

“Study and Analysis of Safety Management Process at Construction Projects”

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Abstract— Cases of accidents at construction projects are more likely to be occurred. In accordance to reduce accidents at construction sites with great efforts, the objectives of this research are filed. First objective of the research covers the detail study of concept of Safety Management for construction projects and current safety practices, which includes the study of basic concepts along with the safety rules and regulation. The safety principles are compared with the realities to know the hazards, risks occurring at construction projects. Also the measures for preventing injuries, accidents and improving safety are discussed. Work is then followed by the case studies i.e. site visits are conducted at which data is collected by site surveys and personnel interviews. General informational data is collected with the project management details. The questionnaire is divided in two parts i.e. questionnaire for SMI analysis and questionnaire for SPI analysis. Analysis is done by using standard formulae. The discussion is done over the management and performance of safety at construction projects. The findings of this research will minimize the gap of literature and understanding on the aspect of safety practices at construction project sites and can be used as a source of reference in the site safety management. And the conclusion is drawn from the analysis and discussion at the last of the research work.

Keywords: Safety, Safety Measure, Safety Practices, Safety management Processes, etc.

I. INTRODUCTION

Construction sites are thus dangerous places wherever injury, death or sickness will cause to labors, engineers and guests. These will happen because of electrocution, injuries from tools, falling from height, machines and equipment's; being hit by moving construction vehicles, injuries by manual handling operations, sickness just because of unsafe substance like chemicals, dust, etc. The speed of accidents in construction sector is incredibly high in several countries together with the developed and developing countries additionally. Construction industry has accomplished in depth growth everywhere the globe in past few years. For a construction project to achieve success, safety of the structures together with the personnel is of a lot of importance. The various accidents happening at construction sites are continued, even when labour safety laws are out there. Management commitment towards health and safety of the staff at construction sites is additionally lagging. A close literature study was applied to know the causes of accidents and their preventive measures, together with development of safe work surrounding.

II. OBJECTIVES

1. To review the thought of safety management for construction project and current safety practices.
2. Collection of data at on-going construction projects.
3. To evaluate SMI and SPI to measure the intensity of safety management activities i.e. safety culture commitment by management.
4. To examine the problems and strategies related to safety on construction project and arranging the ranking of

construction companies depending on the above data collected which on the safety practices and provision adopted by the individuals.

5. To give recommendation for better management of safety at construction projects.

III. NEED OF THE STUDY

1. To identify and deal with potentially hazardous incidents during construction work.
2. To find proper upgrading of safety programs and its revision.
3. To be sure that all preventive measures are in place, so that the company can complete the work on time and do not face the economic loss.
4. To make the accident free and well growing sector.

IV. SCOPE OF THE STUDY

1. Scope of the project is that by adopting the universally discussed safety practices one may achieve its goal.
2. As construction sector is thought to be the most dangerous and accidental sector all among the trade, similarly this only profession which leads to the huge growth of the nation.
3. Application of Safety Management Process at construction project may affect the economic development of the company.

V. RESEARCH METHODOLOGY

Project work started with collection of data for study and analysis from the various research paper published by various authors. Thereafter a theoretical concept of project (work to be carried out) is decided. After studying the research paper it is

concluded that finding of Safety Management Index (SMI) and Safety Performance Index (SPI) will be the best study to know the safety management of individual company. And then the standard sample of questionnaire is being prepared from the research paper studied which will take part in analyzing the SMI and SPI.

A. Sample of Questionnaire Survey

Selection of factor is done by covering the theoretical literature of research's used as reference. The factors are selected by the considering their intensity to manage the safety. The factors comprise all the points right from the basic to detail safety provision. They are categorized to analyze the worst to best condition of safety control measures. The factors are well arranged so that the SMI & SPI can be analyzed. Also the factors reveals that how strongly is overall safety performance related to the intensity of safety management activities.

1. Questionnaire Survey for SMI Analysis: To evaluate the SMI, respondent is asked about the following questions:

Table 1. SMI Analysis Questionnaire Sample

Sr. No.	Question's Description	Remark
A _i	A _i = 0, if a current health and safety policy is not in place	
	A _i = 1, if a current health and safety policy is in place	
B _i	B _i = 1, if "safety" or any other related term does not appear	
	B _i = 2, if "safety" or any other related term appears in the mission statement	
C _i	C _i = 1, if safety meetings are not conducted	
	C _i = 2, if safety meetings are conducted quarterly	
	C _i = 3, if safety meetings are conducted monthly	
D _i	D _i = 1, if internal safety audits are not conducted	
	D _i = 2, if internal safety audits are conducted annually	
	D _i = 3, if internal safety audits are conducted quarterly	
E _i	E _i = 1, If induction training of staff is not conducted	
	E _i = 2, If basic induction training of staff is conducted	

Sr. No.	Question's Description	Remark
	E _i = 3, If intensive induction training of staff is conducted	
F _i	F _i = 1, If on-going safety awareness programmes are not conducted	
	F _i = 2, If on-going safety awareness programmes are conducted	
G _i	G _i = 0, No provision of PPE	
	G _i = 1, Reasonable level provision of PPE	
	G _i = 2, High level provision of PPE	
H _i	H _i = 1, No inspection and maintenance of PPE	
	H _i = 2, Annual inspection and maintenance of PPE	
	H _i = 3, Monthly inspection and maintenance of PPE	
I _i	I _i = 1, No poster of safety is posted at site	
	I _i = 2, Poster about basic safety is posted at site (5 to 10 posters)	
J _i	J _i = 0, No provision of medical facility	
	J _i = 1, Only first aid provision	

2. Questionnaire Survey for SMI Analysis: To evaluate SPI, the following 8 variables (X1 and X8) are selected, based on the literature review studied. This evaluation is carried for knowing the overall safety performance for an organization relative to the industry's norm, and to indicate its pro-activeness in maintaining the claimed safety management commitment. Respondent is asked to evaluate each variable by his / her organisation's performance with respect to the industry's norm and indicate its rating on a five-point Likert's type scale, i.e. 1 refers to 'Poor', 2 refers to 'Fair', 3 refers to 'Average', 4 refers to 'Good' and 5 refers to 'Excellent' :

Table 2. SPI Analysis Questionnaire Survey

Sr. No.	Variable	Rating
X ₁	Safety performance record with respect to the industry's norm	

Sr. No.	Variable	Rating
X ₂	Including sub-contractors in safety discussions	
X ₃	Planning for the detection of potential hazard	
X ₄	Rewarding personnel with excellent safety records	
X ₅	Appointing only appropriate safety officers and providing them with continual	
X ₆	Identifying site employees who are chemically intoxicated and subsequently incapacitated	
X ₇	Use of PPE at site	
X ₈	Incentive to the workers	

B. Procedure for Analysis

1. SMI Analysis:

The following formula is used to find the value of SMI for an organization (i), in the sample:

$$(SMI)_i = (A_i * B_i * C_i * D_i * E_i * F_i * G_i * H_i * I_i * J_i) \quad \dots (1)$$

Since,

$$0 \leq (SMI)_i \leq \max \text{ SMI} \quad \dots (2)$$

The SMI may have minimum value of zero if and only if any one of A, G, J = 0. It may have maximum value of 1296 if and only if A, B, C, D, E, F, G, H, I, and J assume the maximum scaled value. SMI values are then standardized (divided by the maximum value of 1296) across the responding organizations, so that:

$$0 \leq (SMI)_i \leq 1 \quad \dots (3)$$

2. SPI Analysis:

All eight variables are assumed to comprise the overall safety performance and pro-activeness dimension of the organisation (SPI) which is then calculated as follows:

$$SPI = \sum_{n=1}^8 X_n / 8 \quad \dots (4)$$

Where, X refers to the factor
n- to the factor number
SPI- to Safety Performance Index.

VI. CASE STUDY

A. Data Collection:

Various construction project visited are listed below along with their respective builder, developer and promoter companies. All of the sites are located within Pune district.

Most of the buildings are residential and commercial having different turnovers and different completion period. About five companies are visited in presence of their respective safety and project engineer. Construction sites are selected randomly. All the sites are located in Pune city, so it's easy to analyze the safety management in same city. The construction sites are easy to reach and find. Construction projects are having good turnover. Following are the various construction projects visited for the study and analysis of safety management process-

Table 3. Case Study

Project	Construction Project	Name of Company
A.	Hospital Building and Residential Building, Mauje Pandare, Tq. - Baramati, Dist.- Pune	Yogesh Infra and Reality India Pvt. Ltd., Pune
B.	Residential and Commercial Building, Jadhavwadi Chikhali, Pune	Kakade Properties, Jadhavwadi Chikhali Pune.
C.	Residential and Commercial Building, Utsav Homes, Bhosari, Pune.	Primespace Reality Group, Bhosari Pune

B. Data Analysis:

From the collected data SMI and SPI analysis is to be prepared for each construction project. And the analysis of each construction project is done here. Analysis involves safety factors adopted at construction sites which will directly affect the economy and duration of construction project. The method or formulae of analysis is already discussed in chapter of methodology. Both the analysis carried in this study is about the safety management and safety performance at construction project maintained by respective construction companies.

1. SMI Analysis:

Table 4. Analysis of Safety Management Index (SMI)

Project	SMI for an Organization (out of 1296)	Standardized SMI (SMI / SMI max)
A	(1*2*2*2*2*1*1*3*2*1) = 96	96 / 1296 = 0.074
B	(1*2*2*1*2*1*1*2*2*1) = 32	32 / 1296 = 0.025
C	(1*2*3*3*3*1*2*3*2*1) = 648	648 / 1296 = 0.50

The analysis of SMI and shows that Construction Project C is having the greatest SMI (i.e. 0.5<1). Having greater SMI indicates that this project performs good safety practices in actual, it has the provision of PPE at construction project, also

there is provision of safety posters at sites, it has the good medical facility and induction training facility to the staff. Also Construction Project A has the second lowest SMI among the case studies considered (i.e. $0.074 < 1$). Construction Project B has the lowest value of SMI (i.e. $0.025 < 1$) which shows that; this project follows the poorest safety practices, it conducts safety meetings quarterly.

2. SPI Analysis:

Table 5. Analysis of Safety Performance Index (SPI)

Project	Calculation of SPI	SPI for an Organization
A	$(3+2+2+1+4+3+4+2) / 8$	$2.625 \approx 3$
B	$(2+1+1+1+3+3+3+1) / 8$	$1.875 \approx 2$
C	$(5+4+4+1+5+4+5+3) / 8$	$3.875 \approx 4$

It is observed that the value of SPI for Construction Project C is 4 i.e. the project have good safety performance. The value of SPI for Construction Project A is 3 i.e. it has average safety performance. And the value of SPI for Construction Project B is 2 i.e. overall safety performance of this project is fair.

C. Discussion on Analysis

From all above study, data collection and analysis brief information about safety, safety management, safety management at construction project safety practices, various hazards at construction sites, etc is obtained.

1. The construction site has good and structured safety practices namely safety policy, education and training, site safety inspection, safety auditing, safety meeting, site safety organization, personal protective equipment's, emergency support and safety measuring devices, and fall protective systems.
2. It is observed that various types of misbehavior toward equipment handling is the most basic reason for accident and to prevent such case safety practices should be adopted, just because several major problems are encountered in the safety practices.
3. The problems are ignorance of workers on work procedures, lack of financial allocation for safety management, lack of awareness among workers, and language barrier between supervisors and workers.
4. Several strategies have been suggested to overcome the problems, such as to provide effective safety training, provide PPE at construction sites, allocation of budget for safety management, full commitment from the top management, and to provide safety booklets in various languages, to award the personal for implementing safety practices during working; are the strategies to reduce problems in safety practices.

VII. CONCLUSION

1. Complete study about the theoretical concepts of safety and its management is done by referring the literature presented by various national and international authors.

2. Ranking of construction projects run by different companies according to the analysis is mentioned below, which is directly proportional to the safety management process adopted at construction project:

Project	SMI Ranking	SPI Ranking	Final Ranking
A	II	II	II
B	III	III	III
C	I	I	I

3. Common factor having low rating response for analysis of SMI observed during analysis is on-going safety awareness program to be carried at construction projects.
4. And the common factors having low rating response for analysis of SPI observed during analysis are:
 - a. Rewarding the employees having the excellent safety records.
 - b. Providing incentives to the employees.
5. Overall safety performance of individual construction directly depends on its safety management provision or process followed by the company, which indirectly affects the economic growth of company and its reputation.
6. Construction Project C is found to be best at provision safety management process at construction projects.

VIII. RECOMMENDATIONS: SAFETY MEASURES INVOLVED AS PERSONAL PROTECTIVE EQUIPMENT

Table 6. Recommendations to Construction Projects

Sr. No.	Prevention Recommended	Project			Total
		A	B	C	
1	Provide and maintain a safe work system		√		1
2	Provide incentives to the workers	√	√	√	5
3	Provide safety information / instruction / supervision / training	√	√	√	5
4	Provide suitable fall arresting system		√		2
5	Maintain safe workplace	√	√		3
6	Provide suitable guardrail and covering	√			2
7	Provide maintenance program				0
8	Provide suitable design by professional engineer		√		1

Sr. No.	Prevention Recommended	Project			Total
		A	B	C	
9	Provide and ensure use of ladders				1
10	Provide communication between engineers and subcontractor		√		1
	Total	4	7	2	

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