Identifying the Critical Factors Affecting Safety Program Performance for Construction Projects within Pakistan Construction Industry

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ABSTRACT

Many studies have shown that the construction industry one of the most hazardous industries with its high rates of fatalities and injuries and high financial losses incurred through work related accident. To reduce or overcome the safety issues on construction sites, different safety programs are introduced by construction firms.

A questionnaire survey study was conducted to highlight the influence of the Construction Safety Factors on safety program implementation. The input from the questionnaire survey was analyzed by using AIM (Average Index Method) and rank correlation test was conducted between different groups of respondents to measure the association between different groups of respondent.

The finding of this study highlighted that management support is the critical factor for implementing the safety program on projects. From statistical test, it is concluded that all respondent groups were strongly in the favor of management support factor as CSF (Critical Success Factor). The findings of this study were validated on selected case studies. Results of the case studies will help to know the effect of the factors on implementing safety programs during the execution stage.

Key Words: **Safety Culture, Critical Safety Factors, Construction Performance.**

1. INTRODUCTION

The importance and role of construction industry in the development and economical growth of most countries has been confined by several studies. However, construction accidents on site are the challenging task for project manager to control. Sharif, [1] highlighted that construction is one of the most hazardous industries due to its unique nature. Workplace fatalities and injuries bring great losses to both individuals and societies. Table 1 highlighted the Fatality rates in construction industry as compare to the other industries.

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Sorock and Sawacha [2-3] mentioned that the risk of a fatal accident in the construction industry is five times more likely than in other industries. ILO (International Labor Office) estimates that every year, 250 million accidents occur at construction sites causing absence from work for more than three days, and 160 million non-fatal diseases the equivalent of 685,000 accidents every day, 475 every minute, 8 every second and 3,000 fatalities by work every day, 2 every minute.

Due to the nature of construction industry, where multiple tasks are performed and resources are utilized with competency to finish objects/goals/tasks smoothly and eagerly. Such scenario of construction industry produces number of accidents in such conditions, it is responsibility of every one to look out for each-others safety.

The aspect of safety is taken on low priority basis during the execution of project within Pakistan Construction Industry [4]. After mining and agriculture, the construction is the third most hazardous industry. Farooqui, et. al. [5] concluded that most of construction companies of Pakistan lie in the range of extremely unsafe to moderate unsafe conditions (about 58%). Construction workers are also those, who perceive more clearly the lake of job safety. According to Health and safety Executive report 2010, there was a higher level of work related illness in the construction industry than the other industrial sectors.

TABLE 1. FATALITY RATIO PER 100,000 EMPLOYEES (ADOPTED FROM [5])

Country	All Industry	Construction
Australia	2.0	5.0
Canada	6.1	20.9
Hong Kong	8.6	64.2
Sweden	1.4	5.0
United kingdom	0.7	4.4

Construction safety involves many different areas such as individual employee's accidental death on top, secondly injuries due to unsafe environment. To have a safe and risk free construction site, every individual employee should be responsible and accountable to create a safe workplace. Considering the statistics of accidents and injuries in the global and Pakistan construction industry, a need of safety culture is identified which can improve the productivity on site and reduce the ratio of accidents. This study attempts to highlight the factors which are contributing to important to produce a safe workplace. To identify the safe program on site, questionnaire survey was carried out. The result of the survey will help to identify the critical factors, which can create the safe and health working environment on construction sites. Identification of critical factors will be useful in developing a safety policy.

2. IDENTIFICATION OF CSF FOR SAFETY CULTURE

Safety culture is defined by researchers, as a group of ethics, observations, approaches and arrangement of conduct of the stakeholders an organization, In addition it also have strategies, observations and technique to reduce risk in performing any activity, protect an employee from the injuries, illness and unsafe working conditions [6]. Safety culture of an organization is the product of individual and group values, attitudes, competencies, and patterns of behavior that determine the commitment to, and the style and proficiency of, an organization's health and safety programs. Highlighting the construction site as an accident free site, the members of organization bring efforts and make the critical decisions to improve

safety environment on site. The key to this success is establishing a safety-based culture that starts at the top. From literature review, critical dimensions that being consistently concerning about safety culture are:

1. Prizes
2. Preparation
3. Employing
4. Communication/Feedback
5. Management Support.

Within the construction context, a great deal of research has been conducted to identify critical factors. Based on extensive literature review, a list of seventeen factors was proposed by different researchers [7-8]. These factors having a critical influence on the success of the safety program of the organization. These factors are highlighted in the section 5.0 of this paper.

3. METHODOLOGY FOR DATA COLLECTION

To highlight the importance of the factors, a questionnaire survey was conducted within construction industry of Pakistan. Questionnaire survey carried out in two stages, during the first stage of survey, data were collected regarding the perception of the influence of selected seventeen critical factors and during the second stage the verification of the identified critical success factors were carried out. For the verification of the critical success factors, different construction building projects were selected for this study. The result of the verification helps to develop the conclusion of the study. For the selection of project different criteria were assumed, such as: type of project, total cost of project, stage of construction during execution, information for number of subcontractors/suppliers, detail of contractual relationship for the project for designing, monitoring and controlling.

4. ANALYSIS OF THE SURVEY RESULT

To achieve the objectives of this study, mean values were calculated and rank were given to each factor accordingly. The significance of using ranking method identifies the importance of CSF within Pakistan Construction Industry. A statistical test was conducted among the three respondent groups; contractors, clients and consultants. In addition to the correlationship test, a null hypothesis (H_0) is also carried to know the significant agreement in the ranking of different groups of participants, which was determined at 95% of confidence level. This shows that there is an agreement in the ranking between groups of respondents. However, if there is no significance, an alternative hypothesis (H_1) is offered.

The survey invited the respondents to answer an optional question. The rank for each technique was determined by using the mean values computed from the respondents' data. The questionnaire survey was being conducted to determine the importance of critical success factors for safety program implementation which is perceived by clients, consultants, and contractors working within Pakistan Construction Industry. The following sections highlight the findings of the questionnaire survey.

4.1 Perception of the Effect of CSF on Safety Program

This section discusses the result of the initial collected data for the CSF for the safety program implementation. The results of AM (Average Mean) and R (Ranks) by respondent groups are summarized in Table 2. Table 2 also shows the seventeen ranking overall for CSF.

In order to know the correlation between ranking of the CSF for the three participant group, Spearman's Correlation Coefficient (Rs) test was conducted between Client versus Consultant, Client versus Contractors and Consultant versus Contractor groups. Memon, et. al. [9] analyzed the data to test the rank correlation coefficient (the null hypotheses, H_0), by using t-statistic test and this study also use this test to identify the level of significance and the results are shown in Table 3 [9-10]. Table 3 shows the results of statistical test of client versus contractor, it can be observed that Spearman's rank correlation value is 0.821; t-statistics (Calculated) tcal is

TABLE 2. RANKING OF CSFS BY ALL RESPONDENTS

No.	Factors	Client		Contractor		Consultant		Overall	
		Average Mean	Ranks	Average Mean	Ranks	Average Mean	Ranks	Average Mean	Ranks
1.	Management support	4.5	1	4.353	1	4.38	1	4.407	1
2.	Team work	4.375	2	4.235	2	4.238	2	4.277	2
3.	Appropriate safety education and training	4.25	3	3.705	5	4.05	4	4.05	4
4.	Appropriate supervision	4.187	4	3.941	3	4.095	3	4.074	3
5.	Clear and realistic goals	4.062	5	3.764	4	4.047	5	3.962	5
6.	Safety equipment acquisition and maintenance	4.0	6	3.11	13	3.571	10	3.568	9
7.	Continuing participation of employees	3.937	7	3.294	9	3.523	12	3.574	8
8.	Safety meetings	3.875	8	3.352	8	4.0	6	3.759	6
9.	Delegation of authority and responsibility	3.812	9	3.117	12	3.619	9	3.518	12
10.	Good communication	3.75	10	3.47	6	3.714	8	3.648	7
11.	Personal attitude	3.687	11	3.235	10	3.562	11	3.562	10
12.	Personal competency	3.5	12	3.176	11	3.476	13	3.388	13
13.	Sufficient resource allocation	3.437	13	3.0	16	3.095	16	3.166	16
14.	Effective enforcement scheme	3.376	14	3.411	7	3.809	7	3.555	11
15.	Program evaluation	3.375	15	3.058	14	3.323	15	3.222	15
16.	Personal motivation	3.312	16	3.052	15	3.38	14	3.296	14
17.	Positive group norms	3.062	17	2.588	17	3.047	17	2.907	17

5.571 and value of t-statistics tst is taken from t-table. The null hypothesis H_0 for these groups is rejected and the correlation was statistically significant at 5% level. From analysis it can be easily observed that client and contractor agree with each other with the ranking of critical factor for safety factors.

Table 3 also shows the results of statistical test of other two groups. Therefore, it was concluded that the similarity of ranking between client and consultant; and contractor and consultant were strongly significant These results suggest that both groups of respondents having same idea for developing the CSF for developing safety program.

4.2 Verification of CSFs in Construction Projects

In order to test the impact of identified CSFs, different case studies were selected considering the criteria defined earlier. The case studies which were selected are:

(1) Construction of district court building at Matiari.

(2) Improvement and rehabilitation for office of the deputy director industries and residential accommodation at Hyderabad (Deputy Director Office) (construction of main building, ground floor and first floor).

(3) Administration block of MUET (Mehran University of Engineering & Technology), Jamshoro.

4.2.1 Construction of District Court Building at Matiari

This project was started in June 2007 at Matiari and the time allowed for the completion of work was 18 months i.e. December 2009 but due to the late funding by the Government, it is still under construction. The main structural work of the building is completed. Now, this project will be completed up to September 2012. The cost of the project is PKR. 48.7 million.

4.2.2 Improvement and Rehabilitation for Office of the Deputy Director Industries and Residential Accommodation at Hyderabad

This project has been approved by Chief Engineer, Buildings Department, Government of Sindh, Hyderabad. This project was started in June 2010 at Hyderabad and the time allowed for the completion of work is 24 months i.e. June 2012. The main structural work of the building is completed. The cost of the project is PKR. 28.4 million.

TABLE 3. TEST OF AGREEMENT ON THE RANKING OF CRITICAL SUCCESS FACTORS

Groups	Spearman's Correlation Coefficient (Rs)	t-statistics (Calculated) t_{cal}	t-statistics (from t-Table) t_{st}	Null Hypothesis H_0
Client Versus Contractor	0.821	5.571		True
Client Versus Consultant	0.860	6.535	1.746	True
Contractor Versus Consultant	0.946	11.311		True

4.2.3 Administration Block of MUET

Administration Block of MUET was started in November 2009 and the time allowed for the completion of work is 18 months i.e. May 2012. The main structural work of the building has completed. The cost of the project is PKR. 110 million. This project is under the supervision of RCC consultant.

In order to know the impact of factors, in-depth interview and survey form was designed to collect the real data from professionals on selected projects. Questionnaire survey form carries the five options. Respondents were requested to report their point of view according to their experience. The summary of the results of three case studies are presented in Table 4. It can be observed that on project 3 they put more attention to ensure the safety and it can be observed that management support is the most critical factor. Without the help of management support, it is very hard to mark the safety program on site.

5. CONCLUSIONS

From the analysis of survey, it was exposed that the "management support" is the most powerful factor

TABLE 4. RESULTS OF CSFS VERIFICATION

Critical Success Factors	Project-1 Status	Project-2 Status	Project-3 Status
Clear and realistic goals	Fair	Fair	Good
Good communication	Poor	Poor	Fair
Delegation of authority and responsibility	Fair	Fair	Good
Sufficient resource allocation	Poor	Fair	Fair
Management support	Good	Good	Fair
Program evaluation	Poor	Poor	Good
Continuing participation of employees	Good	Good	Good
Personal motivation	Fair	Good	Good
Personal competency	Poor	Fair	Good
Team work	Fair	Fair	Good
Positive group norms	Poor	Fair	Fair
Personal attitude	Fair	Fair	Good
Effective enforcement scheme	Poor	Fair	Good
Safety equipment acquisition and maintenance	Good	Good	Good
Appropriate supervision	Fair	Good	Fair
Appropriate safety education and training	Poor	Poor	Fair
Safety meetings	Fair	Poor	Good

for safety program implementation in Pakistan construction industry. However, team work and training for safety program also rated on second and third by all respondents. It is clear from the analysis that without interest of top management, it is very difficult to successfully bring a safe culture on construction site. Keeping top management support, to have a safe environment on construction site, team work and related training to the members of the organization can also improve the safety culture. In addition of identification of most critical factor, the strong correlations between different groups of respondent were observed on the ranking of factor for safety program. The identified safety factors were tested on selected case studies and from the result of testing, it was observed that project manager on building construction project of Administration Building at MUET has given substantial consideration to safeguard the site from any accident. From implementation of CSF on selected project, it is also observed that project managers on these projects of an idea that 'Management Support' factor is the highly critical for successfully implementing of safety program. However project managers on selected project are in idea of safety equipment acquisition and maintenance can improve the safety program on site.

To bring a safe culture on construction sites, top management level must support in allocating adequate resources (specifically money and staff), actively participating in safety meetings, establishing corrective actions, and encouraging all workers to be involved in such programs.

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