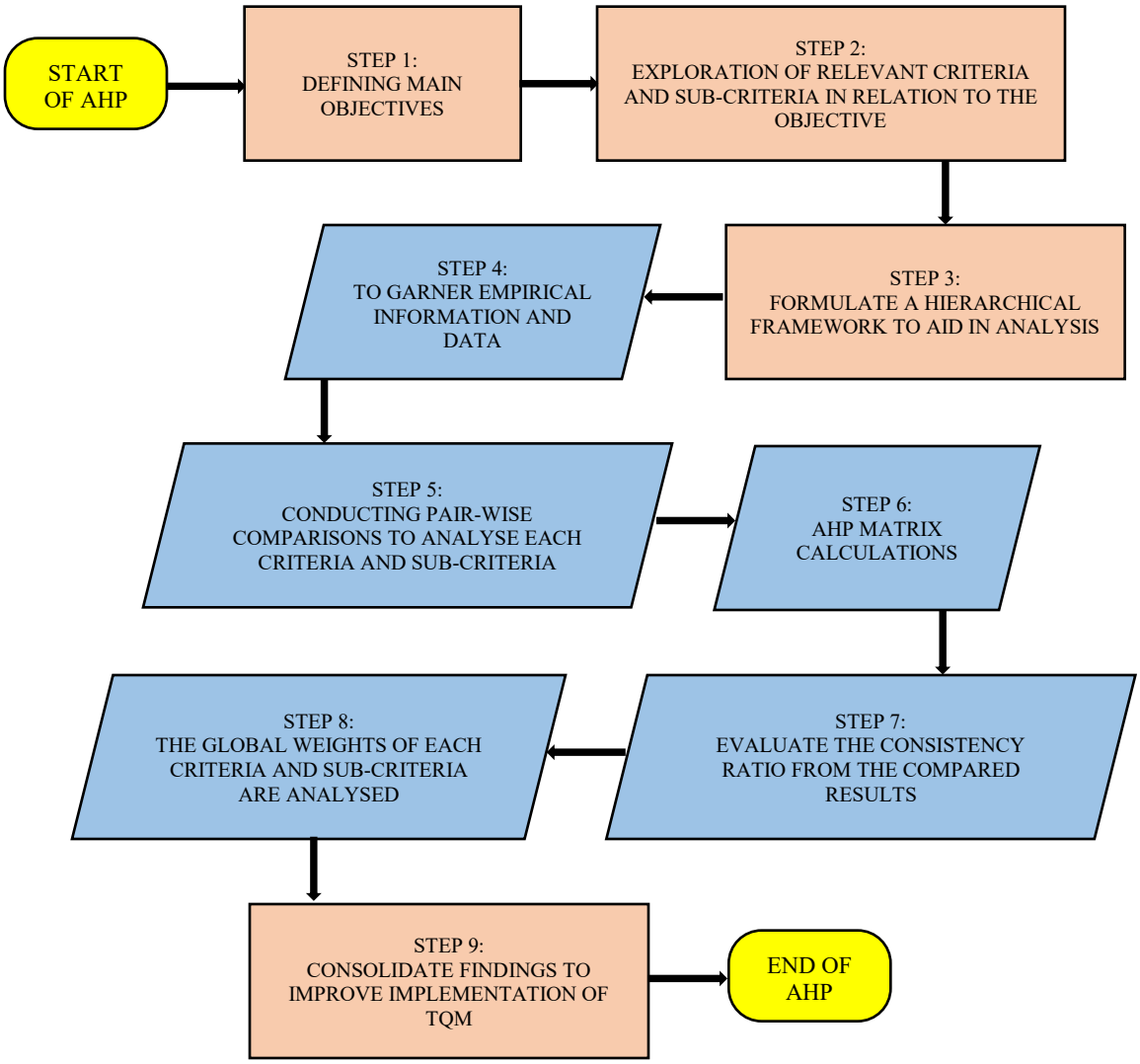

Figure 1. AHP Investigation flow chart

The data required was collected through various means and then analyzed using pair-wise comparisons and grouped according to the level of relative importance. The outcomes of this is depicted in the form of a matrix based off the weight of strength of importance. The weightage of relative importance is based on scales which have been predefined in accordance with Saaty (1994) "Nine Point Scale of Intensity" referenced in Table 2.

Table 2. Nine-point scale of intensity

Scale	Judgements of preferences
1	Equal importance
3	Moderate importance of one over the other
5	Essential or strong importance
7	Very strong or demonstrated importance
9	Extreme or absolute importance
2, 4, 6, 8	Intermediate values between the two adjacent judgements

The completed matrix shall be referred to as the Criteria Matrix, [C]. The elements in each column will have to be summed up and be filled in under each corresponding column. Matrix [C] will then have to be normalized and will be referred to as Matrix Norm [C]. This process is repeated until the sums under each column add up to be one and this validates that the normalization step was carried out properly and repeated if there are errors.

Moving forth, the Criteria Weights, {W} is to be calculated by averaging the rows of Matrix Norm [C]. Each row will have its individual value and the highest value represents the most important criteria of the matrix. The objective of tabulating the matrix is to evaluate the Consistency Ratio from the compared results which is compared against a predetermined margin of consistency which can be derived with the use of numerical measures such as the Consistency Index (CI) and the Consistency Ratio (CR) formulas (Saaty 1994).

The Weight Sums Vector, {Ws} will have to be determined by multiplying the unnormalized Criteria Matrix, [C] with the Criteria Weights, {W}. Using the {Ws} calculated, the Consistency Vector, {CV} will then be calculated by performing the dot product function on {Ws} and {1/W}. The highest value in this new {CV} vector is the λmax also known as the highest eigenvalue of the matrix. Now the CI and CR can be utilized where CI checks for consistency of the pair-wise comparisons and CR checks for consistency of the matrix rankings. The formulas can be observed in Equation (1) and (2) below.

$$CI = \frac{\lambda max - n}{n-1} \quad (1)$$

$$CR = \frac{CI}{RCI} \quad (2)$$

The values needed for these formulae are n which is the number of matrix rankings or the number of Sub-criteria, λmax the highest eigenvalue as well as the Random Consistency Index (RCI). Table 3 is the RCI for several different sized matrixes based on Saaty (1994).

Table 3. Random consistency index (RCI) values

Size of matrix	1	2	3	4	5	6	7	8	9	10
Random consistency index (RCI)	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.51

The next step requires the computation of the Local Weights and Global Weights of the matrix for each Main Criteria and Sub-criteria. The Local Weights are the Criteria Weights, {W} for each Sub-criteria and Global Weights are the weights for each main criterion as it moves up the hierarchy. Global Weights are calculated by summing up the total of the Local Weights for the Main Criteria multiplied with the Local Weights for the Sub-criteria with respect to the corresponding criteria. Once all these steps are completed, the proper recommendations can then be given to the organization to improve required areas.

This research utilized BPMSG's Microsoft Excel AHP Formulation to ease the calculations and analysis of each Main Criteria and Sub-criteria. Up to 20 Experts' Evaluations can be inserted into the formulations and the results were retrieved with ease (Goepel 2013).

4. Data Collection

A structured questionnaire was constructed and was utilized when conducting interviews with the involved personnel and it was to be filled up to the evaluators' relative preference. Individual interviews were conducted with involved personnel who are responsible for the assurance of quality and its related issues within the organization and the results are were kept strictly confidential. The personnel or experts should possess substantial experience and knowledge as well as the understanding of the management of quality improvement initiatives and hold various positions ranging from higher level management to lower level employees.

5. Results and Discussion

Table 4 provides a summary of the results obtained through the AHP analysis of this research. The Main Criteria as well as the highest weighing Sub-criteria for Company P (the selected EPC Organization) has been tabulated respectively.

Table 4. AHP Formulation results of each Deming's point

	MAIN CRITERIA	W	CR (%)	HIGHEST SUB-CRITERIA BASED ON MAIN CRITERIA	W	CR (%)
P1	Long Term Sustainable Goals	0.697	4.70	Research and Development	0.594	5.70
	Short Term Sustainable Goals	0.141		Research and Development	0.398	5.10
	Costing	0.103		Research and Development	0.497	9.50
	Profits	0.059		Research and Development	0.503	9.70
P2	Improving Quality	0.635	9.80	Short Term Projects	0.436	9.70
	Increasing Profit Margins	0.227		Long Term Projects	0.438	9.90
	In-House Fabrication of Materials	0.081		Long Term Projects	0.451	9.30
	Prefabricated Materials	0.057		Long Term Projects	0.441	14.10

Table 4. AHP Formulation results of each Deming's point (Continued)

P3	Descriptive Analysis	0.479	5.20	Quality	0.549	3.00
	Diagnostic Analysis	0.376		Quality	0.619	4.10
	Predictive Analysis	0.086		Quality	0.652	4.30
	Prescriptive Analysis	0.059		Quality	0.704	11.30
P4	International Supplier	0.480	9.40	Quality of Goods	0.640	8.90
	Local Supplier	0.345		Quality of Goods	0.633	9.40
	In-House Supplier	0.121		Quality of Goods	0.679	8.90
	One-off Supplier	0.054		Quality of Goods	0.645	13.50
P5	Client Satisfaction	0.667	8.90	Performance Records	0.613	9.80
	Market Changes	0.194		Performance Records	0.578	9.40
	Material Availability	0.091		Performance Records	0.586	6.90
	Climate Change	0.048		Performance Records	0.607	7.10
P6	Skills Upgrade	0.594	9.80	Cost	0.611	9.90
	Education	0.270		Cost	0.589	12.60
	Tenure	0.080		Cost	0.533	17.00
	Designation of Employee	0.057		Cost	0.490	7.30
P7	Promotions Within the Organization	0.667	14.60	Employee Morale	0.568	12.10
	Hiring of New Talent	0.185		Employee Morale	0.618	17.60
	Restructuring of Departments	0.094		Employee Morale	0.624	7.90
	Reanalysing Work Distribution	0.055		Employee Morale	0.484	8.50
P8	Employee Feedback	0.631	8.60	Employee Morale	0.618	9.90
	Management Decision	0.228		Employee Morale	0.512	8.80
	In-House Surveys	0.079		Employee Morale	0.586	24.50
	Employer-Employee Town Hall	0.063		Employee Morale	0.511	5.50
P9	Inter-Departmental Communication	0.576	3.90	Multi-Level Decision Making	0.457	7.50
	Management Communication	0.262		Multi-Level Decision Making	0.571	7.00
	Employer-Employee Town Hall	0.099		Multi-Level Decision Making	0.512	7.00
	Employer-Employee Task Force	0.063		Multi-Level Decision Making	0.477	9.50
P11	Statistical Data	0.529	6.30	Key Performance Index	0.550	6.50
	Realistic Targets	0.267		Key Performance Index	0.516	1.60
	Timelines	0.147		Key Performance Index	0.611	8.30
	Feasibility	0.057		Key Performance Index	0.578	5.60
P12	Experience	0.673	4.20	Performance	0.593	8.90

& P13	Education	0.135		Performance	0.613	9.10
	Tenure	0.122		Performance	0.611	8.70
	Skillsets	0.070		Performance	0.582	7.90
P14	Performance	0.602	4.70	Growth	0.517	7.90
	Statistical Data	0.236		Growth	0.613	9.10
	Employer-Employee Town Hall	0.092		Growth	0.583	8.00
	Profits	0.070		Growth	0.548	9.90

On an average, Company P, was found to prioritize quality and this is proven through analysis, where the Sub-criteria, Quality, for P3, weighed highest at 0.549, 0.619, 0.652 and 0.704 whilst P4 returned the highest weights for Sub-criteria, Quality of Goods, at 0.640, 0.633, 0.679 and 0.645. The organization also values long term relations with their suppliers which consists of both international and local based service providers. Company P has always put quality first and does not hesitate to purchase from those who meet their requirements.

Besides that, the organization also prioritized client satisfaction, and this is seen with P5's Main Criteria, Client Satisfaction, weighing the highest at 0.667 compared to the others. Company P satisfies clients by relying on Performance Records as shown also with P5 where the weights were 0.613, 0.578, 0.586 and 0.607 respectively.

All these culminated led to establishing Company P as progressive and adaptable to change. This said, Company P, still relied on statistical data as seen with P11 with a weight of 0.529, to establish a base line for their quality output. This is generally due to the fact that Company P specializes in the Oil and Gas Sector which mostly has a fixed operational design with customization where required. Company P has also been deemed to be forward thinking whereby they have invested in research and development as seen in P1 with Long Term Sustainable Goals weighing 0.697 and the Sub-criteria, Research and Development, weighing highest for all four Main Criteria at 0.594, 0.398, 0.497 and 0.503, but are not stringent when it comes to the usage of new technologies where required.
The management style of Company P is that of open interaction. The results of the analysis for P8 and P9 showed that the management was very people oriented and valued its employees' feedback which weighed 0.631 in P8. Enhancements or process changes were established after discussions with all management levels involved as seen with the P9 Sub-criteria, Multi-Level Decision Making, where it weighed highest for all Main Criteria at 0.457, 0.571, 0.512 and 0.477. The organization also believes in promotions from within the organization and the analysis results of P7 supported this theory with weights of 0.667 for Main Criteria, Promotions Within The Organization, and Sub-criteria, Employee Morale, at 0.568, 0.618, 0.624 and 0.484.

Although the management would definitely consider providing its employees with the theoretical and practical knowledge needed for work enhancement, costs are a major consideration as seen with P6 with weights of 0.611, 0.589, 0.533 and 0.490. This however does not deter the management from training and educating their employees, but it is carried out on a slightly more prioritized level for now.

This study was to ensure that Company P was practicing TQM processes based on Deming's 14 Points of Management. Whilst it was possible to assess, 13 out of the 14 Points, Point 10 Eliminate Slogans, Exhortations and Targets for the Work Force was not taken into consideration as Company P is an organization that advocates safety first and has been recognized for their efforts of practicing good safety measures in the past and present. As such, the slogans utilized to advocate safety are part of the organization's identity and cannot be done away with. This said the slogans are meant as a reminder and motivator to practice good safety measure and not a means of exhortations or targets.

6. Conclusion

The objectives of this study were to investigate the application of the AHP Technique in prioritizing TQM processes as outlined in Dr Edward Deming's 14 Points of Management, by acquiring primary and/or secondary data from an EPC Organization and propose necessary recommendations. Data was collected and inputted into the BMPSG's Microsoft Excel Formulation and analyzed whilst considering the Main Criteria and Sub-Criteria Weights as well as the Consistency Ratio. The end results of the analysis have been discussed in detail and the overall objectives of the study were met and fulfilled. In addition, although Deming's 14 Points of Management is not readily exercised at present, it is a good basis for any new and growing organization to establish an understanding of work strategies that are successful and those that need improvement. The usage of the AHP Technique can be repeated at set intervals to

ensure that there is a progress of said objectives. The participating EPC Organization is currently employing TQM successfully with minor areas that require re-evaluation in the near future. This re-evaluation is required to ensure that the company remains competitive in their chosen industry.

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Acknowledgement

The author would like to express utmost gratitude towards the financial support from UCSI University. The author would also like to extend gratitude to Company P for their support in completing this research paper.

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