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Identification of Critical Success Factors for Minimization of Cost of Poor Quality from the Construction Projects

Shahid Mahmood

Engineering Management, Member Planning & Design, Capital Development Authority, Islamabad, Pakistan

Email address:
cda_shahid@yahoo.com

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Abstract: Cost of Poor Quality (COPQ) or cost of failure gets inducted in construction projects during work execution due to failure in preventing defects, reworks and wastage of resources. Poorly defined project objectives, inadequate feasibility studies coupled with poor project planning and designing lead to revision of designs and reworks at later stage during project execution, causing cost and time overrun. Losses of construction companies on this account can go up to 40% of revenues. Since these losses (reworks and wastage of resources etc.) are normally not measured and recorded in the accounting system, therefore, they mostly remain hidden and the management does not know its gravity. Therefore, there is a need for reconnaissance and finding solution to minimize the losses of construction industry. Construction industry has a significant share in the socio-economic development of any country and provides employment to skilled/unskilled labor/poor masses and helps to alleviate poverty. Success of construction industry is dependent on performance of construction companies. The performance of construction companies can be improved by minimizing the COPQ. Completely eliminating COPQ might not be possible being uneconomical, however, it can be minimized with a proactive approach and effective management of Critical Success Factors (CSF), which were yet unknown. This study was therefore taken up to identify the CSF that can help the project management to reduce or minimize COPQ. This research study was successful in exploring and identifying forty (40) CSF falling in five areas of project management (Planning, Organizing, Executing, Monitoring and Controlling) that have the potential to decrease the losses on account COPQ from construction projects. Since it would not be possible for the project management to address and tackle all the forty CSF at the projects therefore, ranking in terms of criticality has been carried out for all the identified CSF. The analysis have revealed that 17 CSF fall in the list of top ten (some CSF have equal scores). It has also be identified that Planning is the most critical stage of any project because six of the top ten CSF pertain to Planning stage. According to ranking of top ten CSF, project Planning is at the top followed by Organizing, Controlling, Monitoring and Executing. It highlights the importance of Planning in any project; therefore, project planning may be completed very carefully so that no revision is needed during the project execution stage and COPQ remains at the lowest possible level.

Keywords: Critical Success Factors, Cost of Poor Quality, Construction Companies, Construction Projects

1. Introduction

Due care and attention is normally not given in clearly defining the project objectives and deliverables in public sector of developing countries, as a result the project planning, designing and execution get badly affected, causing time and cost overrun at the projects. Thereby, it causes induction of COPQ right from project inception and defining stages. However, effective management of critical success factors can play a vital role in minimizing COPQ from construction projects.

COPQ gets generated as a result of producing poor quality products and services and also due to reworks and wastage of resources. Cost of Quality has four components; prevention costs (expenditure on minimizing failure and appraisal costs), appraisal costs (expenditure on finding out the degree of quality conformance), internal failure costs (expenditure on rectification of defects before delivery of product/service to

the customer), and external failure costs (expenditure on rectification of defects after delivery of product/service to the customer), [10].

This study has been conducted to identify the critical success factors which can reduce the COPQ from the construction projects. The research has been conducted from construction companies working in and around Islamabad and hence it comprises the research population. Data has been collected through a questionnaire survey from the construction companies executing projects in private and public sectors.

2. Significance of Research

Identification of CSF having potential to minimize COPQ during construction of work would provide a valuable opportunity to organizations involved in construction projects to complete their projects by reducing reworks, wastages and their consequential costs along with completing projects within the stipulated time. Reduction of COPQ will enhance the company profitability along with improving quality of output, productivity of resources and compatibility in the market. Controlling the wastage of resources would also be enhancing the sustainability of environment, growth of national economy and construction industry.

3. Literature Review

3.1. Construction Industry

The construction industry comprises of organizations that are mainly engaged in design and construction of projects of various nature. They include general contractors, builders, constructors, designers and consultants etc. The construction industry has a significant contribution in socio-economic development and employment in any country. Pakistan's construction industry significantly contributes toward the GDP of 2.53% [1].

According Board of Investment Pakistan [1], the country having a population 220 million is ranked at the 5th most populous nation in the world, The available labor force is around 60 million and its middle class is also fast growing. This sector provided employment to 7.61% of the Pakistani labour force including 2% females. According to the Association of Builders and Developers, Pakistan the under construction projects in the country have a monetary value of PRS. 1.1 trillion or about US$ 7.5 billion. The industry has a potential to grow to a value of PRS. 2,705.5 billion or US$ 17.50 billion by 2028.

According to Raza Ali Khan [9] the construction sector is supported by 40 industries that manufacture and supply building materials, and provide vital investments. Growth in the construction sector can help to create jobs and provide employment opportunities to skilled & unskilled labor/poor masses, and thereby help to alleviate poverty.

3.2. Cost of Poor Quality (COPQ)

David L. Goetsch and Stanley B Devis [6] while defining the quality in construction industry observes that, it is a dynamic condition that describes the customer's acceptability regarding products, services, people, processes and environment in satisfying or exceeding customer's expectations and complying standards and specifications required in its contract. Quality is also conformance to the standards and fitness for purpose. Philip B. Crosby [11] has defined cost of quality (COQ) in his book "*Quality is Free"* by dividing it into two main components: (i) the cost of good quality (or the cost of conformance), having further two components appraisal and preventions costs, and (ii) the cost of poor quality (or the cost of non-conformance), it also has further two components i-e internal and external failure costs. Analysing COQ can help organizations to control their losses/COPQ by identifying, measuring and controlling the causes of failure.

The existing accounting and auditing system does recognize and record the COPQ, therefore, it remains hidden [2, 13-15]. According to Claudia Barbará et all [2] losses due to COPQ range from 10 to 40% of the revenue of organizations whereas Juran [7] contends that in the US about a third of what we do consists of redoing work previously "done". Shahid & Nadeem [14] have concluded that the hidden COPQ ranges between 16.91 to 26.90 % of the company revenues.

3.3. Critical Success Factors

Success is defined as the degree to which a company's goals and expectations are met. Individuals or teams involved in project planning & execution have diverse needs and expectations; therefore, they interpret success of their projects according to their own understanding [3]. "For those involved with a project, project success is normally thought of as the achievement of some pre-determined project goals" [8]. Daniel D Ronald of McKinsey & Company developed the concept of "Success Factors" in 1961 [5]. "Success factors are those inputs to the management system that lead directly or indirectly to the success of the project or business" [4].

3.4. Critical Success Factors (CSFs) to Minimize COPQ at Construction Projects

With the contribution of experts/project managers of various construction companies, which they gave in unstructured interviews coupled with 25 years personal experience of the researcher in the construction industry following success factors have been identified. They have been divided into five groups according to project management stages. These factors fall under the category of prevention and appraisal measures, they are low cost measures to prevent high costs of failure. Table 1 shows the Success factors that can reduce COPQ at construction projects.

Table 1. *Success factors that can reduce COPQ at construction projects.*

S#	**Success factors that influence the *reduction of COPQ***	
	Planning Stage	**Executing stage**
1.	Clearly defining the project objectives (scope, time and cost)	Providing effective leadership
2.	Defining quality objectives (standards and specifications)	Team work and employee involvement
3.	Defining measurement and testing procedures	Optimum use of resources
4	Defining communication process and channels	Fulfilling environmental protection requirements
5	Identification of processes and skills for activities	Fulfilling health and safety requirements
6	Identifying technology requirement for processes	Protecting stakeholder rights
7	Anticipating risks and developing mitigation plan	Fulfilling contractual obligations
8	Cash flow planning	Exercising transparency in procurement process and transactions
	Organization stage	Monitoring stage
1	Defining organizational structure	Measuring performance of activities on critical path
2	Providing effective project management process	Measurement and testing of executed works
3	Defining the decision making process and empowerment	Measure Variation in planned and actual resource utilization
4	Induction of appropriate technology	Audit of expenditure and procurement process
5	Deployment of required resources	Measurement of productivity of resources
6	Team development and deploying skilled work force	Measurement of wastage and reworks (COPQ)
7	Training, development and quality awareness of HR	Measure performance of environment protection measures
8	Defining quality control mechanism	Measure performance of Health and safety measures
	Controlling stage	
1	Reducing the gap in planned and actual resource utilization	
2	Reducing the gap in planned and actual cost	
3	Reducing the gap in planned and actual schedule	
4	Reducing the gap in planned and actual scope	
5	Reducing the leakage and wastage of resources and reworks	
6	Improving the quality of input materials and resources	
7	Improving the productivity of resources	
8	Initiating accountability process	

There are forty (40) factors that can reduce the COPQ from construction projects.

4. Research Methodology

A questionnaire survey has been conducted from contractors, engineers, professional working in various construction companies to obtain their views on the identified CSFs. 80 questionnaires were distributed only 56 received back, making about 70%. The analyses have been based on the evaluation carried out on Relative Importance Index (RII) and results of Likert scale.

The Relative Importance Index (RII) provides a method to calculate the strength of index familiarity, frequencies and agreements of the specific question. This method, by using the following equation helps to translate the five-point Likert scale to carry out ranking of the success factors [16]:

$$\text{RII} = \frac{\sum_{i=1}^{5} ai\ xi}{5N}$$

Where ai is a constant expressing the weight of the ith response, xi is the frequency of the ith response of the total responses for each cause, i is the response category index where i = 1, 2, 3, 4 and 5 respectively, and N is the total number of respondents. The RII value ranges from 0 to 1 [16]. The computation of the RII using this formula yielded the value of RII ranging from 0.2 to 1. The value 0.2 represented the lowest and the value 1 represented the maximum strength. The mean response for the Relative Index (RI) was allocated as in the Table 2:

Table 2. *Detail of Evaluation scales used.*

Likert scale	Equivalent of Likert scale and assessment of Relative Index (RI)
1.	$0 \leq RI \leq 0.2$ Strongly Disagree
2.	$0.3 \leq RI \leq 0.4$ Disagree
3.	$0.5 \leq RI \leq 0.6$ Neutral
4.	$0.7 \leq RI \leq 0.8$ Agree
5.	$0.9 \leq RI \leq 1$ Strongly Agree

5. Results and Discussion

According to the frequency of the respondent and their positions in the construction companies, the highest number of questionnaires were returned by Engineers (32%) followed by supervisors (27%), Chief Executive Officer (23%) and Directors (18%). The respondents belong to Pakistan, Palestine, Uganda, Vietnam and Syria. A diversified response received from respondents from various developing countries has contributed to develop a meaning full and realistic conclusion.

Table 3. *Ranking of Factors that Influence the Success of the Construction Organization.*

S #	Factor group	Rank	Critical Success factors that influence the reduction of COPQ	Likert Scale Av.	RII
1	P	1	Clearly defining the project objectives (scope, time and cost)	4.88	0.93
2	P	2	Defining quality objectives (standards and specifications)	4.80	0.91
3	P	3	Identifying technology requirement for processes	4.75	0.90
4	P	3	Cash flow planning	4.75	0.90
5	P	4	Identification of processes and skills for activities	4.68	0.89
6	P	5	Defining measurement and testing procedures	4.59	0.87
7	O	6	Team development and deploying skilled work force	4.50	0.85
8	E	6	Providing effective leadership	4.50	0.85
9	O	7	Defining the decision making process and empowerment	4.45	0.84
10	E	7	Exercising transparency in procurement process and transactions	4.45	0.84
11	M	7	Audit of expenditure and procurement process	4.45	0.84
12	O	8	Training, development and quality awareness of HR	4.34	0.82
13	E	8	Fulfilling contractual obligations	4.34	0.82
14	C	8	Initiating accountability process	4.34	0.82
15	E	9	Team work and employee involvement	4.29	0.81
16	M	10	Measurement and testing of executed works	4.21	0.79
17	C	10	Improving the productivity of resources	4.21	0.79
18	O	11	Induction of appropriate technology	4.11	0.77
19	M	11	Measurement of productivity of resources	4.11	0.77
20	M	12	Measurement of wastage and reworks (COPQ)	4.04	0.76
21	C	12	Reducing the leakage and wastage of resources and reworks	4.04	0.76
22	O	13	Defining organizational structure	4.02	0.75
23	O	13	Providing effective project management process	4.02	0.75
24	O	13	Deployment of required resources	4.02	0.75
25	C	13	Improving the quality of input materials and resources	4.02	0.75
26	C	14	Reducing the gap in planned and actual resource utilization	3.96	0.74
27	O	15	Defining quality control mechanism	3.91	0.73
28	C	16	Reducing the gap in planned and actual cost	3.84	0.72
29	P	17	Anticipating risks and developing mitigation plan	3.79	0.71
30	P	18	Defining communication process and channels	3.75	0.70
31	E	19	Optimum use of resources	3.71	0.69
32	E	19	Protecting stakeholder rights	3.71	0.69
33	M	20	Measuring performance of activities on critical path	3.64	0.68
34	C	20	Reducing the gap in planned and actual schedule	3.64	0.68
35	E	21	Fulfilling environmental protection requirements	3.59	0.67
36	E	22	Fulfilling health and safety requirements	3.46	0.65
37	M	23	Measure Variation in planned and actual resource utilization	3.43	0.63
38	M	23	Measure performance of environment protection measures	3.43	0.63
39	M	24	Measure performance of Health and safety measures	3.21	0.59
40	C	24	Reducing the gap in planned and actual scope	3.21	0.59

Table 4. *Summary of CSF groups according to the Rank of Importance.*

Overall Ranking	Critical Success Factor Groups	Overall rating of 40 factors			17 Factors in the list of Top ten on Likert scale	
		Average of Likert Scale	RI	RII	Frequency	Contributing share
1	Planning Factors (P)	4.50	0.90	0.85	6	35.29%
2	Organization Factors (O)	4.22	0.81	0.81	3	17.65%
3	Controlling Factors (C)	3.92	0.79	0.79	2	11.76%
4	Monitoring Factors (M)	3.87	0.73	0.73	2	11.76%
5	Execution Factors (E)	3.04	0.66	0.66	4	23.53%

6. Conclusion

Only top five ranked CSFs have been discussed due to space constraint, first four of them pertain to planning and preventive category for reduction of COPQ. According to ranking carried out on RI technique, the most important success factor is "clearly defining the project objectives" with RII of 0.93. Other factors are dependent on project objectives that are scope, time and cost. With well defined project objectives there would be fewer chances of variation/losses on account of COPQ. The second most important success factor "Defining quality objectives" with RI = 0.91. Defining the acceptable limits of standards and specifications of the items going to be executed, and accordingly planning, organizing to achieve the quality objectives prevent and reduce the chances of wastage and failure. "Identifying technology requirement for processes" and "Cash flow planning" with an RI of 0.90 share the 3rd position. Selection of an appropriate technology for value addition and execution process not only makes it possible to execute the project expeditiously but also make it possible to

achieve high degree of quality standards and thereby reduces chances of failure and wastage. “Cash flow planning” is also an important CSF because all the activities are dependent on availability and timely release of finances, project completion might get delayed if the “cash flow” is not adequate. A company cannot implements its construction schedule without having adequate finances resources and stable cash flow.

The 4th position has been taken by “Identification of processes and skills for activities” with RII of 0.89. It is essential to achieve the desired quality objectives with minimum variation and wastage. “Defining measurement and testing procedures” with RII of 0.87 is at the 5th position, this CSF pertains to planning appraisal measures. It would not be possible to verify quality conformance without measurement and testing. There are six CSFs at top five positions and all of them pertain to planning category, elaborating the importance of effective planning before taking up the project at site.

Environmental protection and health and safety measures are at the bottom of the ranking list showing unawareness or lack of interest in public convenience and fulfilling corporate social responsibilities by the construction companies. Shahid et al [14, 15] has established that cost of poor quality on account of external failure or cost of inconvenience can be more than the cost of the project. Therefore, Construction companies should review their existing policies and processes to adopt a proactive approach to address the CSFs identified in this research study for improvement of their performance, profitability, productivity and quality of their executed projects.

Ranking carried out on the basis of average of Likert scale also has the same sequence but the number of CSFs in top ten are 17 as compared to 19 ranked by RII. Therefore the evaluation carried out on the basis of Likert scale is equally good.

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