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Assessment of Safety Management of Construction Sites: A Statistical Approach

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Abstract - *Construction industry is one of those industry which involves maximum human resources. Also, construction sites have a lot of risk involved due to several simultaneous activities being carried out. It is thus prime requisite to manage safety on site. Safety management on site has to be assessed by looking into various safety practices followed on sites. Hence, a questionnaire survey is carried out. The questions in the questionnaire are divided into different categories which pertain to a particular safety practice which should be followed on site. The "SPSS v -16.0" is used. Furthermore, reliability analysis is performed to find out internal linking of the variables. Principal Analysis has also been carried in order to find out the crucial safety practices to be followed on site. A scree plot analysis have also been made to extract the important factors. The Scree plot gives us an idea of how many factors to be extracted. This would give us an idea of which category of safety is important so as to properly maintain site on safety.*

Key Words: Construction Industry, Safety Management, Questionnaire Survey, Principal Component Analysis, Safety Practices, Scree Plot.

1. INTRODUCTION

Construction industry is a major force driving an economy and is on verge of expansion in all developing and developed economy. The construction industry in India is labour intensified. The labour may be skilled or semi skilled. Construction sites are prone to hazards. Hence, injuries in construction industries are very prominent. If safety practices are not followed on site, there might be huge compensation to be paid depending on the severity of the injury. This might even cause the project to be terminated. Ultimately which will lead to addition of expenses or delay in project completion. Hence, following safety rules is a must on site. Project completion on time would even help the organization to promote business growth. And to top it would keep work environment free from hustle. Various sites follow different safety norms. Physical condition of sites matter a lot in the safety. It is thus referred to "Attribute" [3] Safety Management on site depends various reasons and they are (1) Business, (2) Workplace and (3) Workforce. Moreover, due to lack of safety management compromising situation may occur due to dissatisfaction among the client. Hence it is obligatory to know the most mandatory site practices to be worked out on site.

2.LITERATURE REVIEW

Safety is "freedom from hazard"[2]. The evolution of safety on site started with the study of difference in safety management by developed countries and developing countries. The work of OSHA has also been brought in picture. Even various laws related to labour rights are also highlighted [2]. Then the analysis of accidents was done by using OSHA's postulate of Incident Rate. It was also seen that organizations with higher accident rate do not maintain the accident data [5]. Further, an innovation in the safety management on site was done by use of backup alarms used to alert works on site for injuries caused due to maneuvering trucks and mobile equipments [8]. Several terms such as Safety Culture, Safety Climate were introduced. It has also been suggested that different safety instruments could measure qualitatively different safety climate concept [1]. Even various methods were used to find relation between the variables governing safety management. The methods to assess safety on site are

1. Artificial Neural Network

2. Decision Tree

3. Statistical Methods.

4. Structural Equation Models

Also assessment of questionnaire was done in order to understand how a particular work issue was handled at various organization levels[1]. Generally the safety on site could be monitored was by recording the accident rate on site. Studies have also been carried out to study the migrant workers from a few countries where workers' attitude is brought into picture [6].

3.METHODOLOGY

After studying the Standards of safety and the different ways to assess safety on site, a questionnaire survey is to be conducted. Thus, the questionnaire is devised in terms of categories and the respondent in such a way that opinions from all classes of people working on Civil Engineering gets assessed. The questionnaire was developed. It contains 50 questions. These questions are categorized into 6 categories which correspond to one site condition each. The responses

to be given marked on a scale of 1-5 (which go from strongly agree to strongly disagree) i.e. on 5 point likert scale. This is circulated amongst the people related to safety on site. A detail description of the respondent is given below in the table.

Table -1: Designation along with number of respondent

Sr.No.	Designation	Number of Respondents
1.	Junior Engineer	37
2.	Senior Engineer	05
3.	Deputy Engineer	06
4.	Assistant Civil Engineer P.W.D	01
5.	Developer	01
6.	Design Engineer	03
7.	Site Engineer	22
8.	Project Manager	09
9.	Planning Engineer	01
10.	Contractors	06
11.	Lecturers or Professors	03
12.	Builders	02
13.	Quantity Surveyor	01
14.	Officers (Volksvagen)	04
15.	Safety Officer	03
	Total	104

Table-1 does gives the complete information about the Respondents and the number of people. The basic steps involved in the methodology are

i. Literature Study

ii. Data Collection

iii Understanding of the software (SPSS)

iv Data Analysis using SPSS

SPSS is the "Statistical Package for Social Sciences". It is very useful in statistical analysis of data. The Major tests to be performed are

I. Reliability Analysis

II. Factor Analysis

III. Scree Plot Observations

I. Reliability Analysis

The reliability Analysis refers to the extent to which a scale produces consistent results, if the measurements are repeated a number of times. This test gives us the internal consistency of the recorded results. It is measured in terms a co-efficient known as the "Cronbach's Alpha." The range of cronbach's alpha lies between 0-1. The range of the cronbach's alpha and it's significance is given as below

Table -2: Range and significance of cronbach,s alpha

Sr.No.	Range	Significance
1.	_ > .9	Excellent
2.	_> .8	Good
3.	_ > .7	Acceptable
4.	_> .6	Questionable
5.	_> .5	Poor
6.	_ < .5	Unacceptable

II. Factor Analysis

The *SPSS* used includes the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (Kaiser 1970) and Bartlett's test of sphericity (Bartlett 1950) to assess the adequacy of correlation matrices for factor analysis. These tests are equally important for finding out usability of data for performing factor analysis along with Reliability Test. Reliability test assesses only reliability of scale used while KMO test measures adequacy of sample and Bartlett's test of sphericity suggests relationships between variables.

The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy provides an index between 0 and 1 of the proportion of variance among the variables that might be common variance (i.e., that might be indicative of underlying or latent common factors). The *SPSS* suggests that, KMO results near 1.0 supports factor analysis and that are less than 0.5 is probably not amenable to useful factor analysis.

For a large sample Bartlett's test approximates a chi-square distribution. The Bartlett test gives positive results for large sample size, but it is less reliable for small sample size. Very small values of significance below 0.05 indicate a high probability that there are significant relationships between the variables, whereas higher values that is 0.1 or above indicate the data is inappropriate for factor analysis To perform factor analysis few test should be performed and must show positive results initially along with reliability test. After appropriateness of using factor analysis is confirmed it will be used for further analysis. Here the test results for KMO & Bartlett Test which are essential to find out appropriateness of using factor analysis.

4.RESULT AND DISCUSSION

Reliability Analysis

After performing Reliability Analysis we get the value of co-efficient as-

Table -3 Value Of Cronbach's Alpha

Cronbach's Alpha	Cronbach's Alpha based on Standardised Items	N of Items
0.928	0.926	50

The Cronbach's Alpha thus shows excellent internal consistency according to the range.

II. Factor Analysis

The Table IV below shows the results for KMO and Bartlett's Test.

Table -4 KMO and Bartlett's Test Result

Kaiser-Meyer-Olkin measure of sampling Adequacy		0.625
Bartlett's Test of Sphericity	Approx.Chi-Square	4.3863
	df	1225
	Sig.	.000

TABLE IV shows the data adequacy to establish relationship between the variables.

III. Scree Plot and Observations

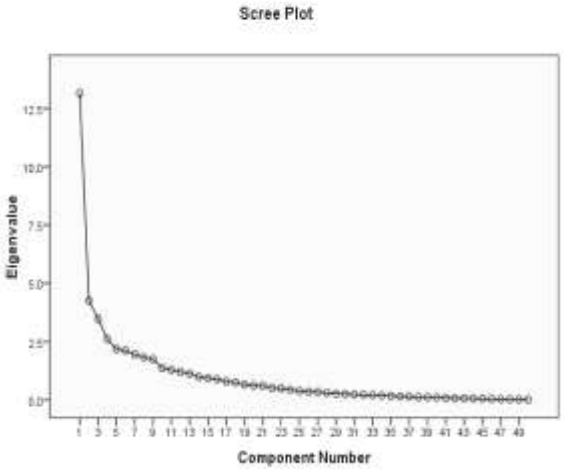

Chart -1: Name of the chart

The above graph (Chart-1) shows Scree Plot of the recorded data. The selection of factors is done till the point where the graph changes it's slope. The change in slope thus occurs prominently twice and slightly around component number 13. Hence, 13 factors are to be extracted. So for further analysis of data in SPSS Factor analysis is used in this work. The concept of factor analysis is explained already.

5. CONCLUSION

The reliability analysis Table III i.e. Cronbach's Alpha shows that the data could be interlinked and thus factor analysis can be performed.

Further, The Table IV below shows the results for KMO and Bartlett's Test. As the value for KMO test is 0.625 which is near to 1.0 it indicates that the sample size is adequate to perform factor analysis of data. Also in Bartlett's Test of Sphericity value of significance is 0.000 which is less than 0.05 indicates significant relationships between all variables. This result suggests that Factor analysis can be performed on this questionnaire survey data for further analysis.

Finally, the scree plot gives us the crucial factors to be retained. These extracted factors are nothing but safety practices and the situation corresponding them in the questionnaire.

6. FUTURE SCOPE

The retained factors can further be evaluated Their eigen values could be found out by deducing the correlation matrix. Even their ranking could be found out so that the most mandatory safety practice to be followed could be highlighted.

REFERENCES

[1] A.I. Glendon, D. K. Litherland, "Safety climate factor, group differences, and safety behavior in road construction", Safety Science, Vol. 39, No. 157-188, 2001.

[2] AV.Praveen Kumar, *CK.*Vishnuvardhanm.E., "A study on construction jobsite safety management", International Journal of Innovative Research in Science, Engineering and Technology Vol. 3, Special Issue 1, February 2014

[3] Behzad Esmaeili, Matthew R. Hallowell, and Balaji Rajagopalan, "Attribute-Based Safety Risk Assessment. II: Predicting Safety Outcomes Using Generalized Linear Models", ASCE, Journal of Construction Engineering and Management, August 2015.

[4] D. A. Patel and K. N. Jha, "Neural Network Approach for Safety Climate Prediction", ASCE, Journal of Management in Engineering, November 2014.

[5] Enno "Ed" Koehn , Rupesh K. Kothari, and Chih-Shing Pan, "Safety in developing countries: professional and bureaucratic problems", ASCE, Journal Of Construction

Engineering and Management, Vol. 121, No.3, September,1995.

[6] Frank Guldenmund , Bryan Cleal and Kathryn Mearns, " An exploratory study of migrant workers and safety in three European countries", Safety Science, Vol. 52, No. 92–99, 2013.

[7] Jesus M. de la Garza, Donn E. Hancher and Lisa Decker, "Analysis OF Safety Indicators in construction", ASCE, Journal of Construction Engineering and Management, Vol. 124, No.4, July / August,1998.

[8] R. B. Blackmon, A. K. Gramopadhye, "Improving construction safety by providing positive feedback on backup alarms", ASCE Journal of Construction Engineering and Management, Vol. 121, No.2, June, 1995

[9] Rohit Laxman Tudayekar, Sushma Shekhar Kulkarni, "Safety and emergency management on construction sites", Current Trends in Technology and Science, Vol. 3, Issue 4, June/July 2014

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