

Applications and Assessment of Quality Management in Construction Projects

Hesham Abdel Khalek

Professor of Construction,
Engineering and Management
Department, Faculty of Engineering,
Alexandria University, Alexandria,
Egypt

Remon F. Aziz

Associate Professor,
Structural Engineering Department,
Faculty of Engineering, Alexandria
University, Alexandria,
Egypt

Esraa A. Sharabash

M. Eng. Candidate, Structural
Engineering Department,
Faculty of Engineering, Alexandria
University, Alexandria,
Egypt

ABSTRACT

Quality Management is one of the important elements of any construction project as cost and time, the role of it for any construction company is not an isolated activity, but intertwined with all the operational and managerial processes of the company as it attracts customer's satisfaction which would bring long term competitiveness and business survival for the companies. This paper focuses on evaluating the practices of quality management in construction projects from the perspective of tools and techniques applied, identifying the level of commitment towards the implementation of quality management in construction projects and finding the solutions to all problems that companies faced in the industry and put a set of proposals and recommendations aimed to improve this industry to the best level and to the development of implementation of the quality management in the construction sector.

It is required critically for any construction company to sustain in current construction market which is highly challenging and competitive and it has to provide the environment within which related tools, techniques and procedures can be deployed effectively leading to operational success for a company.

At the end of the paper, an illustrative example will be presented to demonstrate and verify the applications of the quality management in construction projects in the light of the scientific basics in this industry and improved it through the preparation of a survey of systems and specifications for the construction industry through many people working in the construction industry and find some solutions and proposals that can contribute to avoid the problems of implementation of the quality management in this industry.

Keywords

Quality Management, Construction, Time, Cost, Tools, Teamwork, Survey, Application, Problems, Solution, Control, Human Resource

1. INTRODUCTION

During the past decades, the construction industry has been criticized for its poor performance and productivity in relation to other industries. Many of the Management practices used to support construction organizations are being challenged. The industry's clients are moving forward and Clients demand improved service quality, faster building and innovations in technology. It is no accident that the construction industry has turned to the manufacturing sector as a point of reference and source of innovation.

Successful concepts derived from manufacturing, such as Total Quality Management (TQM), Lean (or Just-in-Time) Production and Reengineering, are being adopted and integrated into the construction industry. Implicitly, the successful implementation of these concepts is heavily dependent on a culture of teamwork and cooperation at both intra- and inter-organizational levels. So the concept of quality management is to ensure efforts to achieve the required level of quality for the product and service which are well planned and organized. From the perspective of a construction company, quality management in construction projects should mean maintaining the quality of construction works at the required standard so as to obtain customer's satisfaction that would bring long term competitiveness and business survival for the companies. Quality management is critically required for a construction company to sustain in current construction market which is highly challenging and competitive and it has to provide the environment within which related tools, techniques and procedures can be deployed effectively leading to operational success for a company. The role of quality management for a construction company is not an isolated activity, but intertwined with all the operational and managerial process of the company.

2. LITERATURE VIEW

The word "Quality" is derived from the Latin word "Qualitas" which means the essence of the thing, person, or the degree of goodness and clarify the meaning of the word quality is rather complicated to some extent as the quality means different things to different people, every person has a different opinion about the meaning of quality as the concept of quality with time variable, Ideas about Quality in the last century are different from today And quality have multiple definitions mention the most important:- Quality is appropriate for use or purpose
- Quality is conformance to requirements and specifications and is pleasing the customer
- Quality is the overall product attributes and characteristics that satisfy the customer's needs and expectations and continuously
- Quality is the freedom from defects
- Quality is the degree of excellence. The meaning of quality is somewhat vague and often associated with the customer's opinion according to the purpose of the product therefore the content of quality in construction can be mainly associated with the following main aspects: 1. Role: Is the construction leads to the required purpose of it? 2. Economic: Is the construction represents value for money? 3. Age: Is the construction solid and capable of endurance with time? 4. Aesthetic: Is the appearance of the construction satisfied and commensurate with the constructions around it? 5. Depreciation and economic power: Is

the construction a good investment?.So the quality management in construction industry related to several factors and expectations surrounding with the construction operation which are workmanship, durability and reliability.[1].In order to achieve quality in construction, the construction project must be contained as a set of activities that start with the requirements of the customers and end with satisfaction and contentment of the customers. It is also worth that quality management in construction is the responsibility of several parties who's themselves is the parties to the construction project (the owner-designer-contractor-supervisor) [2].Modern Quality Management was classified as the following: (1) Quality Inspection, (2)Quality Assurance, (3)Quality Control and (4) Total Quality Management. And it set some responsibilities of the Quality Manager as compliance through managing all company-wide, quality policies, procedures, processes, programs, and practices, to assure the company of continuous conformance with appropriate standards and regulations and he can be also the document control manager, quality auditor, and process improvement specialist. Quality Management System will ensure that two important requirements are met: (1)The customer's requirements: confidence in the ability of the organization to deliver the desired product and service consistently meeting their needs and expectations, (2) The organization's requirements: both internally and externally, and at an optimum cost with efficient use of the available materials, human, technology and information. The International Standard for Quality management (ISO 9001:2008) adopts a number of management principles that can be used by top management to guide their organizations towards improved performance such as: (1) customer focus. (2) Leadership. (3) Involvement of people. (4) Process approach. (5) System approach to management. (6) Continual improvement. (7) Factual approach to decision making. (8) Mutually beneficial supplier relationship. Since an organization and its suppliers are interdependent, therefore a mutually beneficial relationship between them increases the ability of both to add value and these eight principles form the basis for the quality management system standard ISO 9001:2008.The concept of Quality was defined by David Garvin as eight dimensions that can be used at a strategic level to analyze quality characteristics [3] and they can be summarized as follows: (1) Performance: The product's primary operating characteristic. [4]. (2) Features: Secondary aspects of performance. [4]. (3) Reliability: Probability of successfully performing a specified function for a specified period of time under specified conditions. [4]. (4) Conformance: Degree to which a product's design and operating characteristics meet established standards[5]. (5) Durability: A measure of product life [6]. (6) Serviceability: The speed, courtesy, competence, and ease of repair. [7]. (7) Aesthetics: How a product looks, feels, sounds, tastes, or smells. (8) Perceived Quality: Reputation. The quality tools are designed for simplicity,some of them developed by quality engineers, and some adapted from other applications and they provide the means for making quality management decisions based on facts.[8] And these tools are: (1) flow chart, (2) cause and effect diagram,(3) Checklists, (4) Pareto charts, (5) Histograms, (6) scatter grams and (7) control charts.

3. RESEARCH OBJECTIVES

The object of this study is to ascertain perceptions and experiences of practitioners in the industry through the following points: (1) Practices of quality management in construction projects from the perspective of tools and techniques applied. (2) Level of commitment towards the implementation of quality management in construction projects. (3) Problems in relation to the implementation of quality management in construction projects. (4) Find the solutions and put a set of proposals and recommendations aimed to improve this industry to the best level and to the development of implementation the quality management in the construction sector.

4. RESEARCH METHODOLOGY

The methodology of this paper is listed as follows: A thorough literature review was done and also opinions from industry experts were taken, through which a number of quality theories and concepts were discussed and therefore they were used in the survey questionnaire.The questionnaire contained 29 questions needed to be answered to measure how companies implement quality management in their companies through this questionnaire which was divided into six parts namely: their knowledge of TQM, their perception of quality, the data acquisition methods used by them, quality in their organization, the degree of training provided to their employees towards TQM, and the obstacles faced by them in implementing TQM in their businesses. A survey was conducted through personal interviews in which respondents were asked to rank and score quality factors according to their experience. Totally 60 construction companies were surveyed by this questionnaires.Assessment of feedback from questionnaire survey was made. Analysis was carried out of the responses to identify the most important and least important causes of the obstacles faced by the companies in implementation of Quality Management in construction projects in Egypt and find the possible ways to implement quality management in construction projects in Egypt.

5. QUALITY MANAGEMENT IN CONSTRUCTION PROJECTS

Building Construction is the process of preparing for and forming buildings and building systems. Construction starts with planning, design, and financing and continues until the structure is ready for occupancy. Far from being a single activity, large scale construction is a feat of human multitasking. Normally, the job is managed by a project manager, and supervised by a construction manager, design engineer, construction engineer or project architect. For the successful execution of a project, effective planning is essential. Those involved with the design and execution of the infrastructure in question must consider the zoning requirements, the environmental impact of the job, the successful scheduling, budgeting, construction site safety, availability and transportation of building materials, logistics, inconvenience to the public caused by construction delays and bidding, etc.[12]Construction project management is the overall planning, coordination, and control of a project from beginning to completion. CPM is aimed at meeting a client's requirement in order to produce a functionally and financially viable project. The construction industry is composed of five sectors:

residential, commercial, and heavy civil, industrial, and environmental. A construction manager holds the same responsibilities and completes the same processes in each sector. All that separates a construction manager in one sector from one in another is the knowledge of the construction site. This may include different types of equipment, materials, subcontractors, and possibly locations. Project Stages were divided into several ones as the following: (1) the design stage contains a lot of steps: programming and feasibility, schematic design, design development, and contract documents. It is the responsibility of the design team to ensure that the design meets all building codes and regulations. It is during the design stage that the bidding process takes place. [9] (2) the pre-construction stage begins when the owner gives a notice to proceed to the contractor that they have chosen through the bidding process. A notice to proceed is when the owner gives permission to the contractor to begin their work on the project. The first step is to assign the project team which includes the project manager (PM), contract administrator, superintendent, and field engineer. [9]. (3) the procurement stage is when labor, materials and equipment needed to complete the project are purchased. This can be done by the general contractor if the company does all their own construction work. If the contractor does not do their own work, they obtain it through subcontractors. Subcontractors are contractors who specialize in one particular aspect of the construction work such as concrete, welding, glass, or carpentry. Subcontractors are hired the same way a general contractor would be, which is through the bidding process. Purchase orders are also part of the procurement stage. [9]. (4) the construction stage begins with a pre-construction meeting brought together by the superintendent. The pre-construction meeting is meant to make decisions dealing with work hours, material storage, quality control, and site access. The next step is to move everything onto the construction site and set it all up. At this stage, construction monitoring and supervision is of great importance to ensure that a project is completed on time and on budget, while meeting all relevant regulations and quality standards. [9]. (5) Contractor progress payment schedule is a schedule of when (according to project milestones or specified dates) contractors and suppliers will be paid for the current progress of installed work [11]. Once the owner moves into the building, a warranty period begins. This is to ensure that all materials, equipment, and quality meet the expectations of the owner that are included within the contract [9]. Some of Construction Management's functions were classified as: (1) Specifying project objectives and plans including delineation of scope, budgeting, scheduling, setting performance requirements, and selecting project participants. (2) Maximizing the resource efficiency through procurement of labor, materials and equipment. (3) Implementing various operations through proper coordination and control of planning, design, estimating, contracting and construction in the entire process. (4) Developing effective communications and mechanisms for resolving conflicts [10]. Quality in the finished building will generally be appeared as a main factor in Construction projects which required a balance between cost, time and quality. It is possible to have high quality and low cost, but at the expense of time, and conversely to have high quality and a fast project, but at a cost. If both time and money are restricted, then quality is likely to suffer. High quality is not always the primary objective for the client; time or cost may be more important. It is only realistic to specify a very high standard of quality if the budget is available to achieve that standard. The standard of quality that the design

team tries to achieve should reflect the requirements set out by the client in the briefing documentation. The client should then be able to assess design options that are proposed in relation to the criteria they have already defined and the contract documentation describes the design that the contractor is being paid to construct. It will include a specification describing the materials and workmanship required. The contractor's obligation is to carry out and complete the works in a proper and workmanlike manner as shown on the contract documents. This means that the contractor must carry out the works with reasonable skill and care, to the reasonable satisfaction of the contract administrator.

6. QUALITY CONTROL IN CONSTRUCTION PROJECTS

Quality control is a process by which entities review the quality of all factors involved in production. ISO 9000 defines quality control as "A part of quality management focused on fulfilling quality requirements". Controls include product inspection, where every product is examined visually, and often using a stereo microscope for fine detail before the product is sold into the external market. Inspectors will be provided with lists and descriptions of unacceptable product defects such as cracks or surface blemishes for example. Quality control emphasizes testing of products to uncover defects and reporting to management who make the decision to allow or deny product release, whereas quality assurance attempts to improve and stabilize production (and associated processes) to avoid, or at least minimize, issues which led to the defect(s) in the first place. [13] Quality Control of Production factors was divided as the following: The contents of human control includes the overall quality of organization and individual's knowledge, ability, physical condition, psychological state, quality consciousness, behavior, concept of organizational discipline, and professional ethics. Materials (including raw materials, finished products, semi-finished products, components and parts) are material conditions of construction, and material quality is one of necessary conditions to ensure construction quality. Construction machinery and equipment are essential facilities for the modern construction, reflecting the construction power of the enterprise, and having a direct impact on the project progress and quality. Actually, the quality control is to make the type and performance parameters of construction machinery and equipment match the conditions, technology and other factors of the construction site. Construction methods are reflected in the concentration of technical solution, process, testing methods, and arrangements of construction procedures for construction adopted by construction contractors. Creating a good environment will play an important role in guaranteeing the quality and safety of construction projects, achieving civilized construction, and setting social image of Construction Corporation. Control of construction environment includes not only the understanding, restriction, transformation and usage of natural environment, but also activities of creating working environment and environment management. CC has adopted a kind of scientific management procedure and method to do quality control of construction, named PDCA Cycle, which is composed of 4 stages of P (plan), D (do), C (check), A (action). PDCA Cycle is ongoing. The quality goals can be realized and some problems can be solved in each cycle, so that the quality can be improved. The detailed procedures of PDCA are introduced as shown in fig (1).

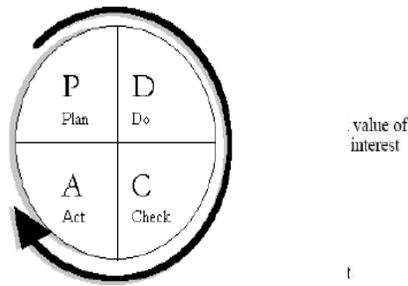


Fig (1): Plan-Do-Check-Act Cycle (PDCA cycle)

7. CONSTRUCTION QUALITY PROBLEMS

Construction quality problems are generally divided into defects, common problems, and quality accidents. Construction quality defects refer to the phenomenon that technical indicators of construction fall short of the allowance of technical standards.

Quality accidents refer to the quality damage with larger loss and influence of the safety of construction structures, functions and form, in the procedure of construction or after delivery for use. [14]. The forms of construction quality problems were different and varied, but the reasons can be mainly summarized in the following aspects: (1) Problems concerning the construction procedures and regulations (2) Problems of design and calculation. (3) Substandard materials and products. (4) Out of control of construction and management. (5) The influence of natural conditions. (6) Improper use of facilities. After construction quality problems occurred, the following procedures can be handled, As the indication from Figure (4.3), the general segments and steps of processing procedures are shown. The detailed contents and measures will be introduced in six aspects.[15]

8. HUMAN RESOURCE IN CONSTRUCTION PROJECTS

Human resource management (HRM or simply HR) is a function in organizations designed to maximize employee performance in service of an employer's strategic objectives. HR is primarily concerned with the management of people within organizations, focusing on policies and systems. HR departments and units in organizations typically undertake a number of activities, including employee recruitment, training and development, performance appraisal, and rewarding (e.g., managing pay and benefit systems). HR is also concerned with industrial relations, that is, the balancing of organizational practices with requirements arising from collective bargaining and from governmental laws. The function was initially dominated by transactional work, such as payroll and benefits administration, but due to globalization, company consolidation, technological advances, and further research, HR as of 2015 focuses on strategic initiatives like mergers and acquisitions, talent management, succession planning, industrial and labor relations, and diversity and inclusion.[16]. Unlike many other industries whose performances are enhanced by new emerging technologies, construction industry is still a labor-intensive and low-tech sector; as a result, human capital is the most important

and very often the most expensive resource deployed within it. According to Hue Mann et al. construction projects have the following characteristics that make HRM policies and practices different from those of the other industries employing routine organization: (1) Managing by projects as the strategy of the company, (2) Temporary nature of projects, (3) Dynamisms, (4) Project portfolio resource and multirole demands and (5) Specific management paradigm. Human resource managers have strategic and functional responsibilities for all of the HR disciplines. A human resource manager has the expertise of an HR generalist combined with general business and management skills. Regardless of the size of department or the company, a human resource manager should have the skills to perform every HR function, if necessary and they provide guidance and direction to compensation and benefits specialists. Within this discipline, human resources managers develop strategic compensation plans, align performance management systems with compensation structure and monitor negotiations for group health care benefits.[17]. Employee training and development includes new hire orientation, leadership training and professional development seminars and workshops. Human resource managers responsible for succession planning use their knowledge of employee development, training and future business needs to devise career tracks for employees who demonstrate the aptitude and desire for upward mobility.[18] Although the employee relations specialist is responsible for investigating and resolving workplace issues, the human resource manager has ultimate responsibility for preserving the employer-employee relationship through designing an effective employee relations strategy. An effective employee relations strategy contains specific steps for ensuring the overall well-being of employees. [19] Human resource managers develop strategic solutions to meet workforce demands and labor force trends. An employment manager actually oversees the recruitment and selection processes; however, an HR manager is primarily responsible for decisions related to corporate branding as it relates to recruiting and retaining talented employees. Human resource managers responsible for this usually look at the recruitment and selection process, as well as compensation and benefits to find ways to appeal to highly qualified applicants. [20]

9. QUESTIONNAIRE SURVEY

9.1. Questionnaire design

The questionnaire design took into consideration the objectives of the study with the aim to answer the research questions. Great effort and brainstorming were done for designing the questionnaire. Meetings with members of the industry were conducted to identify the right questions required and to present them in a clear and unambiguous format. Special care also was done for phrasing the questions in a language that is easily understood by respondents. In anticipation that all respondents were not being fluent English readers or speakers, an Arabic version of the questionnaire was developed.

9.2. Contents of the questionnaire

The questionnaire was divided into two sections. The first section contains general information about the respondents such as: (1) Name of the company; (2) Nature of the company such as (prime contractor/sub-contractor/consultant); (2) Company size; and (3) Age of the company. Addresses the general industry characteristics such as: (1) Years of experience; (2) List of their

projects which ongoing and which completed by the company. The second section addresses about implementation quality management as read from the literature is presented and the respondent is asked to evaluate it in their companies. The design philosophy of the questionnaire was based on the fact that they had to be simple, clear and understandable for respondents, and at the same time they should be able to be interpreted well by the researcher. The questionnaire has a definite advantage of requiring smaller time to be responded and is more accurate in the final outcome. Factors of evaluation the quality management in their companies were identified through the literature based on previous research together with input, revision and modifications by local experts. The participants were required to rate the factors in the way they affect quality management in construction projects using their own experiences on building sites. The questionnaire required the respondents to rank these through different answers for each question according to the degree of importance on implementation quality management for construction projects.

9.3. Data gathering

Questionnaires were mailed to respondents (Consultants, Managers, Engineers, and Contractors) and completed forms were requested to be mailed or faxed back to the researcher, the response for this request was poor. Another approach of collecting data was used; involved follow up telephone calls and subsequent visit to firms and work sites, most of data were collected by this method. Forms were given to respondents to complete, and completed forms were collected later. In many instances, forms were completed at the meeting; this method has the added benefit of making clarifications to respondents about questions in forms. Over a period of 5 months later, the researcher collected 1.160 responses from 1.740 total forms at 60 construction firms; this means the rate of response was 66.6%. The details of various professional cadres of respondents with their classifications were mentioned in (Table 2) for clarifications. This research is based on a survey designed to gather all necessary information in an effective way. The survey presents 29 questions generated on the basis of related research works on implementation quality management for construction projects. These questions were classified into six categories based on previous section and as advised by researcher: and it was divided into six parts namely: (1) their knowledge of TQM; (2) their perception of quality; (3) the data acquisition methods used by them; (4) Quality in their organization; (5) the degree of training provided to their employees towards TQM; (6) the obstacles faced by them in implementing TQM in their businesses.

9.4. Contents of the Model

The studied target population includes multi respondents such as: consultants, managers, engineers and contractors. Here it was tried to apply the questionnaire as shown in Fig (2), (3), (4) and (5) which any company could input her data and answer the questions then the excel sheet will analysis this answers and give them directly the result of the percentage of implementation quality Management in their company therefore some recommendations will be suggested to them which can help in implementation quality management and improve their market share.

Company Information

Name of the company: _____

Nature of company (prime contractor/sub-contractor/consultant/supplier/vendor): _____

Size of the company (no. of persons): _____ (admin) _____ (technical)

Age of the company: _____

Ongoing/completed projects _____

Would you like to be contacted again regarding this questionnaire, if your answer is YES, please write down your name and contact details: _____

Your Knowledge of TQM

- In your view, which of these words best define quality? (not limited to one answer)
 - Expensive
 - Satisfying internal customer (within the organization)
 - Satisfying external customer (outside the organization)
 - Appearance
 - Increased profit
 - Value for money
 - Teamwork
 - Partnership between organization and supplier
- Do you think that TQM will (or does) work in your organization?
 - Very well
 - To some extent
 - Won't work
 - Can't say
- TQM would be used to improve:
 - Project design
 - Cost estimating
 - Warranty claims
 - Reduce change order
 - Reduce claims
 - Increased market share
 - Reduced lawsuits

Are you aware of any industry programs to implement TQM or of the ISO 9000 standards? _____

Your Perception of Quality

- What is your organization's perception of quality?
 - Elimination of defects
 - A tool to increase profits
 - A competitive advantage
 - Others (please specify) _____
- How would you rate the importance of product/service quality:
 - Very important
 - Important
 - Somewhat important
 - Can't say
- How would you rate customer satisfaction:
 - Very important
 - Important
 - Somewhat important
 - Not important
 - Can't say
- Please rate the potential for improvement within the following processes: (Scale 1 to 5, 1:Low 5:High)

	High	Low	No
● On site supervision	5 - 4 - 3 - 2 - 1		0
● Redesign	5 - 4 - 3 - 2 - 1		0
● Testing procedures at job sites	5 - 4 - 3 - 2 - 1		0
● Certification of material	5 - 4 - 3 - 2 - 1		0
● Administration of change orders	5 - 4 - 3 - 2 - 1		0
● Close-out of projects	5 - 4 - 3 - 2 - 1		0
● On-site safety	5 - 4 - 3 - 2 - 1		0
● Personnel management of employees	5 - 4 - 3 - 2 - 1		0
● Coordination with other members of a project	5 - 4 - 3 - 2 - 1		0
- Please rank in order of importance (1,2,3,4,5):
 - Cost : _____
 - Scope : _____
 - Time (Schedule) : _____
 - Quality : _____
 - Safety : _____
- Do you set your quality goals to the level of:
 - The leading company in your field
 - The competition in general
 - To a level set internally
 - Other (please specify) _____

Fig (2) part 1 of the questionnaire: Company information – their knowledge of TQM

Fig (3) part 2 of the questionnaire: their perception of quality

Applications and Assessment of Quality Management in Construction Projects

Data Acquisition Method

How does your organization solve problems?

- Assign individual to solve
- Set up a multi-disciplinary team for each problem
- A permanent team is available

How do you measure customer satisfaction?

- Not measured
- Questionnaire surveys
- By the number of complaints
- Other methods (please specify)

Do you have a system for gathering employee suggestions?

- Yes
- No
- Can't say

Are employees empowered to make significant changes to operations?

- Fully empowered
- Only key personnel are empowered
- Empowerment is not needed
- Can't say

Are suppliers/subcontractors rated?

- All
- Most
- None
- Can't say

Quality in your Organization

Has your organization developed a clear definition of quality?

- Yes
- No
- Can't say

Percentage of employees who are aware of the importance of quality?

_____ %

Does your organization have a quality improvement program?

- No (Please go to next section of question)
- Such a plan is under consideration
- A quality improvement program has been implemented recently
- A quality improvement plan has been a part of corporate policy for some time now

What type of quality improvement program do you have?

- Total Quality Management
- ISO 9000
- Quality Control / Quality Assurance
- Others (please specify)

Which of the following factors provided the motivation to start TQM

- Pressure from competitors
- Demanding customers
- Your company's Chief Executive
- Environmental issues/considerations
- Need to reduce costs and improve performance

Your organization's quality improvement program can be described as:

- There is no formal program
- Periodic short-range solutions or motivational program
- A formal program is underway with widespread employee awareness
- Others (please specify)

Fig (4) Part 3: Data acquisition Method & Quality in their organization

Quality is first incorporated in the project at:

- Concept development
- Research and development
- Operations
- Final inspection

After the implementation of your quality improvement program, service/product quality has:

- Drastically improved
- Improved
- Remained the same
- Decreased
- Can't say
- Not applicable

After the implementation of your quality improvement program, relationship with your customers and suppliers has:

- Drastically improved
- Improved
- Remained the same
- Decreased
- Can't say
- Not applicable

Training

Is formal training in TQM or other quality improvement philosophies given to employees?

- No training is given (please skip the rest of question)
- Some training is available
- A formal training program is in effect
- Other (please specify)

Percentage of managerial/supervisory staff who have undergone quality improvement training* _____ %

Percentage of non-managerial/technical staff who have undergone quality improvement training* _____ %

Training currently emphasizes:

- Process control
- Statistical analysis
- Data gathering & analysis
- Team work
- Communication
- Customer satisfaction

Others

Obstacles in the implementation of TQM program

- Changing behavior and attitude
- Schedule and cost treated as the main priorities
- Emphasis on short-term objects
- Lack of education and training to drive the improvement process
- Too much documents are required (Lack of documentation ability)
- Lack of top-management commitment/understanding
- Lack of employees commitment/understanding
- Tendency to cure symptom rather than get to the root cause of a problem
- Lack of expertise/resources in TQM
- Current tendering/bidding climate

Fig (5) Part 4: Training & others

This model will be answered by the respondents by choosing their answers for each question depending on their experiences in the construction field.

9.5. Scoring

In this model, the answers of each company about the questions modified by an excel sheet which gave them some scores depending on the importance of each answer in implementation the quality management in the project as if it was so important will give it 10 and if it was important will give it 5. So when the company chooses their answers for each question, the model will put some values to each answer and give it her weight equal to one of these equations as the following:

$$weight\ 1 = \frac{\sum(x_i)}{28} \quad x_i = 7, 6, 5, 4, 3, 2, 1$$

Where weight 1 is the weight of questions number (1, 3, 20, 28, and 29)

$$\text{weight 2} = \frac{\sum(x_i)}{9 \times 5} x_i = 5, 4, 3, 2, 1$$

Where weight 2 is the weight of question number (8)

$$\text{weight 3} = \frac{x_i}{2} x_i = 2, 1, 0$$

Where: weight 3 is the weight of questions number (2, 14, 15, 21, 23, 24, and 25)

$$\text{weight 4} = x_i x_i = 1, 0$$

Where: weight 4 is the weight of questions number (4, 9, 12, 13, 16, and 19)

$$\text{weight 5} = \frac{x_i}{3} x_i = 3, 2, 1, 0$$

Where: weight 5 is the weight of questions number (5, 6, 7, 11, and 18)

$$\text{weight 6} = \frac{x_i}{100} x_i = \text{percent (0~100\%)}$$

Where: weight 6 is the weight of questions number (17, 27 and 26)

Therefore the model will analyze the weight of each question and find the result as the following: If the weight = (0.66-1.00) so the result is "Yes", If the weight = (0.33-0.66) so the result is "to some extent" and if the weight = (0-0.33) so the result is "No". Then the model will calculate the percentage of quality management equal to:

$$\% \text{ percent of QM} = \frac{\sum \text{Weight} \times \text{Score}}{\sum \text{Score}} \times 100$$

Where If the result was (0-50%) it's not accepted, If the result was (50%-70%) it's accepted but need to develop their system and if the result was (70%-100%) it's accepted and it doesn't need any development.

9.6. Analysis and discussions

The factors of evaluation the quality management for construction projects in Egypt will be looked at from different perspectives. It will examine the data provided by respondents and that will be the basis for case selection. The Relative Important Index will be calculated as final outlined results. These factors will be ranked and categorized based on their Relative Importance Index report. The following tables are the results gathered from answers of the 40 respondents about the questionnaire which is composed of 29 questions and divided in six sections as follows: Knowledge of TQM; Your perception of Quality; Data acquisition method; Quality in your organization; Training; Other and in the following analysis the numbers of each result represent the number of companies who gave response to the questions, in other cases an average and a percentage is used.

9.6.1 Knowledge of TQM

In this section, four questions were asked to evaluate the knowledge of TQM of the contractors in the Construction Industry and the results from this section show that the majority of the contractors and Engineers agreed that if a contractor satisfies his clients, the profits would increase in the long run. They feel that TQM will work very well in their organizations and not only that they felt that this program is going to be beneficial for their organizations. They are however not aware of any implementation programs. Most of them feel that TQM is a philosophy used to reduce the claims of the customers and it can increase the market share of their organizations. This shows their

lack of knowledge about the TQM and the potential benefits in implementing this program in their organizations.

9.6.2 Perception of Quality

In this section, six questions were asked to evaluate the company's perceptions of quality and the analysis of this section tells us that the majority of the contractors and engineers perceive quality as Elimination of defects next to a competitive advantage. They feel that that product / service quality is very important for them in gaining customers satisfaction because it ultimately translates to higher profits for them. They feel that customer satisfaction is their main goal. Interestingly however, when they were asked to rank in the order of importance the following attributes: Cost, Time, Scope, safety and Quality: they ranked Cost and Time as the important considerations followed by Quality, Scope and Safety.

9.6.3 Data Acquisition Methods

In this section five questions were asked to know how they gather information and the results of this section show that the majority of the companies do collect data to measure the performance of operations and the way they solve problems is by setting up a multi-disciplinary team for each problem to solve them. On the other hand, 67.5% of the companies have a system for gathering customer suggestions and 55% of them measure customer satisfaction by the number of complaints and 37.5% measure it through questionnaire surveys.

9.6.4 Quality in their organization

In this section, contractors were asked 12 questions to find out about quality in their organizations, so it observed from this section that although only about 95% of the contractors and engineers surveyed had a clear definition of quality in their organizations, 48 % are aware of the importance of quality. The majority of the respondents said that they have a plan to implement a Quality Improvement Program (75%) and (25%) of them don't have a quality improvement program. Also, they use a mix of Quality Control, TQM and ISO 9000 principles in their QIP. Demanding customers, Environmental considerations, the need to reduce costs and improvement performance and pressure from competitors were identified as the key reasons for implementing the quality improvement programs. 62.5% of the contractors felt that the quality of their products and services improved after implementing such a program.

9.6.5 Training

In this section, contractors were asked 4 questions to find out about the training they provide to their employees in their organizations and training programs mostly emphasize customer satisfaction as a primary goal followed by teamwork, process control and communication.

9.6.6 Others

The following shows the obstacles in the implementation of Total Quality Management Program most important to least important based on the data gathered: (1) Current tendering climate. (2) Lack of expertise/resources in TQM. (3) Schedule and cost treated as the main priorities. (4) Lack of education and training to drive the improvement process. (5) Tendency to cure symptom rather than getting to the root cause of a problem. (6) Lack of employee commitment/understanding. (7) Emphasis on short-term objects. (8) Changing behavior and attitude.

10. CASE STUDY

10.1 Basic Information

- Name of the company: Beltagi Company for Construction,
 Nature of Company: Prime contractor, Age of the Company: 18
 years, Company projects: 3 ongoing projects and more than 30
 completed project.

10.2 Company questionnaire

As shown in Fig (6) & (7) the company filled out the Arabic version of the questionnaire and then it was modified to an excel sheet which turned its answers and give each answer weight and score depending on its importance in implementation quality management.

Weight * Score	Score	Result	weight	الإجابات	السؤال	رقم	المجموعة
6.43	10	إلى حد ما	0.64	<input checked="" type="checkbox"/> لا يوجد العمل <input checked="" type="checkbox"/> فريق العمل <input checked="" type="checkbox"/> لجاهله <input type="checkbox"/> لا يوجد البرج <input type="checkbox"/> فيه لراس المال <input type="checkbox"/> يظهر خارجه <input type="checkbox"/> الشركة بين الشركه و المورد	اي من هذه الكلمات تعتبر احسن تعريف للجودة (اي عدد من الاجابات)	1	A
5.00	10	إلى حد ما	0.50	<input type="checkbox"/> جيد جدا <input checked="" type="checkbox"/> الى حد ما <input type="checkbox"/> لا يوجد	هل ترى ان ادارة الجودة الشاملة ستفيد شركتك	2	
4.29	10	إلى حد ما	0.43	<input checked="" type="checkbox"/> تفضل الشاوي <input type="checkbox"/> تعيد الكافيه <input checked="" type="checkbox"/> يريد لاسم الشركه <input type="checkbox"/> لا يحضر المشروع <input type="checkbox"/> تفضل بصير الطليات <input type="checkbox"/> تأسس <input type="checkbox"/> تفضل القطارى القصابه	يمكن استخدام ادارة الجودة الشاملة لتحسين اى من الاتى	3	
0.00	5	لا	0.00	<input type="checkbox"/> نعم <input checked="" type="checkbox"/> لا	هل تعلم اى برنامج يستخدم لتطبيق ادارة الجودة	4	B
5.00	5	نعم	1.00	<input checked="" type="checkbox"/> القضاء على العيوب <input type="checkbox"/> زيادة ارباح البرج <input type="checkbox"/> عمرة مناسبة	ما هي ملاحظات شركتك عن الجودة	5	
3.33	5	نعم	0.67	<input type="checkbox"/> نعم جدا <input checked="" type="checkbox"/> نعم <input type="checkbox"/> وعا ما	كيف تقيم اهمية جودة الخدمة	6	
10.00	10	نعم	1.00	<input checked="" type="checkbox"/> نعم جدا <input type="checkbox"/> نعم <input type="checkbox"/> وعا ما <input type="checkbox"/> ليس مهم	كيف تقيم ارضاء العميل	7	
4.67	10	إلى حد ما	0.47	<input checked="" type="checkbox"/> لا تشارك على الصعيد فى الموقع <input type="checkbox"/> العمل الضخم <input checked="" type="checkbox"/> لا تشارك فى الموقع <input type="checkbox"/> 3 <input checked="" type="checkbox"/> لعمال المواد الخام وجودها <input type="checkbox"/> 2 <input checked="" type="checkbox"/> زيادة معدل الطيات <input type="checkbox"/> 3 <input checked="" type="checkbox"/> لانها من المشروع <input type="checkbox"/> 1 <input checked="" type="checkbox"/> لا تشارك فى الموقع <input type="checkbox"/> 1 <input checked="" type="checkbox"/> تحسين العائلى <input type="checkbox"/> 2 <input checked="" type="checkbox"/> لتسليم بين افراد المشروع	قيم امكانية تحسين العمليات الاتية بالدرجات من (5-0)	8	
3.30	10	لا	0.33	<input type="checkbox"/> مرتبه (2-1) <input type="checkbox"/> مرتبه (3) <input type="checkbox"/> مرتبه (4-5)	قيم الجودة من حيث الاهمية بالمرتبه من (5-1)	9	
3.33	10	إلى حد ما	0.33	<input type="checkbox"/> فريق دائم لحل المشكلات <input type="checkbox"/> تكوين فريق مختص لكل مشكله <input checked="" type="checkbox"/> حل المشكله بقرار فريق <input type="checkbox"/> استعصاء راي	كيف تقوم شركتك بحل مشكلاتها	11	C
10.00	10	نعم	1.00	<input checked="" type="checkbox"/> تعدد الشاوي <input type="checkbox"/> لا يلقى	كيف تقوم بقياس ارضاء العميل	12	
5.00	5	نعم	1.00	<input checked="" type="checkbox"/> نعم <input type="checkbox"/> لا	هل لديك نظام لتجميع اقتراحات الموظفين	13	
5.00	10	إلى حد ما	0.50	<input type="checkbox"/> كلمه كلمه <input checked="" type="checkbox"/> لا يتردد احد منهم <input type="checkbox"/> لا يتكلموا بالسلطة	هل الموظفين لديهم السلطة لعمل تغييرات مهمه لثناء تنفيذ المشروع	14	
5.00	5	نعم	1.00	<input checked="" type="checkbox"/> لا <input type="checkbox"/> لا <input type="checkbox"/> نعم	هل مقاول الباطن يتم تقييمهم	15	
10.00	10	نعم	1.00	<input checked="" type="checkbox"/> نعم <input type="checkbox"/> لا	هل تطور شركتك من مفهومها عن الجودة	16	
2.50	10	لا	0.25	<input type="checkbox"/> 25 <input type="checkbox"/> 0 <input type="checkbox"/> 66%-100%	ما هي نسبة الموظفين المدركين لمفهوم الجودة	17	

Fig (6) :Beltagi company questionnaire part 1

0.00	10	لا	0.00	<input type="checkbox"/> يوجد برنامج مطبق حاليا	هل لدى شركتكم برنامج لتحسين مفهوم الجودة	18	D
				<input type="checkbox"/> يوجد خطة كجزء من سياسة الشركة			
				<input type="checkbox"/> يوجد خطة بأموال في التصدير			
0.00	10	لا	0.00	<input type="checkbox"/> لا يوجد	اي برنامج لتحسين الجودة تقوم شركتكم باستخدامه	19	D
				<input type="checkbox"/> إدارة الجودة الشاملة			
				<input type="checkbox"/> التحكم في الجودة			
5.00	10	إلى حد ما	0.50	<input type="checkbox"/> إدارة الجودة 9000	اي من هذه العوامل تزيد حافز بدء استخدام برامج ادارة الجودة	20	D
				<input type="checkbox"/> إدارة الجودة الشاملة			
				<input type="checkbox"/> التحكم في الجودة			
0.00	10	لا	0.00	<input type="checkbox"/> انضباط في العاملين	كيف تصف اداء البرنامج المستخدم في شركتكم لتحسين الجودة	21	D
				<input type="checkbox"/> عوامل المحطة (السور)			
				<input type="checkbox"/> يوجد برنامج رسمه محدد			
0.00	10	لا	0.00	<input type="checkbox"/> انضباط في العاملين	بعد تطبيق برنامج تحسين الجودة كيف اصبحت جودة الخدمة	23	D
				<input type="checkbox"/> يوجد برنامج			
				<input type="checkbox"/> اجتمعت تدريبا			
0.00	10	لا	0.00	<input type="checkbox"/> اجتمعت تدريبا	بعد تطبيق برنامج تحسين الجودة كيف اصبحت العلاقة بين العملاء والشركة	24	D
				<input type="checkbox"/> اجتمعت تدريبا			
				<input type="checkbox"/> اجتمعت تدريبا			
0.00	10	لا	0.00	<input type="checkbox"/> اجتمعت تدريبا	هل يوجد تدريب فعلى على ادارة الجودة	25	E
				<input type="checkbox"/> يوجد بعض البرامج			
				<input type="checkbox"/> لا يوجد برنامج			
0.00	10	لا	0.00	<input type="checkbox"/> نسبة (0-33%)	ما هي نسبة الموظفين الذين خضعوا للتدريب	26	E
				<input type="checkbox"/> نسبة (33%-66%)			
				<input type="checkbox"/> نسبة (66%-100%)			
0.00	10	لا	0.00	<input type="checkbox"/> رضاء العميل	ما هو محتوى البرامج التدريبية	28	E
				<input type="checkbox"/> طرق العمل			
				<input type="checkbox"/> التحكم في الصلة			
6.00	10	إلى حد ما	0.60	<input type="checkbox"/> اتصالات	العقبات في تطبيق برنامج ادارة الجودة الشاملة	29	F
				<input type="checkbox"/> جميع البيانات وحفظها			
				<input type="checkbox"/> تحليل الصافي			
93.85	235.00			<input type="checkbox"/> تعزيز السياسة العامة للشركة			
				<input type="checkbox"/> توفير الموارد البشرية والتدريب			
				<input type="checkbox"/> توفير الموارد المادية والبشرية			
39.93515704	Percent of Quality %			<input type="checkbox"/> توفير الموارد البشرية والتدريب			
				<input type="checkbox"/> توفير الموارد المادية والبشرية			
				<input type="checkbox"/> توفير الموارد المادية والبشرية			

Fig (7): Beltagi company questionnaire part 2

10.3 Analyzing & Discussion

From studying this questionnaire and analyzing the data, it was found that the company's percentage of quality management was equal 39.9% which is not accepted. Therefore some recommendations were set to help the company to implement quality management and improve its market share as the following: (1) the senior management needs to increase her awareness and knowledge about the concepts of quality management and its importance. (2) The company needs to change its approach in the management of solving problems and crises, through the formation of specialized teams to solve problems, whether permanently or specialized team for each problem. (3) The Company needs to increase staff awareness about the concept of quality management and the importance of it. (4) The company needs to set up a training program for employees as a platform for how customer satisfaction, the importance of teamwork, how to control the various operations of the project and other programs. (5) Despite the company's knowledge of the concepts of quality management, but it does not use any of the quality management programs which requires taking serious steps to apply any of these programs to get to the improvement and development of the company. (6) The company needs to give some of the powers and authorities of the employees if necessary to make significant changes during operations.

10.4 Case Study Conclusion

From studying and analyzing the previous questionnaire, it was found that the company applied quality management with only 39.9% which isn't accepted although it has a little knowledge of the concepts of quality management, so it requires increasing their knowledge more and taking serious steps to apply any of the quality management programs to get to the improvement and development of the company.

11. CONCLUSION

It is easy to infer from the previous chapter that although 'Total Quality Management' has been a magic word in the construction Industry for the past few years, methods and techniques to implement the Quality Management program in the Industry are still to be developed. The basic problem attributed to the lack of expertise or resources in TQM and also that most of the

companies treat Schedule and Cost as the main priorities so it makes implementing quality improvement programs is hard. Customer satisfaction can be greatly enhanced by improving construction underestimation, conformance to specifications, project management coordination, design changes by clients and change orders from the procurement department. The key to understand is that the client is now a moving target their expectations and requirements are constantly changing. To keep up with their ever-hanging goals, the companies need to have in place a system of identifying, measuring and continuously improving their tangible and intangible products and services which can be developed when we implement TQM principles. The Top Findings of the Report as the following: (1) Familiarity with the concept and process of the overall quality is weak due to a lack of opportunity for individuals to learn about this system. (2) Total Quality System is applied in the port and most of the construction companies with the analysis showed that the institutions needed for this large and unnecessary system. (3) The study showed that construction companies do not have clear plans for training and raise standards and the uptake ratios of training courses in the field of quality is weak due to the lack of the necessary incentives by management and full conviction that the administration will not implement and apply quality concrete reality system. (4) The study showed that construction firms do not use the computer in the conduct of its business despite the fact that the analysis showed that the use of computers in construction firms leading to quality control. (5) The study showed that most of the departments of construction firms do not bother to provide a good work environment as it does not create sophisticated models to solve business problems. (6) The Lack of committed leadership and a lack of strategic planning for the communication channels and the formation of working groups to improve quality. (7) The Lack of commitment to the same philosophy and not to give individuals a sufficient mandate necessary for the success of the overall quality. (8) Lack of specialization in the application of total quality management.

12. RECOMMENDATIONS

(1) The need to disseminate knowledge and do studies and seminars in the field of quality management. (2) The need for the state to establish a special device management and

control of the overall quality. (3) Exchange experiences with countries and companies and international companies in the field of total quality management. (4) Full encouragement to those who are implementing total quality management through material and moral incentives and others. (5) Develop plans and programs for future strategy and innovation of advanced solutions to resolve, processing and development work. (6) Focus on the use of computers and other modern techniques within the administrative structure as it helps to quality application. (7) Requires the state move towards increasing the ways of implementing the overall quality of corporate management and that the establishment of a unit or department of the quality of the Ministry of Housing, Utilities and in all departments of housing nationwide to raise awareness of the concepts of administration to the quality and importance of the application and granting privileges to companies that implement quality management, which in turn help improve the construction industry and gain customer satisfaction and therefore accrue to the companies to increase profit and increase its shares to the labor market. And in order to perform the entrance of companies applying TQM it done solving problems and obstacles to the application and in the following manner: (1) Wisely make the change by entering the required adjustments in the pattern of performance gradually and over time, do not be a radical change sharply or undesirable. (2) Commitment on the part of senior management by applying this approach, support, and support for him by declaring its application and provide the resources necessary for the application and determine the powers and responsibilities and coordination between them. (3) Design organizational structures form that fits with the philosophy of this entrance. (4) Focus on training programs that earn top management members of self-confidence and lack of fear of change. (5) Make adjustments in quality systems and standards and processes in line with changes in the needs and desires and tastes and supports competitive position. (6) The establishment of an information system for total quality management with the consolidation of the individuals who are able to provide information to support continuous improvement efforts. (7) Continuing motivation for the program by encouraging employees to submit their proposals on improving the quality and development work and strengthen the working groups and workshops

quality efforts. (8) Involve all employees in the responsibility for the success or failure of the company. So if companies want to develop their market shares and gain their Customer's Satisfaction which considered as their target, they should firstly develop our definition of quality as they should put it in their main priorities like schedule and Cost and they should work on increasing our employee's culture about Quality through give them a formal training in TQM or other quality improvement. The objective of this study was to develop and demonstrate how a system of continuous improvement can be put in place by adoption and implement quality Management in the construction industry.

13. FUTURE STUDIES

Although the current research study was able to fully accomplish its objectives, a number of additional researches directions have been identified during performing its main research tasks, including: (1) Determination and ranking the obstacles that the companies faced which prevented companies to apply quality management in all types of Egyptian construction projects; (2) Determination and ranking the factors affected in making implementation quality management useful and profitable in all types of Egyptian construction projects; and (3) Proposed software to measure and predict exactly the percentage of quality management in all phases of all Egyptian construction projects.

REFERENCES

- [1] Rose, Kenneth H. (July 2005). "Project Quality Management: Why, What and How", Fort Lauderdale, Florida: J. Ross Publishing.
- [2] Paul H. Selden (December 1998). "Sales Process Engineering: An Emerging Quality Application".
- [3] Tenner, DeToro. (2008). "Garvin's Eight Dimensions of Product Quality", Retrieved December 28, 2012.
- [4] David A. Garvin , Harvard Business review. (1987) ."Competing on the eight dimensions of quality", Retrieved December 23, 2012.
- [5] Joseph M. Juran. (1998). "Quality handbook".
- [6] Legal Language. 1836. "The Wonderful One-Hoss Shay", Retrieved December 23, 2012.
- [7] Report1979."Consumer Complaint Handling in America", Retrieved December 23, 2012.
- [8] RAC Publication, QKIT, Quality Toolkit, 2001.
- [9] 3rd Forum (June 2003. "International Construction Project Management".

- [10] Gerardo Viera. (September 2008). "What Is Construction Project Management?" , PM Hut, Retrieved 2010-07-04.
- [11] Minks, William. (2011). "Construction jobsite management".
- [12] Arditi, D., Gunaydin, H. M. (1997). "Total quality management in the construction process", International Journal of Project Management, 15(4), 235-243.
- [13] Feigenbaum, Armand V. (1956). "Total Quality Control". Harvard Business Review, Cambridge, Massachusetts: Harvard University Press, 34 (6): 93-101, ISSN , OCLC 1751795.
- [14] Phillips, Joseph. (November 2008). "Quality Control in Project Management", the Project Management Hut, Retrieved 21 December 2012.
- [15] Cheng Hu. (2004). "Construction Project Management", second edition, China Construction Industry Publisher, 22.
- [16] Liang Shilian. (2004). "Engineering Project Management, second edition, China: Dongbei University of Finance and Economics. 71 - 79
- [17] Johnason, P. (2009). "Human resource management: A critical approach", London: Routledge. pp. 19-370.
- [18] Lepak, David P., Scott A. Snell. (2015) "Virtual HR: Strategic Human Resource Management in the 21st Century, " Human Resources Management Review 8.3 (1998): 214-34.
- [19] Ensher, E. A., Nielson, T. R., & Grant-Vallone, E. (2002). "Tales from the Hiring Line: Effects of the Internet and Technology on HR Processes", Organizational Dynamics, 31(3), 224-244.
- [20] Mondy, R. Wayne, Harlow, Judy Bandy (2014). "Human resource management", England: Pearson Education Limited, p. 28.