International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 08 | Aug 2021 www.irjet.net p-ISSN: 2395-0072

The Strategy of Implementation of Quality Management System in Offshore Construction Field

Twinkal B. Mhatre[1], Dr. Madhav. B. Kumthekar[2]

[1]M.Tech student (Construction Management), Department of Civil Engineering, Government College of Engineering, Karad, (India)
[2]Professor and Head of Department, Department of Civil Engineering, Government College of Engineering, Karad, (India)

Abstract - *For the successful implementation of offshore construction projects quality models for an organization plays a vital role. Fewer quality issues in the project mean less wasted resources and faster project lead time, which then again results in higher efficiency and savings so that quality management models are important in offshore construction. Quality management models make sure changes within the systems and processes eventually end in better quality in construction work. The principal outcome of this study is to develop a management model for the improvement of quality management systems (QMS) in the offshore construction field which will be used as a tool to measure QMS and assess a company's strengths and weaknesses. The aim of the model is to facilitate investigation on which factors are important for achieving outstanding quality performance. Applying this model will lead to continuous improvement.*

Key Words: Quality Management System, Quality management, Critical Success Factors, Offshore Construction Field

1.INTRODUCTION

Success on a project implies that expectations for a given member were met, whether owner, architect, engineer, contractor, or operator. However, these expectations could also be different for every participant (Sanvido, V. et al. 1990) and therefore the study of project success and important critical success factors (CSFs) is usually considered together of the vital ways to enhance the effectiveness of project delivery (Chan et al., 2004). Current project management practices of organizations in the offshore construction sector do not always ensure project success. A successful offshore construction project greatly depends on how the project has been managed and controlled. The main problem with projects management practices has always been bringing up as planning, project execution, cost and time overruns, and quality non-accomplish.

In the academic view, Karuppusami & Gandhinathan (2006) express that researchers should recognize the importance of CSFs as crucial few CSFs to carry their researches. This can be a good way to develop "reliable instruments", and investigate the effects of QMS on organizations. Amazingly, although identifying CSFs is an important issue in implementing QMS in the offshore construction field, but literature survey showed that a few studies were just carried out to determine CSFs into the offshore construction field. Some studies were proven that critical factors of successful QMS implementation are equivalent altogether sectors because the business and behavior issues are tightly associated with CSFs, not the context of business (Delgado-Hernandez & Aspinwall, 2008; Arumugam et al., 2011;). Accordingly, it seems that the best solution for this problem in the offshore construction field is to develop CSF based model.

This paper begins by providing sub factors of CSFs. It is then followed by identifying some of the important key variables on the basis of available literature that contributes to the success of an organization. The next section talks about the methodology that is used to identify the rank and importance percentage of critical success sub factors & development of the model. This paper ends with the research conclusion & limitations.

2. CSFs FOR OFFSHORE CONSTRUCTION FIELD

In this study, CSFs in managing the offshore construction sector in India were surveyed, sorted, and classified into eleven major factors, in order to facilitate this study, every major factor includes several minor factors related to the major one. These factors have been surveyed and compiled through making interviews with some related parties, also by reviewing some publications that reflect factors for improving the implementation of QM in the offshore construction sector.

1. Top Management Commitment

- Management establishing a clear definition of quality in the mission.
- Reviewing quality issues in the top management meetings.
- Regularity and speed of the owner in decision making.
- Procedures of selecting contractors and awarding the tender to the most accurate bidder not to the lowest evaluated bidder.
- Development and implementation of plans on the basis of the company's capabilities.

2. Human Resources Management
- Skill and experience of contractor's staff and using labors with high experience.
- Skill and experience of supervision staff and their authority in the project site.
- Coordination between supervision staff and contractor staff.
- Skill and experience of designers.
- Training courses for employees in quality improvement skills and technical skills.

3. Customer/Client Focus
- Owner organization nature
- Owner's requirements are used as the basis for quality.
- Budget
- Responding effectively to owner's inquiries and complaints.
- Corrective actions undertaken to delight customers.
- Using the facilities properly by the owner.

4. Quality Process Management
- Clarity of work or process instruction giving to employees, artisans, and site staff.
- Testing and inspection of incoming products or work for specification compliance.
- Using a continuous supervision system.
- Process flow chart and inspection for activities that affect quality.

5. Information Analysis
- Review of drawings & specifications before tendering.
- Continuity audit to ensure high-quality work.
- Documentation of project.
- Documentation of corrective and preventive actions.

6. Supplier management
- Reliance on suppliers who are evaluated and selected based on capability and Commitment to product and service quality.
- Supply materials for the project in a timely manner.
- Provide clear specifications to suppliers.
- Providing technical assistance of suppliers by contract or companies.
- Suppliers having programs to ensure the quality of products.

7. Contract Documents & laws
- Absence of a conflict between the tender documents.
- Conditions of a written contract are clear and fair, also responsibilities distribution is clear.
- Bill of quantity is detailed and accurate.
- A competent authority or party to audit drawings of the design.
- Offshore construction bye-laws.

8. Material & Equipment
- Laboratories competence for samples testing and approval.
- Regular maintenance of equipment.
- Optimal use of Materials.
- Using storage & handling system for materials.
- Role of Indian standard.

9. System Used
- Implement a safety program.
- Implement a Time Schedule.
- Using computer software & application.
- Using a complete applied resources management system.

10.Surrounding Environment
- Consideration of marine aggressive environment, biological marine environment.
- Ocean weather studies.
- Lack of space for construction.
- Heavy parts and equipment.
- Cooperation of nearby residents to projects in the implementation of works.
- Changes in government policies.
- The socio-economic environment.

11. continuous Improvement
- Finding the root causes in the diagnosis of problems and defects.
- Identification of areas for quality improvement and implementing it.
- Teamwork.
- Tracking Cost of the quality process for continuous improvement.
- Identification of quality tools.
- Change the company's policy in relation to quality gradually.

3. RESEARCH METHODOLOGY

This study deals with eleven major variables with fifty-six sub-variables were selected on the basis of the review of the literature and on the basis of thorough discussion with knowledgeable people of the offshore construction field. The data was collected from secondary data which is (journal, articles, books, & electronic databases) whereas primary data is the questionnaire. This research adopted quantitative research and questionnaires were used as an instrumental tool for the study. A random sampling method was used to select the respondents in various offshore construction projects.

For the purpose of the study, a structured questionnaire was designed which has four sections. The first section includes the general information about the respondent, the second section evaluates the current level of the implementation of QM in the offshore construction field, the third section includes problems & obstacles affecting QM implementation, and section four includes Critical Success Factors. The Likert scale of 1 to 5, where 1 - Strongly disagree, 2 - Disagree, 3 -

neutral, 4 - Agree, and 5 - Strongly agree was used. The Likert scale is a popular format of a questionnaire that is used in education research. (Mashwama et. al., 2016). The Likert scale is chosen in this study because it allows the respondents to express how much they agree or disagree with certain statements. In order to achieve the objectives of the study, managers and engineers of offshore construction fields in India were selected to be the population. To analyze data in this study, Microsoft Office Excel and Statistical Package for Social Sciences (SPSS.28) were used. Frequencies, percentages, means, and standard deviations were used to provide a comprehensive description of the acceptable degree of the study sample on the different questionnaire statements, and Importance percentages were used to develop the model.

4. DATA ANALYSIS

4.1 Ranking of Critical Success Factors (CSFS)

Having identified factors critical for the successful implementation of QMS in the offshore construction field, it is necessary to rank these factors according to their importance from the offshore construction projects respondents' viewpoint. In order to analyze each factor, each statement had been ranked for each major factor according to the value of its average, starting from the largest average to the smallest average by giving the value 1 for the statement that has the largest average value, 2 for the statement that has the second-largest average value, and so on. According to the SPSS analysis by the five-point Likert scale, when the statement means increase, its importance will be increased. The statement that has the ranking number of value (1) means that it has the highest importance among the other statements in the main one. In order to understand the findings of the study, the mean key in Table 1 shown below will be useful.

Table 1: Mean Key for the Findings of the Study

No.	Mean	Level of Importance
1	2.52 – 3.20	Low
2	3.21 – 3.52	Moderate
3	3.53 – 4.68	High

Table 2: Ranking of CSsF

Rank No.	CSFs	Critical Success sub	Mean	Level
1.	Materials and Equipment (3.93) High	5. Role of Indian standard	4.51	High
		1.Laboratories competence for samples testing and approval.	4.02	High
		2. Regular maintenance of equipment.	3.83	High
		3. Optimal use of Materials	3.75	High
		4. Using storage & handling system for materials	3.55	High
2.	Surrounding Environment (3.60) High	1. Consideration of marine aggressive environment, biological marine environment.	4.68	High
		2. Ocean weather studies.	4.07	High
		3. Lack of space for construction.	3.77	High
		4. Heavy parts and equipment's.	3.37	Moderate
		5. Cooperation of nearby residents to projects in implementation of works.	2.52	Low
		6. Changes in government policies.	3.40	Moderate
3.	Information analysis (3.56) High	2.Continuity audit to ensure high qualitywork.	3.82	High
		1.Review of drawings & specification before tendering	3.70	High
		3. Documentation of project	3.45	Moderate
		4. Documentation of corrective and preventive actions.	3.27	Moderate
4.	Quality Process Management (3.55) High	2. Testing and inspection of incoming products or work for specification compliance.	3.62	High
		3.Using continuous supervision system	3.59	High

		1. Clarity of work or process instruction giving to employees, artisans and site staff.	3.52	Moderate
		4. Process flow chart and inspection for activities that affect quality.	3.49	Moderate
5.	**Supplier Management (3.47) Moderate**	2. Supply materials for the project in a timely manner.	3.20	Low
		3. Provide clear specification to suppliers.	3.92	High
		1. Reliance on suppliers who are evaluated and selected based on capability and Commitment to product and service quality.	3.16	Low
		5. Suppliers having programs to ensure quality of products.	3.45	Moderate
		4. Providing technical assistance of suppliers by contract or companies.	3.64	Moderate
6.	**Contract Documents & Laws (3.42) Moderate**	5. Offshore construction bye laws.	3.73	High
		1. Absence of a conflict between the tender documents.	3.48	Moderate
		2. Conditions of written contract are clear and fair, also responsibilities distribution is clear.	3.41	Moderate
		4. A competent authority or party to audit drawings of design.	3.29	Moderate
		3. Bill of quantity is detailed and accurate.	3.16	Low
7.	**Continuous Improvement (3.37) Moderate**	3.Teamwork	4.11	High
		2. Identification of areas for quality improvement and implementing it.	3.30	Moderate
		1. Finding the root causes in the diagnosis of problems and defects.	3.41	Moderate
		4. Tracking Cost of quality process for continuous improvement.	3.28	Moderate
		5. Identification of quality tools.	3.25	Moderate
		6. Change the company's policy in relation to quality gradually.	2.85	Low
8.	**Human Resource Management (3.35) Moderate**	5. Training courses for employees in quality improvement skills and technical skills.	3.64	High
		1. Skill and experience of contractor's staff and using labors with high experience.	3.47	Moderate
		4. Skill and experience of designers.	3.39	Moderate
		2. Skill and experience of supervision staff and their authority in the project site.	3.14	Low
		3. Coordination between supervision staff and contractor staff.	3.11	Low
9.	**Top Management Commitment (3.23) Moderate**	4.Procedures of selecting contractors and awarding the tender to the most accurate bidder not to the lowest evaluated bidder.	3.93	High
		1.Management establishing a clear definition of quality in the mission.	3.52	Moderate
		2. Reviewing quality issues in the top management meetings.	3.15	Low

		3. Regularity and speed of the owner in decision-making.	2.87	Low
		5. Development and implementation of plans on the basis of the company's capabilities.	2.66	Low
10.	**Systems Used (3.13) Low**	1. Implement a safety program.	3.36	Moderate
		2. Implement Time Schedule.	3.15	Low
		4. Using acomplete appliedresources management System.	3.09	Low
		3. Using computer software & application.	2.92	Low
11.	**Customer/Client Focus (the Owner) (2.80) Low**	3. Budget specified by the owner.	3.48	Moderate
		2. Owner's requirements are used as the basis for quality.	2.71	Low
		6. Using the facilities properly by the owner.	2.66	Low
		4. Responding effectively to owner's enquiries and complaints.	2.65	Low
		5. Corrective actions undertaken to delight customers.	2.64	Low
		Owner organization nature	2.64	Low

Figure 1: Ranking of Critical Success Main Factors

4.2. Model Development

There is a consensus among researchers and offshore construction field experts that one of the principal barriers to promote improvement in offshore construction projects is the lack of a quality management model.

Different approaches were adopted to develop such a model. (Abdel- Razek, et al., 2001) and (Al-Tayeb, 2008) studied the factors affecting the quality of construction works in Egypt & the Gaza strip and developed a model based on an average weighted approach for the different factors affecting quality.

Also, (Chan and Tam, 2000) studied the factors affecting the quality of construction projects in Hong Kong. They developed a model by applying factor analysis and multiple regression techniques. In this study, the Pareto approach was adopted to develop the model. Pareto- an Italian economist who created a mathematical formula to show the unequal distribution of wealth in his country, observing that twenty percent of the people own eighty percent of the wealth, which means 20% of factors, achieves 80% of the importance percentage.

This approach was developed and applied based on calculating the importance percentages of the main factors and sub-factors. The model represents the CSFs of QMS implementation on offshore construction projects in India. To develop the model the following steps have been followed:

4.2.1. Calculation of the importance percentages of the main factors according to their impact on the QMS implementation, by summing the mathematical means of the main factors, which were obtained in Table 3, then equation (1), is used to calculate the importance percentage for each element as shown in Table 3

$$I.P_{Main} = \frac{X_{main}}{\sum_{1}^{11} X_{main}} \times 100\% \quad \ldots\ldots\ldots (1)$$

Where:

$I.P_{main}$ = Main Factors Importance percentage,

X_{main} =mathematical mean for Main Factors

Table 3: The Importance Percentages of the Main Factors

No	Main Factors	Xmain	I.P main
1	Top management commitment & Leadership	3.23	I.P main(1)= 8.63%
2	Human Resources Management	3.35	I.P main(2)= 8.95%
3	Customer/Client Focus	2.80	I.P main(3)= 7.48%
4	Quality Process Management	3.55	I.P main(4)= 9.50%
5	Supply management	3.47	I.P main(5)= 9.28%
6	Information Analysis	3.56	I.P main(6)= 9.52%
7	Contract Documents & Laws	3.42	I.P main(7)= 9.14%
8	Materials & Equipment's	3.93	I.P main(8)= 10.50%
9	System Used	3.13	I.P main(11)= 8.37%

11	Surrounding Environment	3.60	I.P main(12)= 9.62%
12	Continuous Improvement	3.37	I.P main(13)= 9.01%
QMS		Sum X M= 37.41	

4.2.2. Calculation of the importance percentage for sub factors under main factors in reference to their impact on QMS implementation using equation (2).

$$I.P_{Main\text{-}sub} = I.P_{Main} \times \frac{X_{main}}{\sum_{1}^{No.(sub)} X_{main\text{-}sub}} / 100\% \quad \text{.....(2)}$$

Where:

$I.P_{main\text{-}sub}$ = Importance percentage for subfactors under main factors,

$X_{main\text{-}sub}$ =mathematical mean for subfactors under main factors

4.2.3. The sub-factors are organized in descending order of priority and the sub factors' cumulative percentage is calculated to use the Pareto principle, which states that 20% of the factors attain 80% of the importance percentage to find the critical success factors of QMS implementation. Table 4 shows the cumulative percentages of sub-factors in descending arrangement

Table 4: Cumulative Percentages of sub factors in Descending Arrangement

No.	Sub Factors	I.P main-sub	Sub factor importance percentagerelated to QMS	Cumulative sub factor percentage
1	2.Continuity audit to ensure high quality work.	I.P 6-2	2.5542	2.5542
2	1.Review of drawings & specification before tendering	I.P 6-1	2.4733	5.0275
3	2. Testing andinspection of incomingproducts or work for specification compliance.	I.P 4-2	2.4187	7.4462
4	5. Role of Indian standard	I.P 8-5	2.4087	9.8549
5	3.Using continuous supervision system	I.P 4-3	2.3987	12.2536
6	1. Clarity of work instruction giving to employees, artisans and site staff.	I.P 4-1	2.3513	14.6049
7	4. Process flow chartand inspection foractivities that affect quality.	I.P 4-4	2.3313	16.9362
8	3. Documentation of project	I.P 6-3	2.3067	19.2429
9	1. Implement a safety program.	I.P 9-1	2.2465	21.4894
10	4. Documentation of corrective and preventive actions.	I.P 6-4	2.1857	23.6751
11	1.Laboratoriescompetence for samples testing and approval.	I.P 8-1	2.1473	25.8224

12	2. Implement Time Schedule.	I.P 9-2	2.1059	27.9283
13	4.Procedures of selecting contractorsand awarding thetender to the mostaccurate bidder not to the lowest evaluated bidder.	I.P 1-4	2.1023	30.0306
14	3. Provide clear Specification to suppliers.	I.P 5-3	2.0945	32.1251
15	4. Using acomplete applied resources management system	I.P 9-4	2.0657	34.1908
16	2. Regular maintenance of equipment.	I.P 8-2	2.0454	36.2362
17	3. Optimal use of materials to reduce wastage	I.P 8-3	2.0024	38.2386
18	5. Offshore construction bye laws.	I.P 7-5	1.9971	40.2357
19	3. Using computer Software & application	I.P 9-3	1.9519	42.1876
20	4. Providing technicalassistance of suppliers by contract or companies.	I.P 5-4	1.9451	44.1327
21	5. Training courses for employees in quality improvement skills and technical skills.	I.P 2-5	1.9448	46.0775
22	4. Using storage & handling system for materials	I.P 8-4	1.8963	47.9738
23	1.Management establishing a clear definition of quality in the mission.	I.P 1-1	1.8831	49.8569
24	1. Absence of a conflict between the tender documents.	I.P 7-1	1.8636	51.7205
25	3.Teamwork	I.P 11-3	1.8516	53.5721
26	5. Suppliers having programs to ensure quality of products.	I.P 5-5	1.843	55.4151
27	2. Conditions of written contract areclear and fair, also responsibilities distribution is clear.	I.P 7-2	1.8253	57.2404
28	4. Skill and experience of designers.	I.P 2-4	1.8115	59.0519
29	1. Consideration of marine aggressive environment, biological marine environment.	I.P 10-1	1.7845	60.8364
30	4. A competentauthority or party toaudit drawings of design.	I.P 7-4	1.7613	62.5977
31	2. Supply materialsfor the project in a timely manner.	I.P 5-2	1.7094	64.3071
32	3. Bill of quantity is very detailed and accurate.	I.P 7-3	1.6918	65.9989
33	1. Reliance onsuppliers who are evaluated and selected based on capability and Commitment to product and service quality.	I.P 5-1	1.688	67.6869
34	2. Reviewing quality Issues in the topmanagement meetings.	I.P 1-2	1.6854	69.3723
35	2. Skill and experience of supervision staff and their authority in the project site.	I.P 2-2	1.6781	71.0504

36	3. Coordination between supervision staff and contractor staff.	I.P 2-3	1.662	72.7124
37	1. Skill and experience of contractor's staff and using labors with high experience.	I.P 2-1	1.5844	74.2968
38	2. Ocean weather studies.	I.P 10-2	1.5517	75.8485
39	3. Budget specified by the owner.	I.P 3-3	1.5506	77.3991
40	5. Development and implementation of plans on the basis of the company's capabilities.	I.P 1-5	1.5353	78.9344
41	1. Finding the root causes in thediagnosis of problems and defects.	I.P 11-1	1.5262	80.4606
42	2. Identification of areas for quality improvement and implementing it.	I.P 11-2	1.4867	81.9473
43	4. Tracking Cost of quality process for continuous improvement.	I.P 11-4	1.4777	83.425
44	5. Identification of quality tools.	I.P 11-5	1.4641	84.8891
45	3. Lack of space for construction.	I.P 10-3	1.4372	86.3263
46	3. Regularity and speed of the owner in decision-making.	I.P 1-3	1.4231	87.7494
47	7. The socio-economic environment.	I.P 10-7	1.3045	89.0539
48	6. Changes in government policies.	I.P 10-6	1.2968	90.3507
49	4. Heavy parts and equipment's.	I.P 10-4	1.2852	91.6359
50	6. Change the company's policy in relation to quality gradually.	I.P 11-6	1.2839	92.9198
51	2. Owner's requirements are used as the basis for quality	I.P 3-2	1.208	94.1278
52	6.Using the facilities properly by the owner.	I.P 3-6	1.1856	95.3134
53	4. Responding effectively to owner's inquiries and complaints.	I.P 3-4	1.1811	96.4945
54	1. Owner organization nature	I.P 3-1	1.1766	97.6711
55	5.Corrective actions undertaken to delight customers.	I.P 3-5	1.1766	98.8477
56	5. Cooperation of nearby residents to projects in implementation ofworks	I.P 10-5	0.961	100

4.2.4. Figure 2 shows that 80% of the results were achieved by 41 sub-factors, meaning that the 80/20 assumption is not applicable. However, the critical success subfactors (CSsF) were assumed as the sub-factors that meet 70% of the importance of the Pareto Chart which is 35 sub-factors according to Figure 2

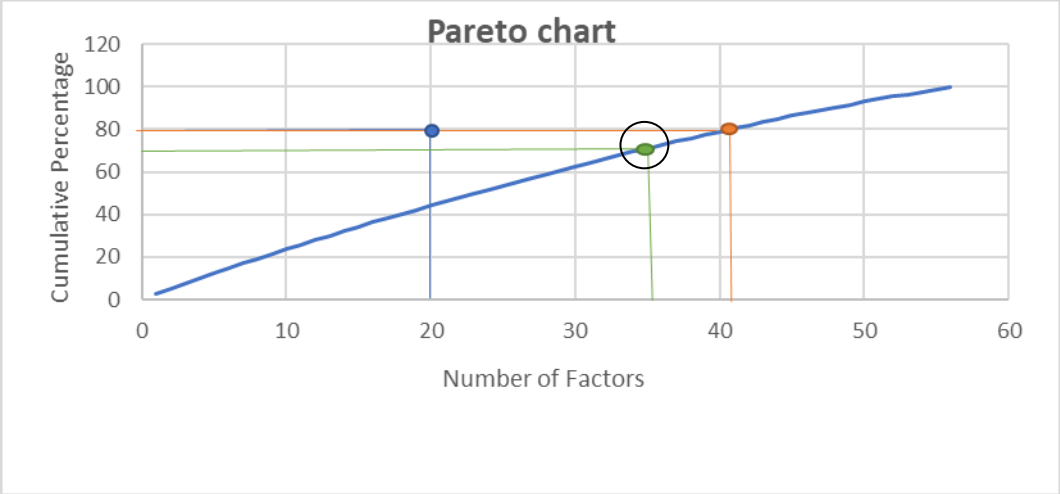

Figure 2: Pareto Chart for QMS Sub Factors Number

4.2.5. After finding CSsF that affect the QMS implementation, they are rearranged based on their main factor as shown in Table 6. The sum of these parameters represents about 70%, to change it to 100% representation the sub-factors were multiplied by 100% and divided by the overall total of the percentages as shown in the 4th column of Table.

Table 6

Main Factor	Sub Factors	CSsFi1 %	$\frac{CSsFi1}{\sum CSsFi1}$ %
1. Top management commitment (7.9814)	4.Procedures of selecting contractors and awarding the tender to the most accurate bidder not to the lowest evaluated bidder.	I.P 1-4 = 2.1023	2.9589
	1.Management establishing a clear definition of quality in the mission.	I.P 1-1=1.8831	2.6504
	2. Reviewing quality Issues in the top management meetings.	I.P 1-2 =1.6854	2.3721
2. Human Resource Management (7.6486)	5. Training courses for employees in quality improvement skills and technical skills.	I.P 2-5 =1.9448	2.7372
	4. Skill and experience of designers.	I.P 2-4 =1.8115	2.5496
	2. Skill and experience of supervision staff and their authority in the project site.	I.P 2-2 =1.6781	2.3618
4. Quality Process Management (13.3708)	2. Testing and inspection of incomingproducts or work for specification compliance.	I.P 4-2 =2.4187	3.4042
	3.Using continuous supervision system	I.P 4-3 =2.3987	3.3761
	1. Clarity of work orprocess instructiongiving to employees, artisans and site staff.	I.P 4-1 =2.3513	3.3093
	4. Process flow chartand inspection for activities that affect quality.	I.P 4-4 =2.3313	3.2812
5. Supplier Management (13.0612)	3. Provide clear Specification tosuppliers.	I.P 5-3 =2.0945	2.9480
	4. Providing technicalassistance of suppliers by contract or companies.	I.P 5-4 =1.9451	2.7376

	5. Suppliers havingprograms to ensure quality of products.	I.P 5-5 =1.843	2.5939
	2. Supply materialsfor the project in a timely manner.	I.P 5-2 =1.7094	2.4059
	1. Reliance onsuppliers who are evaluated and selected based on capability and Commitment toproduct and service quality.	I.P 5-1=1.688	2.3758
6. Information Analysis (13.3989)	2.Continuity audit to ensure high quality work.	I.P 6-2 =2.5542	3.5949
	1.Review of drawings & specification before tendering	I.P 6-1 =2.4733	3.4811
	3. Documentation of project	I.P 6-3 =2.3067	3.2466
	4. Documentation of corrective and preventive actions.	I.P 6-4 =2.1857	3.0763
7. Contract Document & Laws (12.8627)	5. Offshore construction bye laws.	I.P 7-5 =1.9971	2.8108
	1. Absence of a conflict between the tender documents.	I.P 7-1 =1.8636	2.6229
	2. Conditions of written contract areclear and fair, also responsibilities distribution is clear.	I.P 7-2 =1.8253	2.5690
	4. A competentauthority or party toaudit drawings of design.	I.P 7- 4 =1.7613	2.4789
	3. Bill of quantity is detailed and accurate.	I.P 7-3 =1.6918	2.3811
8. Materials & Equipment (14.7783)	5. Role of Indian standard	I.P 8-5 =2.4087	3.390
	1.Laboratoriescompetence for samples testing and approval.	I.P 8-1 =2.1473	3.0222
	2. Regular maintenance of equipment.	I.P 8-2 =2.0454	2.8788
	3. Optimal use of materials to reduce wastage	I.P 8-3 =2.0024	2.8183
	4. Using storage & handling system for materials	I.P 8-4 =1.8963	2.6690
9. System Used (11.7804)	1. Implement a safety program.	I.P 9-1 =2.2465	3.1618
	2. Implement Time Schedule.	I.P 9-2 =2.1059	2.9640
	4. Using acomplete applied resources management system	I.P 9-4 =2.0657	2.9074
	3. Using computer Software & application	I.P 9-3 =1.9519	2.7472

10. Surrounding Environment (2.5117)	1. Consideration of marine aggressive environment, biological marine environment.	I.P 10-1 =1.7845	2.5117
11. Continuous Improvement (2.6060)	3.Teamwork	I.P 11-3 =1.8516	2.6060
QMS Summation		71.0504	100%

5. RESULT

From the results it is clear that the critical main factors that affect QMS implementation are: Top management commitment, Human resource management, Quality process management, Supplier management, Information analysis, Contract documents & laws, Materials & Equipment, Systems Used, Surrounding Environment and Continuous Improvement. Figure 3 shows the importance percentage of each main CSFs of QMS implementation.

Figure 3: Critical Success Factors (CSFs) of QMS Implementation

5.1 Model Application

In order to create a practical, easy-to-use model that measures QMS implementation an Excel form was developed. The model was developed base on the modified importance percentage for the CSsF. The CSFs are answered by the user, who suggests a value that quantifies the extent to which the organization has achieved on this factor X, the model then calculates the organization's achievement of the QMS by multiplying the modified importance percentage by X.

6. CONCLUSION

The results of this study clearly indicate that there are ten CSFs with 35 CSsF that were needed for the successful implementation of QMS in the offshore construction field in India. From the results, a model has been developed. This model describes the primary QM methods, which may be used to assess an organization's present strengths and weaknesses with regard to its use of QM methods.

The model has the main interface, which contains the ten critical factors as shown in fig 3. By pressing any of these buttons a new page will appear in excel form, the user completes column (X) by a percentage ranging from 0 to 100 based on the extent that the sub-factors have been actually applied then the user presses in the QMS model on the same page to return to the main interface. This is repeated for all main factors. The final result that represents the percentage of applying QMS by the organization is then displayed in Excel form.

7. LIMITATIONS

This study is restricted by the subsequent items:

1. Developed model based on data collected in this research can be used for the offshore construction field only.

2. For calculation of sample size only ongoing offshore projects in India were considered as the total population.

3. The area of study is limited to Indian coastal states like Maharashtra, Gujarat, Goa, Karnataka, Kerala, Tamil, Nadu Andhra Pradesh, and Odisha, except West Bengal and Coastal Union territories.

4. Only eleven major variables of CSFs are taken into consideration, which were related to the success of the offshore construction project, so further studies with more items/variables could be taken into account

REFERENCES

[1] Al-Tayeb, M., (2008), "Critical Success Factors of TQM Implementation on Construction Projects in Gaza Strip." Gaza Strip: Islamic University of Gaza.

[2] Abdel-Razek R.H; El-Dosouky A.I. and Solaiman A.M. (2001). A Proposed Method to Measure Quality of the Construction Project. Egypt. International Exhibition Conference for Building & Construction.

[3] Al-Tayeb, M., (2008), "Critical Success Factors of TQM Implementation on Construction Projects in Gaza Strip." Gaza Strip: Islamic University of Gaza.

[4] Al-Musleh, A., (2010)' "Development of A Framework for Total Quality Management Principles in the Construction Companies withSpecial Reference to the Construction Companies in the State of Qatar.' London, United Kingdom: University of London.

[5] Al-Musleh, A., (2010)' "Development of A Framework for Total Quality Management Principles in the Construction Companies withSpecial Reference to the Construction Companies in the State of Qatar.' London, United Kingdom: University of London.

[6] Baidoun, S., Zairi, M., (2003), "Proposed Model of TQM Implementation in the Palestinian Context.", TQM & BusinessExcellence,14(10), 1193–1211.

[7] Chan, A. P., Chan, D. W., Chiang, Y. H., Tang, B. S., Chan, E. H., & Ho, K. S., (2004), "Exploring critical success factors for partnering in construction projects." Journal of construction engineering and management, 130(2), 188-198.

[8] Chan, A. P., Scott, D., & Chan, A. P., (2004), "Factors affecting the success of a construction project." Journal of construction engineering and management, 130(1), 153-155.

[9] Dale, B.G.,"Managing quality." 4th edition, Oxford: Blackwell Publishers Oxford, (2003).

[10] Dís Dagbjartsdóttir, S., (2012), "Quality Status and Quality Aspects inthe Icelandic Construction Industry." Iceland: Reykjavík University.

[11] Delgado-Hernandez, D.J., & Aspinwall E., (2008), "A framework for building quality into construction projects – Part I", Journal of Total Quality Management & Business Excellence, 19(10), 1013–1028.

[12] Endrijonas, J. (1994) "Certification a bane or a boon", Managing Automation, 9(5), 38–39.

[13] Gunduz, M.; Yahya, A.M.A., (2018), "Analysis of Project Success Factors in Construction Industry.", Technol. Econ. Dev. Econ., 24, 67–80.

[14] Gader, A.M.A., Ismail, M.Y., Hamouda, A.M.S., Ismail, N. and Al-Khalifa, K., (2009), "ISO 9000 performance among the Malaysian companies: the effects of motives", International Journal of Industrial and Systems Engineering, 4(1), 32–45.

[15] Hoonakker, P., Carayon, P., Loushine T., (2010), "Barriers and benefits of quality management in the construction industry: An empirical study", Total Quality Management & Business Excellence, 21(9), 953-969.

[16] Khalid, Z. (2005), "Improving Quality of Construction Projects in Governmental Contracting Companies- Views of Project Managers at Ministry of Construction and Housing." Iraq: University of Tikrit.

[17] Karuppusami, G. and Gandhinathan, R., (2006), "Pareto analysis of critical success factors of total quality management: A literature review and analysis." TQM Magazine, 18(4), 372-85.

[18] Landin, A., (2000), "Impact of Quality Management in the Swedish Construction Process." Sweden, Lund University.

[19] Motwani, J., Kumar, A., (1996), "A roadmap to implementing ISO 9000", International Journal of Quality and Reliability Management, 13(1), 72–83.
[20] Rabaya, D., (2013), "Status and Challenges of Total Quality Management Application in Selected Palestinian Chemical Industries. Palestine": An Najah National University.
[21] Sanvido, V.; Parfitt, K.; Guveris, M.; Coyle, M., (1990), "Critical success factors for construction projects." ASCE J. Constr. Eng. Manag., 118, 94–111.
[22] Water, H.V.D., (2000), "A maintenance model for quality management", International Journal of Quality and Reliability Management, 17(7), 756–770.
[23] Xiao, H. and Proverbs, D. (2002), ""The performance of contractors in Japan, the UK and the USA – an evaluation of construction quality", International Journal of Quality and Reliability Management, 19(6), 672–687.
[24] Zhang, Z., Waszink, A., Wijngaard, J., (2000), "An Instrument for Measuring TQM Implementation for Chinese Manufacturing Companies." International Journal of Quality and Reliability, 17(7), 730-755.
[25] Zou, W., Kumaraswamy, M., Chung, J., Wrong, J., (2014), "Identifying the critical success factors for relationship management in PPP projects." Int. J. proj. management. 32, 265-274.