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Study on Impact of Safety in Construction using (SPSS) Multiple Linear Regression Model

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ABSTRACT
An experimental data-based SPSS (Statistical Package for the Social Sciences) with multiple linear regression model to identify the various levels of Impact of Safety in construction field has been dealt in this project. SPSS is an absolute system for analyzing data. The version used was IBM SPSS v21 for Windows Evaluation. The authors had done questionnaire survey in various levels of construction fields which includes various categories of respondents like Safety Officer, Site-in-charge, Project Manager, Assistant General Manager, and General Manager [1]. The response of the respondent subjected to Descriptive Analysis, Kaiser-Meyer-Olkin (KMO) Test and Bartlett's Test, Total Variance Extraction, Scree Plot and then the authors got important underlying extracted factors in construction safety management [2, 3]. The significant factors are subjected to SPSS in linear Regression. These significant factors developed a model for impact of safety on construction projects. The scale of reliability testing of performance measures and its correlation develop a Multiple Linear Regression Model for impact of safety index.

Key words : Construction Safety Management, Statistical Package for the Social Sciences (SPSS), Multiple Linear Regression Model, Regression Analysis.

1. INTRODUCTION
Regression analysis was done to get a relationship between dependent variable and the extracted underlying factors. Regression analysis identifies the strongest predictor among the independent variable which had a cause and affected relationship on dependent variable [15]. The initial factors included under the underlying factors were identified as critical factors that are to be monitored closely. The critical success factors are shown in Table-1.

From the 15 underlying factors the questionnaire was prepared and distributed to the 45 respondents. The extracted factors and case studies' data were used to identify the regression equation. The case study questionnaire is shown in Fig.1.

Table 1: Critical success factors

Factor ID	Extracted Underlying Factors
F-1	Management support and workers' responsibilities.
F-2	Prevention of fire and excavation hazards.
F-3	Proper materials handling and storage methods.
F-4	Fall prevention and protection.
F-5	Precaution activities for formwork and concreting.
F-6	Prevention of electrical hazards.
F-7	Standard methods and maintenance of confined space.
F-8	Scaffolding and working platform standards.
F-9	Hazard prevention from welding and grinding.
F-10	Hazard prevention from hand tools and power tools.
F-11	Grinding machine and operator standards.
F-12	Motor vehicle rules.
F-13	Drilling machine and operator standards.
F-14	Hazard prevention methods for scaffolding, gas cutting and vehicles.
F-15	Precaution and maintenance of woodworking machines.

CASE STUDY ON SAFETY IN CONSTRUCTION PROJECTS

PROJECT DETAILS:

1. Type of the Project:
   - Residential building
   - Commercial building
   - Industrial building
2. Name of the project with place:
3. Total area of the Project:
4. Type of client:
   - Private
   - Government
5. Total cost of the Project:
6. Total duration of the Project specified in the contract :
7. Site safety level in (%): ☐-90% ☐-80% ☐-70% ☐-60% ☐-50%

SAFETY PARTICULARS:

Note:1 - Strongly Agree, 2 - Agree, 3 - Neutral, 4 - Disagree ,5 - Strongly Disagree

✓ **Please mark in the appropriate Box**

Sl.No	Factor	1	2	3	4	5
1	Management support and workers' responsibilities.					
2	Prevention of fire and excavation hazards.					
3	Proper materials handling and storage methods.					
4	Fall prevention and protection.					
5	Precaution activities for formwork and concreting.					
6	Prevention of electrical hazards.					
7	Standard methods and maintenance of confined space.					
8	Scaffolding and working platform standards.					
9	Hazard prevention from welding and grinding.					
10	Hazard prevention from hand tools and power tools.					
11	Grinding machine and operator standards.					
12	Motor vehicle rules.					
13	Drilling machine and operator standards.					
14	Hazard prevention methods for scaffolding, gas cutting and vehicles.					
15	Precaution and maintenance of woodworking machines					

Figure 1. Case Study Questionnaire

2. RESEARCH METHODOLOGY

The research methodology step by step procedure is shown in Fig. 2.

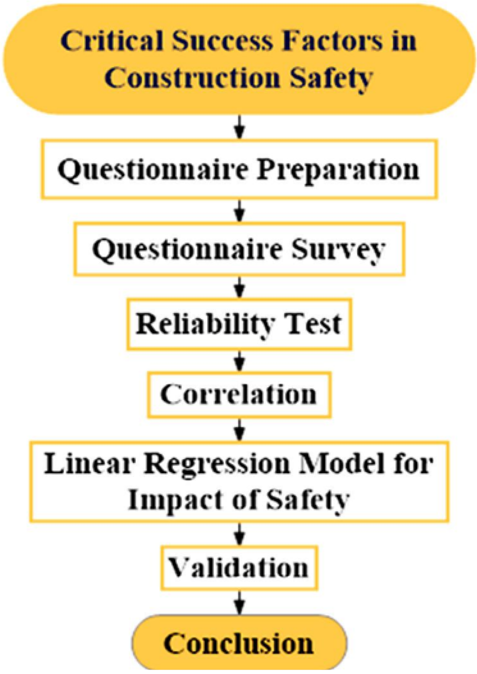

Figure 2. Research methodology step by step procedure

2.1 Reliability Test

The term 'Reliability' is a concept for evaluating or testing to identify the degree of consistency measures in each factor. The Cronbach's coefficient alpha was evaluated for each variable of case study in construction safety. In this study, the average cronbach's coefficient alpha value for all variables was 0.902, which indicates that the questionnaire reliability result was very good. The results for the variables were shown in Table-2. The Cronbach's Alpha coefficients of each variable were 0.905 for "Grinding machine and operator standards, 0.903 for "Standard methods and maintenance of confined space", 0.901 for "Proper materials handling and storage methods", 0.900 for "Scaffolding and working platform standards", 0.900 for "Precaution activities for formwork and concreting", 0.899 for "Fall prevention and protection", 0.898 for "Motor vehicle rules", 0.895 for "Prevention of fire and excavation hazards", 0.891 for "Hazard prevention from hand tools and power tools", 0.890 for "Management support and workers' responsibilities", 0.888 for "Precaution and maintenance of woodworking machines", 0.887 for "Drilling machine and operator standards", 0.886 for "Prevention of electrical hazards", 0.884 for "Hazard prevention from welding and grinding" and 0.883 for "Hazard prevention methods for scaffolding, gas cutting and vehicles". The results of the reliability values were satisfactory, Nunally (1978) has recommended that the minimum value of cronbach's alpha coefficients be above 0.700. From the results of reliability analysis, the questionnaire was found valid, reliable and ready for the regression analysis [4].

Table 2. Cronbach's alpha coefficients of each variable

Factor ID	Variables	Cronbach's Alpha Value
F-11	Grinding machine and operator standards.	0.905
F-7	Standard methods and maintenance of confined space	0.903
F-3	Proper materials handling and storage methods.	0.901
F-8	Scaffolding and working platform standards.	0.900
F-5	Precaution activities for formwork and concreting.	0.900
F-4	Fall prevention and protection.	0.899
F-12	Motor vehicle rules.	0.898
F-2	Prevention of fire and excavation hazards.	0.895
F-10	Hazard prevention from hand tools and power tools.	0.891
F-1	Management support and workers' responsibilities.	0.890
F-15	Precaution and maintenance of woodworking machines	0.888
F-13	Drilling machine and operator standards.	0.887
F-6	Prevention of electrical hazards.	0.886
F-9	Hazard prevention from welding and grinding.	0.884
F-14	Hazard prevention methods for scaffolding, gas cutting and vehicles.	0.883

2.2 Correlation

According to Bryman and Cramer (1990), a correlation value lower than 0.39 was considered as a low value for analysis. If the correlation among the fifteen underlying variables lies between 0.40 and 0.90, they are considered good for analysis [5]. So, the variables were used to measure the safety performance. Table-3 shows the lists of correlation analysis results for management support and workers' responsibilities, prevention of fire and excavation hazards, proper materials handling and storage methods, fall prevention and protection, precaution activities for formwork and concreting, prevention of electrical hazards, standard methods and maintenance of confined space, scaffolding and working platform standards, hazard prevention from welding and grinding, hazard prevention from hand tools and power tools, grinding machine and operator standards, motor vehicle rules, drilling machine and operator standards, hazard prevention methods for scaffolding, gas cutting and vehicles and precaution and maintenance of woodworking machines. There was also a positive correlation between them; moreover all coefficients were above 0.41, so it was satisfactory for analysis.

Table 3. Correlation matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	1	-	--	-	-	-	-	-	-	-	-	-	-	-	-
2	0.57	1	-	-	-	-	-	-	-	-	-	-	-	-	-
3	0.68	0.89	1	-	-	-	-	-	-	-	-	-	-	-	-
4	0.42	0.58	0.61	1	-	-	-	-	-	-	-	-	-	-	-
5	0.59	0.47	0.85	0.79	1	-	-	-	-	-	-	-	-	-	-
6	0.67	0.49	0.48	0.44	0.66	1	-	-	-	-	-	-	-	-	-
7	0.72	0.51	0.42	0.51	0.48	0.75	1	-	-	-	-	-	-	-	-
8	0.46	0.50	0.51	0.43	0.65	0.49	0.69	1	-	-	-	-	-	-	-
9	0.76	0.54	0.41	0.64	0.42	0.85	0.62	0.55	1	-	-	-	-	-	-
10	0.69	0.66	0.84	0.54	0.58	0.79	0.49	0.61	0.64	1	-	-	-	-	-
11	0.45	0.63	0.72	0.48	0.78	0.67	0.48	0.54	0.49	0.55	1	-	-	-	-
12	0.46	0.61	0.57	0.67	0.53	0.46	0.52	0.89	0.47	0.67	0.76	1	-	-	-
13	0.82	0.89	0.45	0.59	0.46	0.76	0.65	0.59	0.84	0.55	0.42	0.56	1	-	-
14	0.84	0.68	0.64	0.41	0.67	0.84	0.46	0.55	0.81	0.63	0.47	0.52	0.83	1	-
15	0.61	0.76	0.82	0.51	0.45	0.56	0.62	0.71	0.55	0.52	0.45	0.5	0.45	0.54	1

2.3 Linear Regression Model for Impact of Safety in Construction

Regression was a technique used to predict the value of a dependent variable using one or more independent variables. The coefficients for the model were shown in Table-4. The result of the regression model shows that the fifteen factors were the strongest predictors in showing the cause and effect relationship with the dependent variable "Impact of Safety". The regression model summarized that the R value was 0.939, R square value was 0.882, Adjusted R-square value was 0.783 and standard error of the estimate was 0.544.

Table 4. Results of multiple linear regression model

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-0.78	0.45		-1.73	0.10
	Factor-1	-0.57	0.27	-0.55	-2.10	0.05
	Factor-2	0.20	0.17	0.21	1.17	0.26
	Factor-3	0.09	0.11	0.08	0.77	0.45
	Factor-4	0.12	0.16	0.12	0.78	0.45
	Factor-5	0.17	0.12	0.17	1.38	0.18
	Factor-6	0.18	0.24	0.17	0.77	0.45
	Factor-7	0.27	0.13	0.29	2.04	0.06
	Factor-8	0.10	0.13	0.10	0.79	0.44
	Factor-9	0.18	0.22	0.18	0.79	0.44
	Factor-10	-0.22	0.18	-0.21	-1.20	0.25
	Factor-11	0.25	0.18	0.25	1.38	0.18
	Factor-12	0.21	0.15	0.23	1.41	0.17
	Factor-13	0.18	0.28	0.16	0.63	0.54
	Factor-14	-0.22	0.44	-0.23	-0.51	0.61
	Factor-15	0.60	0.37	0.42	1.60	0.13
a. Dependent Variable: Impact of Safety						

Impact of Safety = -0.78(Constant)-0.57(Management support and workers' responsibilities) +0.20(Prevention of fire and excavation hazards) +0 .09(Proper materials handling and storage methods) +0.12 (Fall prevention and protection) +0.17 (Precaution activities for formwork and concreting) +0.18 (Prevention of electrical hazards) +0.27 (Standard methods and maintenance of confined space) +0.10 (Scaffolding and working platform standards) +0.18 (Hazard prevention from welding and grinding) -0.22 (Hazard prevention from hand tools and power tools) +0.25 (Grinding machine and operator standards) +0.21 (Motor vehicle rules) +0.18(Drilling machine and operator standards) -0.22 (Hazard prevention methods for scaffolding, gas cutting and vehicles) +0.60 (Precaution and maintenance of woodworking machines).

2.4 Validation

For the purpose of validation, the data relating to the results of the extracted factors (i.e., critical factors) were taken. The data were compared with several published literature on this topic. Towards accomplishing the above objective were compared from the research papers published by Hinze (1992), Sawacha (1999), Abdel Hamid (2000), Langford (2000), Fang (2004), Choudary (2008), Cheng (2011), Zubair (2013), and Terwel (2014) [6-14] . Source data used for validation is presented in Table-5. It can be seen that the frameworks have fifteen critical success factors Table-1.

Table 5. Comparative analysis of various safety management frameworks

Safety Frame works	CRITICAL SUCCESS FACTORS														
	F-1	F-2	F-3	F-4	F-5	F-6	F-7	F-8	F-9	F-10	F-11	F-12	F-13	F-14	F-15
Hinze (1992)	S	S	S	S	S							S			
Sawacha (1999)	S					S	S				S		S		
Abdel Hamid (2000)	S			S						S			S	S	S
Langford (2000)	S					S			S	S	S				S
Fang (2004)	S			S		S	S		S	S			S	S	
Choudary (2008)	S						S			S			S		
Cheng (2011)	S		S	S	S			S	S		S				
Zubair (2013)	S	S	S	S			S			S		S	S		S
Terwel (2014)	S		S			S		S	S			S			

3. CONCLUSION

After conducting the analysis, the R-square has been obtained as 0.882. The above observation clearly indicates the validity of the proposed regression equation for the purpose of estimating the performance of safety in construction industry.

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