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## Quality Control and Quality Assurance in Building Construction Maintenance

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### Abstract

The purpose of this thesis is to evaluate the use of Quality Function Deployment (QFD) as a management tool to benefit project managers. The United States building construction of Engineers is one of the largest construction management organizations in the world, annually performing over 3.5 billion dollars worth of work. The project manager has primary responsibility within the construction, to ensure the design both fulfils user's requirements and is prepared correctly, and that quality control/assurance procedures are correctly administered. QFD was developed and to improve quality and lower costs in industrial and business related fields, by assuring all of building construction operational decisions are driven by owner needs. It uses a set of matrices to relate owner wants and needs with project specifications and requirements. QFD assists project managers to clearly identify and prioritize owner and labour requirements in development of the conceptual and final design. It is best suited to projects involving repetition of units or when higher-than-average quality is demanded. Managers are able to make better informed decisions made during the delivery process, resulting in a better owner satisfaction. To testing of required building construction materials and to determine the quality and quantity of our required area of the building construction The CQAP details the systems and controls that GE has put in place so that the quality of the project will meet the requirements specified in the report. GE provides definition and overall management of the quality approach to be followed by its contractors and consultants. The quality of the RA implementation will be ensured through an integrated system of quality assurance performed by the Construction Manager and quality control provided by the contractors. GE's Construction Manager is responsible for the day-to-day Coordination of quality assurance and quality control measures in the field. The growth in the significance of building maintenance (BM) as a proportion of the output of the construction industry has led to a growing awareness of the need to manage and maintain buildings effectively. In Saudi Arabia, practically the projects in Riyadh city based on the annual report from high commission for development of Riyadh City (HCDR) in 2014, the total governmental construction projects was (2824) with total cost around SR 181 billion that not include the operation and maintenance projects that cost SR 10 billion in 2014. However, this segment of the industry struggles for improving the building maintenance industry in proper way. During the last decades, different quality management concepts, including total quality management (TQM), six sigma, lean management, Lean Six Sigma and International Organisation for Standardization (ISO) series of standards have been applied by many different organisations to improve business performance. Introducing the Quality Management concepts (QMCs) into the Saudi maintenance industry might be a step in the right direction to improve the current situation and resolve its problems. The main purpose of the present study is to evaluate the degree of readiness of Saudi building maintenance industry towards the implementation of QMC and the most effective quality management concept to be used in the industry. Therefore, this study identifies and assesses the available QMCs for BM industry. Several interviews and four focus group sessions were conducted. The perception of managerial about QMC is investigated and analysed. Results show a high degree of misunderstanding of QMC approach, tools and methodology in public sector. The study indicates several barriers impeding the implementation of QMC in the Saudi building maintenance industry.

**Keywords:** Building industry, quality management concepts, building industry, public Sector.

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### 1. Introduction

The Construction industry of India is an important indicator of the development as it creates investment opportunities across various related sectors. The construction industry has contributed an estimated ₹ 6708 billion to the national GDP in 2011-12 (a share of

around 8%). The industry is fragmented, with a handful of major companies involved in the construction activities across all segments; medium sized companies specializing in niche activities; and small and medium contractors who work on the subcontractor basis and carry out the work in the field. In 2011, there were slightly over 500 construction equipment manufacturing companies in all of India. The sector is labor-intensive and, including indirect jobs, provides employment to more than 35 million people. This paper draws on five

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Quality Management Concepts (QMCs) (Total Quality Management, Six Sigma, Lean Management, Lean Six Sigma, and ISO 9001) to underpin the research principles, methodology, and implementation. Fundamentally, the concepts of quality management share three principles: customer focus, continuous improvement, and the centrality of people. From the empirical findings showing what are considered the most effective QMCs in the Saudi BM industry. Different quality management concepts have been increasingly introduced into construction organizations in many countries as an improvement strategy for achieving customer satisfaction and business excellence [1]-[4]. Total Quality Management (TQM) has been embraced in construction industry organizations in Europe, United States, Canada, Australia, Japan and Hong Kong to help raising levels of quality, productivity and customer satisfaction [5]-[8]. TQM is top-down management philosophy focused on monitoring process, employee involvement, and continuous quality improvement in order to meet customer needs. It can also be appreciated that TQM involves all people in all functions, and at all levels [9]. In addition, Six Sigma allows organisations able to understand fluctuations in a process, which then enables them to pinpoint the cause of a problem [10]. The purpose of Six Sigma is to reduce cost by minimising the variability in processes, thus leading ultimately to fewer defects. Six Sigma is also hailed as a method to reduce waste, increase customer satisfaction, and improve financial results [11]. Furthermore, Lean management strives to make organisations more competitive in the market by increasing efficiency and decreasing costs by eliminating the non-value-adding (VA) steps and inefficiencies in the processes [12], [13] as well as by reducing cycle times [14], [15], and increasing profit for the organisation (Claycomb *et al.*, 1999).

### 1.1 Construction Industry and QA&QC

Construction Industry plays a major role in the economic growth of a nation and occupies a pivotal position in the nation's development plans. India's construction industry employs a work force of nearly 32 million and its market size is worth about Rs. 2, 48,000 crores. It is the second largest contributor to the GDP after the agricultural sector. Construction sector is viewed as a service industry. It generates substantial employment and provides growth impetus to other manufacturing sectors like cement, bitumen, iron and steel, chemicals, bricks, paints, tiles etc. whose combined value is Rs.1, 92,000 crores annually. The construction equipment market is valued at Rs.1,05,000 crores. The Project owner, construction companies, consultants, bankers and financial institutions, vendors & suppliers and even the service providers, each has his own fears of following QCAO in the conduct of business. The magnitude of the quality is indeterminate at times. What needs to be determined is:

1. The proportion of real versus perceived quality and approval. This document is being submitted and to satisfy that requirement of quality.
2. The real import and the importance of quality control and assurance in small building construction.

### 1.2. Quality Control

Monitoring specific project result to determine if they comply with relevant quality standards and identifying ways to eliminate cause of unsatisfactory performance. Contract documents comprise a clear, complete, and accurate description of the facility to be constructed, correctly conveying the intent of the owner regarding the characteristics of the facility needed to serve his or her purposes. The contract documents define a constructed facility considered acceptable under the applicable regulatory codes and standards of professional practice, in terms of its reliability, the ease with which maintenance and repairs can be performed, the durability of its materials and operating systems, and the life safety provided to its users. The facility is constructed in accordance with those documents. The various approaches are also very different in the way they are practiced. For example, ISO formalises a guide to be followed, and incorporates an interdependence between the support tools and the core values of the organisation through the quality criteria. The approaches such as TQM, Lean, and ISO outline a desired end state and demand for self-thinking by the organisation. All the approaches can be useful if handled carefully.

### 2. Building Maintenance

Building management is considered as a matter of the larger unit the Facilities Management (FM) [15]. Building maintenance is a collection of a lot of activities. Maintenance projects serve as a challenge in terms of size, quantity of manpower required and requirement. The stringent budget provided for the purpose also serves as a challenge for the maintenance action. In order to carry out the maintenance job we may require some approvals for the work arrangement, which may vary according to size, characteristics of the project, management style, work environment and the cooperation of all parties involved. Due to the dependence of these factors some of the work orders may not be completed. In an ideal maintenance operation, the important parties involved in the execution of the work are the owner or the client, the contractor and the user. The relationship between the key partners and their attitudes towards each other is the main factor which promotes the speed at which the work is completed and also estimated the efficiency of the execution and the maintenance operations [11]. In the country of Saudi Arabia the management procedures currently used by the maintenance contractors do not support the present building scenario as they do not have a scientific background. In general there is an absence of understanding of the need for maintenance work.

Saudi Arabia is having a diverse set of infrastructural facilities. Elements of this infrastructure need be continually maintained to ensure its optimal value over its lifecycle. The building and construction industry is the fastest growing sector in most of the developing countries amounting to about 10% - 20% of GNP. In the country of Saudi Arabia, the building and construction industry is the second largest sector that participates with 6.9 % of GNP (MEP 2008). Maintenance and operation services for public building is not a core service or business activity in Saudi Arabia. As rustle, maintenance services are usually outsourced to specialty contractors (Assaf, 2011). As a developing country with growing facilities and infrastructure, Saudi Arabia has a clear need for efficient and effective maintenance programmes to guarantee the serviceability and safety of its buildings. However, as noted by Assaf *et al.* (2010), maintenance is frequently viewed negatively in most of the Kingdom's governmental offices, and to date, the government has issued no standardised guidelines in respect of quality in maintenance. Among local contractors, there is a distinct lack of competitiveness, their performance is poor, they show low levels of efficiency, low productivity, high exaction costs, an inability to change, and conflict among the parties involved is evident [13]. Most of the maintenance work in Saudi Arabian governmental offices is undertaken by independent maintenance contractors [7], working as already indicated, in the absence of official quality standards.

### 3.Methods and Materials

#### 3.1. Materials

The materials used for this study includes stone, brick, cement, fine aggregate, coarse aggregate, steel, concrete.

#### Stone

The stone is always obtained from rock. The rock quarried from quarries is called stone. Quarried stone may be in the form of stone blocks, stone aggregate, stone slabs, and stone lintels. Here to be used as impact test, water absorption test, hardness test and crushing strength. It is preferred according to SP27-1987.

#### Brick

Brick is made up of soil and it is used to made the masonry structure Absorption test, Shape and size test, edges. Bricks be table-moulded, well burnt in kilns, copper- coloured, free from cracks and with sharp and square Crushing strength test, Soundness test, Hardness test.

#### Cement

The most common cement used is Ordinary Portland Cement. The type I is preferred according to IS: 269-1976, which is used for general concrete

structures. 53 Grade ordinary Portland cement is confirming to 12269.

### 3.2. Methods

Based on the literature review dealing with the question of QMCs implementation in the building maintenance industry, Four focus group sessions, involving twenty six participants, were then conducted to select the most effective and suitable QMCs for implementation in the BM industry. The main purpose of the focus group sessions was to report on the views and experiences of participants regarding QMS implementation as means of quality improvement in building maintenance projects. The focus group discussion method is a valuable approach in qualitative enquiry as it provides an environment for a homogeneous group of professionals and experts to interact and freely exchange ideas and opinions, and at the end of the discussion, to establish a consensus view on a particular topic. In terms of the ideal number of participants for a focus group session, suggest between six and eight participants as the ideal. As noted by [14] the number of items for discussion should not exceed six or seven. Four separate focus group sessions were held in Riyadh, Saudi Arabia's capital city each group was comprised of different participants. Seven participants attended the first focus group session, eight attended the second, five attended the third, and six attended the fourth. It is good practice not to allow focus group sessions to extend beyond two hours since boredom can arise among members, and this advice was followed in the study. The sessions took place in a fully integrated meeting room at the five star Hotel. The reason for holding the events in a hotel was to encourage and motivate participants to attend; the setting was intended to be comfortable and respectful of people in high positions with considerable experience. Two consultants were invited by the researcher to participate in all focus group sessions, with the purpose of encouraging the proposed members to attend. The researcher's aim was to ensure that all sessions had adequate numbers of participants, and that all of them would be motivated to contribute. The first consultant was a Master Black Belt Six Sigma with 24 years' experience of working in the private sector, and an excellent grasp of QMCs through his background in this respect. The second consultant was ISO certified, with 32 years of experience applying the principle of ISO 9001 in both the public and private sector. Both consultants were able to provide the participants with information about each QMC from a practical perspective, in contrast with the researcher's largely academic and theoretical presentation. The ultimate aim was to configure the groups with individuals capable of providing the highest quality discussion regarding the topic being researched. In the main, the consultants were silent, recording their impressions of the meeting, and only assisting where required in the discussion phase. It was important to minimise any bias which their presence may have

introduced and therefore they were asked to avoid any attempt to influence the participants' views in relation to QMCs.

The process of and selecting the most effective QMCs for the BM industry. In step 1, the participants were asked to introduce themselves and their jobs or responsibilities. The researcher then made a presentation on the QMCs (TQM, ISO 9001, Lean, Six Sigma, and Lean Six Sigma), explaining each one separately, and then encouraged the participants to interact and discuss the questions. In step 2, the key question asked for their overall opinions regarding on which QMCs were believed to be suitable for implementation in the BM sector. In Step 3, the researcher briefly summarised the main points of the discussion.

#### 4. Results and Discussion

The first FGS was comprised of seven participants, including among them, five heads of maintenance departments in the public sector, each with more than 20 years' experience. The additional two participants were QM consultants as discussed previously. The group was created as a homogenous one so that members had the same levels of seniority and experience, would be able to understand each other, and would be able to approach the discussion from the viewpoint of heads of department with heavy responsibilities. The first QMC introduced in the presentation was Total Quality Management (TQM). In their consideration of TQM, members believed this could be applicable if a system of in-house maintenance were adopted because in that situation it would be possible to lead and manage all the maintenance team since that team in its entirety would be reporting to the director of the maintenance department. However, the Saudi government's policy is to outsource its maintenance requirements, and hence, the majority of participants indicated that in the current BM environment, TQM would not be applicable. Being a comprehensive concept, it requires the ability to control the contractor, which is not possible when outsourcing. Moreover, it was commented that the implementation of TQM was difficult because it is "very tedious, and it wasn't worth the time". The second QMC introduced was Six Sigma. In this respect, the consultants followed the researcher's overview by presenting more information regarding its implementation from a practical perspective. It was evident that none of the participants had ever heard about Six Sigma, so it was necessary to provide substantial detail to ensure they understood the concept and were able to give informed feedback. Indications were that Six Sigma could be applied in technical areas (mechanical, electrical) but not in general management. In respect of its potential for technical improvement, it was considered that the approach could help to monitor the lifetime of machines, which would be helpful because currently, proper maintenance is not performed as there is no IT tool to measure and analyse the performance of machines.

Hence, Six Sigma was believed to be applicable to guarantee the quality of equipment, but not for improving the quality of management. Indeed, the members did say that as this was the first time they had heard about the concept, it was hard for them to properly make a judgement, and definitely too early for them to consider applying it. The third QMC, Lean Management, the majority of members agreed that this was a new concept for them, but nonetheless observed that in practice that methodology is already applied via a weekly BM department meeting.

The integration between Six Sigma and Lean Management was then discussed. In fact the members expressed the view that the application of Lean Six Sigma would deliver an excellent environment, but that it would be difficult to handle two QM concepts at the same time. Nonetheless, they did agree that to start such implementation on a step-by-step basis would help to improve the performance of the BM process.

The last QMC introduced during this session was the ISO 9001 standard, and in this respect all of the members showed some awareness of this concept because of their long experience in the field of BM. One mentioned this as being the easiest and most suitable QM strategy for implementation in BM department currently. It was believed that the ISO 9001 was easier to understand than other QMCs, and could lead to an improvement in BM departments. One participant argued from experience that it was useful in improving BM processes and in distributing duties clearly. Another, however, said that a contractor who was not qualified and had no experience in ISO 9001 would struggle to apply the concept. But it was also suggested that if ISO 9001 provided standards and templates to follow, this would be the most useful quality strategy to adopt since definite instruction was what was required.

#### A. Second Focus Group Session

A second focus group contained eight members, these six practitioners, and two consultants. Of the practitioners, four were directors of BM departments, and two were assistant managers. Following the same format as the first focus group, the researcher opened the discussion with a presentation on TQM. It was indicated by one member that TQM might be applicable to contractors, because they have tools and human resources but that it would not be effective for the client. And another member expressed the opinion that TQM requires a large supervisory effort to ensure procedures are being followed, and that the BM departments lacked people with supervisory skills. Others argued that TQM would not be suitable just for the maintenance department as the overall philosophy was that the concept should be applied to entire organisations for it to work, and in this respect it was felt that it was difficult to maintain because of the need to education all employees within an organisation, and subsequently control their behavior. Another participant observed that applying TQM is a lengthy process, and yet another added that if

there is no clear structure for a department it is not possible to apply and maintain TQM. TQM requires good communication and good relationships with other departments, but it was noted that this would present a genuine difficulty as the current situation did not involve the maintenance department sharing information even within the department itself, let alone, across the organisation. Overwhelmingly, therefore, it was agreed that TQM was not appropriate.

### B. Third Focus Group Session

The researcher arranged the third focus group session because it was not yet felt that the data had become saturated since there were new and different opinions being expressed in the first two group discussions. The number of members was smaller than the first two groups, however, there being five in total, consisting of two managers, one assistant manager, and two consultants. The participants emerged as a result of the purposive and snowball sampling mentioned in Chapter Four, with all of them being recommended by people who had taken part in either the first or second focus group sessions.

Regarding TQM, it was agreed that it this was difficult to apply because in reality its success depends upon people's interest and behavior. For example, in a maintenance department, one section may work hard while the other sections do not. Consequently, changing the culture inside these maintenance departments would be a challenge and that would have to be overcome prior to any attempt to implement TQM.

### C. Fourth Focus Group Session

Morgan (1996) has suggested that diversity in either the participants or the range of topics covered in focus group sessions increases the number of groups necessary to achieve saturation, and for this reason the researcher conducted the fourth and final group discussion. From one to ten sessions are generally suitable for most studies (Powell and Single, 1996). Hence, given the emergence of the data, four were believed to be sufficient. At the fourth focus group session, there were six participants, including one consultant. In regard to TQM, members raised the difficulty of implementing this in the public sector because of the lack of awareness and commitment from top management. The problems of the need for training among the entire workforce and of raising workforce awareness of the TQM culture were also discussed, as was the issue of such training not being part of the maintenance departments' strategic plans.

Concerning the potential for implementing Six Sigma, the members believed it would be difficult to reduce maintenance costs through this concept because in the current situation, preventive maintenance is either neglected or not performed properly. Furthermore, the last of an IT software application within the departments was felt to be a large obstacle to the introduction of Six Sigma.

## 5. Conclusion

This paper has discussed the outcomes of four focus group sessions, which assisted in determining the most effective QMC for BM in public organisations in Saudi Arabia. The focus group sessions included 19 BM practitioners, and two QM consultants. It was seen how the five QMCs that were discussed within the four focus groups in terms of their principles, tools, methodology, and approaches, all differed in the way in which the improvement process should be handled. It has also been shown that the point of saturation had been reached with the fourth focus group session and that no further discussions were necessary. A comprehensive debate had concluded that the ISO 9001 standard was the most suitable approach to use as an initial move to improve the BM process. The next chapter discusses the development of the quality manual based on ISO 9001.

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