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A Review Paper on Quality Management System in Offshore Construction Field

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Abstract - *Construction is a continuously developing field and offshore construction is a representative example of that. Offshore construction is a fast-developing field with a lot of scope for quality improvement. Quality is one of the critical factors in the success of offshore construction projects. Offshore construction projects involve immensely complex processes. There are many factors affecting the quality standard of offshore construction. This paper identifies parameters that are responsible for the vulnerable situation, which causes issues in the implementation of QMS in offshore construction. This paper also explores the role of the quality management system (QMS), such as ISO 9001, and total quality management (TQM), and their approaches in the offshore construction field. The aim is to determine if these systems have the potentiality to generate new knowledge for improving quality management practices and outcomes in the offshore construction field. This paper reviews all the prior work of literature relevant to QMS and finds some critical success factors (CSFs) that affect the implementation of QMS. The findings and conclusions obtained are sorted out into different categorizations to develop the framework of the paper.*

Key Words: Offshore construction, Quality management, Quality management systems, Critical success factors, ISO 9001, Total quality management.

1.INTRODUCTION

Quality is the sign of human civilization, and with the progress of human civilization, a quality management system will play an outstanding role.

The concept of quality management is to ensure efforts to attain the required level of quality for the product which is well planned and organized. From the purpose of view of a construction company, quality management in construction projects should mean maintaining the quality of construction works at the essential grade so on acquire customers' satisfaction that would bring long-term competition and business survival. (Silva *et. al*., 2016)[37]

Quality Management has widely been adopted by construction companies being an initiative to restore quality problems and to generally meet the demand of the last customer (Gudmestats *et. al*., 2013)[15]. Offshore construction challenges are different from onshore construction challenges. The main rationale for the selection of this area of study is the notable role that quality management system plays in the offshore construction field.

Quality management system (QMS) has been widely implemented and adopted within the construction industry, especially by companies capable of handling mega-projects, big infrastructure projects. Although uncountable researches are administered to review the role of QMS in various industries (e.g., manufacturing, food, service, etc.) but there's an absence of relevant studies for the role of QMS within the construction industry. (Soetanto *et. al*., 2001) [38]; (Xiao and Proverbs, 2002) [45]; (Kam and Tang, 1997) [23].

Some studies have examined the effects and benefits of implementing QMS in the construction industry. Some evidence shows that implementing QMS had improved communication problems, minimized mistakes, reduced rework and wastage of materials, and exercised better control on sub-contractors and suppliers. Thus, the productivity, profitability, and market share gradually increased which enabled contractors to satisfy clients' requirements (Motwani and Kumar, 1996) [30].

Besides, a study by Water (2000) [43] aimed at designing a model for maintaining the processes of QMS in the construction industry because it has been suggested as an essential activity for every organization.

Nonetheless, most of the studies on QMS are not only done specifically to examine the objectives of the construction industry, but their scope also includes exploring numerous industries for comparison purposes. For example, the latest study by Kim et al. (2011) [24] identified 10 critical success factors for QMS implementation after reviewing a hundred studies from different industrial backgrounds.

Furthermore, some researchers have also emphasized the relationship of QMS with organizational and business performances (Martinez-Costa *et al.,* 2009) [32] instead of project performances that the implementation of ISO 9000 can benefit organizations by improving their production performance and quality awareness of their employees in diverse industries. (Mo and Chan, 1997) [31]; (Parsa and

Keivani, 1997) [34]; (Thelen, 19970 [40]; (Endrijonas, 1994) [12]; (Gader et al., 2009) [18]

2. Literature review

2.1 Previous studies on quality management

Quality management (QM) refers to all activities of overall management functions, especially top management leadership, that determine quality policy objectives and responsibilities for all members of the organization. It includes all activities that managers perform in an attempt to implement their quality policy. These activities include quality planning, Quality Control. Quality Assurance and quality improvement, (Abusa, 2011) [5]. QM is additionally defined as "coordinated activities to direct and control a corporation with reference to quality" [ISO 9000: 2000]. The quality policy is that the general intentions and aspect of an organization as regards quality, as formally expressed by top management (McCabe, 1998) [29].

Project Management Body of Knowledge [PMBOK], is a guide to project management, states that project QM is a subset of project management that includes the process required to ensure that the project will satisfy the requirement that it had been undertaken (Landin, 2000) [26].

The activities are normally management-driven and blended into a system. This is referred to as the systems approach to managing quality and other people are required to participate or are inspired to participate. The quality system is defined in ISO 8402 as "Organizational structures, Procedures, processes, and resources for implementing QM" (McCabe, 1998) [29]. The most common QM implemented in recent history is TQM and ISO quality Management system.

Gunaydin's (1997) [13] study of TQM in US construction projects reported that training of employees in the construction process is important than the design phase. And teamwork between the parties participating in the construction process was found very important. The statistical method which provides a problem-solving tool was found the least important factor that affects quality. According to Gunaydin's (1997) [13] survey of United State designers and construction managers indicated that the effect of codes and standards on quality operations was less. And the quality of drawing and specification was found such a factor that affects the quality of the constructed facility.

According to Hoonakker et al. (2010) [19] study the primary barrier to the management system was found the nature of the construction process, the secondary barrier was a greater number of parties, third was non-standardization and the final barrier was found bidding process. Health, safety, and environment are important in integrated management systems in offshore construction but also the quality is equally important.

Thomas and Jayakumar (2017) [42] elucidated that quality management has been adopted by construction companies being an initiative to repair quality problems and to generally meet the requirements of the customer. ISO registration was used for marketing purposes. Implementation of quality management was greatly perceived as a way to satisfy contractual obligations in situ places of satisfying the requirements of clients.

Prabhakar (2017) [33] made an attempt to develop a tool for quality management system implementation in the offshore construction field with a documented approach that helped in maintaining quality in work and reduce rework with effective cost. A quality management system in construction with exhaustive activities for planning and execution in oil and gas projects was presented by the researcher.

2.2 Obstacles to implementing quality management in offshore construction and responsible factors

There is evidence of disappointing results in many organizations decide to implement quality management due mainly to obstacles in implementation [Yusoff et al, 2006]. Obstacles in implementation appear from improper attitude and approach of management and employee, inadequate resources, and training also as inappropriate environments (willar, 2012) [44].

Yusoff et al. (2006) [46] enumerated obstacles to QM: High cost especially initial cost, resistance to change, loss of productivity of the workforce because of effort exerted in learning the new system, management interference, limited ability of personnel, remote job sites making it hard to control, communication problem between personnel within the workforce.

Jones and Stendius (2006) [20] discussed the challenges of offshore power HVDC wind construction and mentioned that the weight of parts and space are major problems that occur during offshore construction. The offshore environment is the major factor needed to consider while selecting material for construction and surface treatment. According to Gudmenstad and Karunakaran (2012) [15] wave, the unpredictability of weather, visibility problems due to fog and fall are some physical environmental factors that cause delays to projects.

Kronborg (2016) [22] concluded that damages and corrosion attacks originated from poor painting operations. The unpredictability of weather could be the reason for the delayed construction process. An aggressive environment not only during the construction but also after the construction affects the quality of the structure so proper measures should be taken at the initial stage. (Koch et al. 2017) [25].

Gudmestad (2019) [14] dealt with adjusted construction processes during the construction phase of the Troll offshore gas platform. The field is located in the Northern North Sea; a gravity-based platform is located at the field

in 305m water depth. Due to large waves platform experienced large oscillation. This problem was solved by making the slender part of the platform. Another problem was occurred due to the high waves were ringing phenomenon. To recover from this problem inner reinforcement in the wall was increased. This study made us understand the vulnerability in offshore construction and how offshore construction challenges are different from onshore construction. So that this area needs more research attention.

Durability damages cause a continuing decline within the seismic capacity of the pier and an increase of the seismic demand under earthquake action also because of the probability to reach the ultimate failure stage; compare to higher piers, lower piers are more susceptible to offshore corrosion. So, maintaining quality is very essential for offshore construction projects (Liang et al. 2019) [26].

2.3 Critical Success Factors (CSFs) For QMS

To successfully implement QMS it is important to identify the factors required for the implementation process. Saraph et al., (1989) [37] in their study develop a QM instrument, identifying eight CSFs of QMS (Shown in Table -1). Their study had considerable influence on later studies, and subsequent study has resulted in the development of different frameworks based on varying perceptions (Zhang *et. al*., 2000) [47]. Although these frameworks have different QMS approaches, they all lay emphasis on leadership, strategic planning, customer and market focus, human resources focus, process management, continuous improvement, and supplier management in one way or the other (Dale, 2003) [10].

The study by Sila and Ebrahimpour (2002) [36] reviewing 347 articles on total quality management identified 76 studies that employed factor analysis to extract factors for successful implementation of TQM. Out of these, they compiled 25 TQM factors that are widely used by researchers to measure TQM implementation. Their study revealed eight common cores of the factors as shown in Table-1. Gunduz and Almuajebh (2020) [17] found 40 critical success factors that affect the construction process that was compiled into seven categories: project-related, company-, and work-related, client-related, project-management-related, design-team- related, contractor-related, project-manager- related factors. Silva *et. al.* (2016) [39] found 40 external factors and 34 internal factors were identified. 10 external factors and 19 internal factors are repeated in 3 or additional papers.

Literature also informs those different countries have adopted similar QMS factors as criteria for quality awards under different titles. However, the criteria for all quality awards are derived from three basic frameworks: the Malcolm Baldrige National Quality Award [MBNQA] in the United States of America, the European Quality Award [EQA] in Europe now called the European Foundation for QM [EFQM] Excellence Award and the Deming Prize [DP] in Japan. A comparative description of the QMS factors derived from major studies on QMS, and the QM program (three basic award frameworks) in the MBNQA, EFQM, and DP. From an extensive review of QMS literature from quality leaders and a QM research total of 21 critical sub-factors are indicated in Table-1. A final list of the success factors of QMS implementation for this study also included the following main critical success factors.

Table -1: Summary of studies on CSFs for QMS implementation

Critical success factors from previous literature			
No.	**Critical success factors**	**Critical success sub factors**	**Reference No.**
1	Top management commitment and leadership	Top management commitment and leadership	[4], [7], [3], [18], [6], [11], [34], [43], [33], [9], [17]
		Vision and Plan Statement	[6], [24], [43], [17]
		Planning	[3], [11], [33] ,[17]
2	Human resource management	Employee relations	[4], [7], [3], [2], [18], [6], [1], [34], [33], [17]
		Employee involvements	[4], [7], [3], [18], [11], [17]
		Training	[4], [3], [18], [1], [11], [24], [34], [43]
		Learning	[11], [23]
		Communication	[4], [7], [3], [1], [11], [17]
		Role of the Quality Department	[34], [17]
		Recognition and Reward	[4], [43], [17]
3	Externa Customer Focus	Customer management	[7], [3], [6], [1], [11], [23], [24], [43],

			[33], [9], [17]
4	Process management	Process management	[4], [3], [2], [18],[24], [34], [43], [33]
		Product/service design	[24], [34], [43]
5	Supplier quality management	Supplier quality management	[4], [6], [24], [34], [43], [33], [17]
6	Information Analysis and Evaluation	Information and Analysis	[3], [34], [33]
7	Continuous Improvement	Continuous Improvement	[4], [3], [18], [6], [1], [11], [24], [43], [9]
		Teamwork	[18], [6], [1]
8	Contract Documents	Contract Documents	[4], [2], [24]
9	Materials & Equipment's	Materials & Equipment's	[3], [2], [18], [6], [24]
10	Systems Used	Systems	[2], [18], [6]
11	Surrounding Environment	Surrounding Environment	[2], [18], [24], [17]

Top Management Commitment and Leadership

The degree of support that management takes in implementing a total quality environment is critical to the success of QMS implementation. Without upper management involvement, commitment, and leadership, a QMS program cannot succeed. Allocation of budgets, planning for change, and provision of monitoring structures of the progress of works are normally done by top management which clearly accentuates the importance of top management involvement in QMS implementation (Zhang, 2000) [47]. Baidoun *et. al.,* (2003) [9] pointed out that the success factor is consistent with all previous studies, literature, and quality awards. The study has revealed that the major problem of QM implementation is a lack of top management commitment and participation, which eventually leads to its failure. Many types of research discuss this success factor such as Zhang, (2001) [47]; Antony et al, (2002) [8]; Sila & Ebrahimpour, (2005) [36], and others as mentioned in table-1.

Human Resource Management

Management participation in quality activities is not enough to contribute to quality developments. Employees are encouraged to show commitment to quality issues (Al-Tayeb, 2008) [3]. When workers themselves are committed to delivering quality, they take greater initiative towards meeting specifications; detecting and eliminating obstructions; improving designs, and setting realistic yet challenging performance targets. This is better amplified if resources are provided for employees. With QMS, quality becomes everyone's responsibility and the training must be picked out for every level of the company (Landin, 2000) [26]; (Al- Musleh, 2010) [4]. Customized training plans should be organized for management, engineers, technicians, office staff, and field labor in line with the quality objectives and goals of the organization.

Customer Management

In the QMS philosophy, customer satisfaction is the goal of the entire system, and a persistent customer focus improves a firm's performance. The function of the construction organization is to provide customers with facilities that meet their needs. Customers may be either internal or external. The external customer is the owner. An internal customer is a second process or department within the organization, which depends on the product of the first (Abusa, 2011) [5]. For example, for a carpenter preparing formwork, the final customer may be the owner, but the internal customer is the crew that will use the forms when placing the concrete (Al- Musleh, 2010) [4]. However, in this study the focus is on the external customer, that is the owner. The owner in construction has a greater and directinfluence on the quality of the project than the owner in the manufacturing or service sectors. The main reason for this is that the owners have greater input in many stages of pre-construction such as design, specification,while in manufacturing or service the input is restricted to standard.

Process Management

A process is a course of action of getting things done. A process consists of the tasks, procedures, and policies necessary to carry out the customer's needs. According to the QMS philosophy if the process is correct, so will be the end result. Thus, the organization should work to enhance the method so on improve the top product or service.

Supplier Management

Supplier quality is an important dimension of QM as defective incoming materials and parts lead to process and product quality problems. Purchased materials often become the major contributors to quality problems. Most researchers identified good supplier relationships as a necessity of maintaining competitive advantage such as Abu Bakar *et al.* (2011) [7]; Lombard (2006) [27]; Al-Musleh, (2010) [4] and others as mentioned in Table-1. Suppliers have an outsized and direct impact on the

worth, quality, technology,and time-to-market of products. So many different companies stimulate their engineers to learn the systems, procedures, and processes of suppliers in order to improve communication, reduce errors, and understand capabilities (Rabaya, 2013) [35].

Information Analysis and Evaluation

Documentation is an important element that facilitates the review process, assessment' and attainment of QM in a firm. Review is an organized effort that promotes quality in designs and construction works. It is an organized and independent examination to find whether quality activities comply with planned arrangements and whether these arrangements are implemented effectively and are suitable to achieve objectives. A quality audit can be used for QMS, processes, products, and services. The purpose of a quality audit is to estimate the need for improvement or corrective action. The reviews can be focusing on procedures and practices in an organization, designs (aesthetics, functionality capacity, calculations and capacity), standards, and construction processes.

Continuous Improvements

Continuous improvement is crucial for the survival of a company. The goal of continuous improvement is common to several managerial theories. This process consists of nine steps: Identify the process, Organize a multi-disciplinary team, Define areas where data is needed, Collect data on the process, Analyze the collected data and brainstorm for improvement, Determine recommendations and methods of implementation, Implement the recommendations outlined in step six, Collect new data on the method after the suggested changes are implemented to verify their efficiency , and again follow step five and again analyze the data and brainstorm for more improvement (Al-Sehali, 2001) [1].

Furthermore, quality teams provide companies with the structured environment necessary for successfully implementing the TQM process. The eventual aim of the team approach is to urge everyone, including contractors, designers, vendors, subcontractors, and owners involved in the QMS process. According to Abu Bakar et al. (2011) [7], teamwork among construction parties such as structural, electrical, environmental, civil engineers, architects, and owners is important to succeed quality goals.

Contract Documents

Contract and design drawings are essential for improving the quality of construction. The contract is the prime contract between the owner and the contractor.

Material and equipment resources

This includes all things related to material and equipment, like specifying the required material, using a storage system, the best using of materials and the working equipment's are suitable, safe, and effective for the project.

Systems used

This includes: using computer software, using a cost control system, using applied resources management system, using and implementing a time schedule, and implement a safety program.

Surrounding environment

The environment can be considered as all external influences on the construction process. Broadly, these may be grouped as physical, economic, socio-political, and industrial relations, and they act at the national or local level, and in different ways in the public and private sectors. There have been sizeable changes in attitudes to the environment over the past 30 years. These changes can create uncertainty, not regarding prices, but also in terms of investment in the work of an organization, which will affect the demand for quality (Amer,2002) [2]

3. Research Methodology

The tool adapted to achieve the connection between the critical success factor and project performance during this study is by developing a conceptual framework. The critical success factor may be a variable that will have a big impact that delivers measurable improvements to the offshore project's success. Organizations/companies look to forecasting tools/models to assist them to speed their progress toward performance improvement and to guide them around pitfalls which may otherwise slow or maybe halt their initiatives of project performance. Therefore, so as to enhance project performance and to develop new models, it's essential to work out the critical success factors within current project management practices. In order to know this, the variables for research success are essentially important to be identified and established towards achieving the target of this study.

The target population of the questionnaire survey will be the company manager, project manager, Quality manager, site engineer, supervision engineer, and who have experienced in the offshore construction field in India. Sets of the questionnaire will be distributed to identify the effect of critical success factors on quality management implementation in the offshore construction field. A questionnaire will be designed based on CSfs which are identified from the rigorous literature review. The analysis of data from the questionnaire's responses can provide precise data and after that analysis of data will be done. Based on that analysis model will be developed which will help to assess the effectiveness of the implementation of a quality management system in offshore construction projects. A pilot study will be also carried out to test the relevance and comprehensiveness of the questionnaire. Furthermore, it will be used to improve the questionnaire,

fill in gaps and determine the corrections in it. Then questionnaire will be sent to the respondents.

4. Conclusion

The findings of this study show overview of the quality management system and the surrounding factors which are responsible for the vulnerable situation in the offshore construction field. The main outcome of this study is the identification of critical success factors that can affect the implementation of the quality management system. The extensive literature review of QMS has been carried out from different research papers 21 critical success sub-factors are identified which are indicated in table-1. The sub-factors were regrouped to ensure that factors addressing similar issues were combined into one main factor. The eleven main factors were developed based on their characteristics and from the suggestions of professionals in the offshore construction field.
Finally, it is hoped that this study will beneficial to all parties involved in the offshore construction field and would stand as a good basis for future research.

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