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Risk Assessment and Management in Building Construction Project

Deepak Tiwari[1], Manoj Sharma[2], Dr. Ashutosh Shankar Trivedi[3]

[1]*Research Scholar M.Tech (Construction Technology & Management),Institute of Professional Studies (IPS), Gwalior Madhya Pradesh, India*
[2]*HOD of Civil Engineering Department, Institute of Professional Studies (IPS), Gwalior Madhya Pradesh, India.*
[3]*Professor of Civil Engineering Department, Institute of Professional Studies (IPS), Gwalior Madhya Pradesh, India*

ABSTRACT: Risk management in construction projects has been apparent as very imperative processes of all management to realize goals such as cost, time, safety, quality, and ecological sustainability. The projects have become a multifaceted effort with the construction project and management a good example of an area where the existence of the project is an extremely complex network of actors. By adopting risk assessment, savings' potentials can be realized in construction projects. For this reason, consideration of the risk management process is worthwhile for project managers as well as real estate developers. The impression of the risk management system does not propose the development of the search-oriented existence of the projection and permeability of a material, process, and projector processes. To analyze the levels of different risk factors in the construction industry, questionnaires were used to collect data. Based on a global assessment of the probability of occurrence of various risks and their impact on project objectives, this document identifies sixty-four major risk factors. This research has found that these risks are mainly related to (ranking) contractors, project manager, architect and designers, owner, engineer with some other government agencies, subcontractors/suppliers, and external issues. Among them, it is recognized that "Risk" affects all project destinations at the most while Increase of materials price, Project delay, Teamwork, Increase of labor costs defective design and Increase of materials price are also important risk factors. This research also found that risks are spread throughout the life cycle of the project and many risks occur in more than one phase, with the construction phase being the most dangerous phase followed by the feasibility phase. We conclude that customers, designers, and government agencies should work cooperatively from the feasibility step forward to discuss potential risks in time. In addition, contractors and subcontractors with solid construction and management skills should be used quickly to make good preparation for safe, efficient, and constructive construction activities. The aim of this research is to show and assess the risks and uncertainties in the current construction sector through a vast survey of the literature. It is also intended to serve as a basis for future studies to develop a risk assessment and management structure to be adopted by potential investors, developers and entrepreneurs from developing countries.

Keywords: risk, risk management, risk analysis, construction projects.

I. INRODUCTION

The risk is defined as an uncertainty of the result, whether a helpful opportunity or negative hazard, of actions and dealings. The risk has to be assessed in the high opinion of the combination of the possibility of something incident, and the impact which arises if it does actually occur. Risk assessment and management includes identifying and assessing risks (the "inherent risks") and then responding to them. Project management is the science which applies skills, tools, and techniques to fulfill project behavior in a way that the opportunity and requirements of stakeholders are fulfilled or exceeded. Project risk assessment and management is an essential part of the process which aims at identifying the possible risks related to a project and respond to those risks. It includes activities which aim to maximize the consequences related with positive events and to minimize the impact of negative events. It is believed generally that risk in an environment is an option rather than fate, and the inherent improbability in the plans can affect the desired conclusion of achieving project and business goals. The risk is present in all the activities of a project; it is only the quantity which varies from one activity to another. Risks and uncertainties are more inherent in the construction industry. The evolution of planning, executing and maintaining all project activities is difficult and time consuming. The complete process requires a countless of people with various skill sets and the management of a vast amount of difficult and interconnected activities. The situation is made even more complex by many external factors. The track record of the

construction industry is very poor in terms of coping with risks, resulting in the failure of many projects to meet time schedules, targets of budget and sometimes even the scope of work Consuming events. The structure must be designed in accordance with relevant codes and standards, culminating in working drawings and specifications that explain the work in enough details for its accomplishment in the field. The construction projects have been separated into four main categories: residential construction, building construction, heavy engineering construction and industrial construction.

II. PAST STUDIES ON RISK MANAGEMENT AND ASSESSMENT

Various researchers have done study on risk assessment and management in the detailed below:-

- **Akintola S Akintoye and Malcolm J MacLeod (1997) -** Studied the construction industry's opinion of risk related with the activities and the coverage to which the construction industry uses risk analysis and management techniques with the help of a questionnaire survey of contractors and project managers. The authors fulfilled that risk management is very essential to all construction activities to minimizing losses and attractive profitability. Construction risk is generally supposed as events that influence project objectives of time, cost, and quality. Risk analysis and management in construction depend mainly on conclusion and experience. Formal risk analysis and management techniques are seldom used due to a lack of Knowledge's and to doubts on the appropriateness of these techniques for construction industry activities.

- **Alfredo del Cano, P.E, M.ASCE, and M.F de la Cruz, P.E. (2002)** - This object presents a general assignment risk management process that has been individual for construction projects from the point of view of the owner and the consultant who may be supporting the owner. The development could also be modified to the needs of other project participant, and many points referred to in the article can be directly applied to them. Any project risk management process must be modified to the particular circumstances of the project and of the organization undertaking it. Then the application to a real project is summarized. As a final validation, a Delphi study has been developed to assess the project risk management methodology explained here, and the results are accessible.

- **Hun –Ho C.H.N Cho and J.W.Seo (2004**) – Accessible a risk conclusion methodology for rebel construction projects. A decorous system and associated tool were increasing to assess and deal with the risks occupied in underground construction. The optional risk evaluation method is collected of four steps of identifying, analyzing, evaluating and managing the risk measurement methodology is the risk analysis software. The risk analysis software is built upon a doubtfulness model based on a fuzzy concept other tools developed in this study include the survey sheets for collecting risk associated information and the element check sheets for risk classification and analysis.

- **Wenzhe Tang, Maoshan Qiang, Colin F. Duffield, et al. (2007)** – In the discussed paper, an empirical Chinese industry survey on the importance of project risks, application of risk management techniques, status of the risk management system, and the barriers to risk management, which were alleged by the main project participants. The study reveals that most project risks are common of distress to project participants; the industry has shifted from risk transfer to risk decrease, current risk management systems are inadequate to manage project risks and lack of joint risk management mechanisms is the key barrier to passable risk management.

- **Dariusz Skorupka (2008)** - This paper presents an analysis of the Polish construction market with examples of project risk assessment taking into reflection one of the biggest markets in Central Europe. The writer has conducted research in identification and quantification of construction risks based on the Polish market that has developed considerably since joining the European Union. The risk analysis consists of verbal and quantitative description. The specification of risk indicators is directly connected to the Polish construction market and the writer has provided examples for applying the risk evaluation process in construction projects.

- **Yasser Abdelghany, A.Samer Ezeidin (2010)-** This document focuses on the analysis of the different ICJV risk environments. The related risks are analyzed in the country, operating, sociopolitical and economic risks and then recognized and grouped into internal, project specific, schedules, and major contract clause risks. A simplified decision support system (RAMSCO) is proposed that breaks down project risk into discrete phase systematically.

- **Hong-bo Zhou, S.E. M.ASCE, and Hui Zhang,(2011) –** Risk Assessment and Management in Building Construction Project for deep foundation pit engineering are essential for quality and safety in civil engineering owing to the needs of urban construction projects. However, doubt and uncertainty continue to challenge studies of the probability and consequences of risks in this area. Therefore, a fuzzy comprehensive evaluation method based on Bayesian networks (BNs) is potential to assess the risks of deep foundation pit construction. This methodology has five main parts: modeling of BNs, determination of occurrence probabilities of risk events, assessment of consequences, calculations of risk value and membership degree of risk rating, and definitions of

risk acceptance criteria. The probability of every risk event is calculated by using deductive BN techniques. Then the result of each event is calculated by using fuzzy analysis (i.e., statistical consequence distributions and weight coefficients of risk events are determined through the database). A fuzzy comprehensive estimation model with a membership function is also presented, and each risk event in the deep foundation pit construction his rating. In addition, risk precautions and control measures are suggested on the basis of the risk assessment results and are applied to risk management in deep foundation pit construction.

- **Hariharan Subramanyan, Priyadarshi H. Sawant and Vandana Bhatt (2012) –** The focus of the present research is to identify factors that manipulate the smooth completion of a project and develop a risk assessment model. Student's t-test, a significance test, has been applied to know the significance of test findings on the general construction industry. The risk response policy recommended in this paper will be useful in justifying the adverse effects of risk in project completion in the Indian construction industry.

- **Patel Ankit Mahendra et al., (2013)-** Present important impact on construction projects in conditions of its main objectives. Construction projects which are convoluted in nature, ambiguity, and risks in the same can develop from different sources. The record of the construction industry is not acceptable in terms of coming up with risks in projects. Risk management is a method which consists of identification of risks, an assessment with qualitatively and quantitatively, response with a suitable method for handling risks, and then controls the risks by monitoring. This study proposes to apply the risk management technique which includes well - documented procedures for the one-stop solution all types of hazards most likely to occur during any construction project Lifecycle.

- **Renuka et al., (2014)-** Explain infrastructure development will increase the growth of countries economy and generates a large number of job opportunities. Hence those projects involve a large amount of investment to carry out. In view of that, if any sort of consumption (either time, resources etc) occurs that would lead to the massive financial losses. These losses occur due to various risks associated with such extra-large projects. Consequently, these risks play a crucial role in the completion of the project within the time schedule and planned budget. In this connection, this study mainly discusses the critical risk factors and its assessment techniques through the comparative study of various international construction projects. About 50 applicable articles published over the last 25 years have been reviewed. The review resulted that a simple methodical tool will be developed for each project task to assess the risk easily and rapidly, which will hearten the practitioners to do the risk analysis in their project.

- **Dr. Firas Khairy Jaber (2015)- This** study aims to identify and evaluate key risk factors and their frequency and severity and then their impact on different types of construction projects in Iraq. A questionnaire survey was conducted and a total of sixty-five critical factors were identified and categorized into eight groups. These are 1. Financial risk, 2. Legal risk, 3. Management risk, 4. Market risk, 5. Political risk, 6. Technical risk, 7. Environmental & natural risk, and 8. Social risk. Seventy-five respondents participated in the survey representing clients, consultants, and contractors. The results are presented on the basis of their frequency, severity, and importance.

- **V.Sathishkumar; P.N.Raghunath et.al (31 January 2015)-** The objective of this study is to identify the risks that are caused by various construction projects and calculating the risks severity of personal and property. Thorough literature review factors are collected. The questionnaire ready for the pilot examination was formulated based on the applicable literature in the area of Risk Assessment and Management in Building Construction Project. The data were analyzed by Descriptive Statistics and ANOVA, both Descriptive analysis (Mean, Standard Deviation), Differential analysis (t-test and ANOVA) test has been done all the aspects before making a change in top management will clear the negative impact in work progress of construction..

- **Closure:** Most of the studies as mentioned above are carried out in developed countries. Very few studies are carried out in India. Also, most of the studies are with reference to the construction industry in general. Hence, the necessity arises for present study which is specific to building construction industry.

III. DATA ANALYSIS METHOD

In all questionnaires was mailed and personally contacted to fifty organizations/ companies/ personal out of which twenty-six has responded. The rate of response is 51%, which may be considered to be fair operational to the pre-occupation of the senior person. To referee the comparative significance of risks, earlier literature lessons suggests establishing a risk significance index by calculating a significance score for every risk. For calculating the significance score, multiply the probability of occurrence by the degree of impact. The significance score for each risk assessed by each respondent can be obtained during the model.

$$S_j^i = \alpha_j^i \beta_j^i$$

Where S_j^i=significance score assessed by respondent j for risk i.; α_j^i=occurrence of risk i, assessed by respondent j; & β_j^i = degree of impact of risk i, assessed by respondent j.

By averaging scores from all the responses, it is possible to get an average significance score for each risk, and this average score is called the **risk index score** and is used for ranking the risks. The model for the calculation of risk index score can be defined as:

$$Rs^i = \frac{\Sigma_j^T = S_j^i}{T}$$

Where Rs^i = index score for risk i; S_j^i= significance score assessed by responding j for risk i ; And T = total number of responses.

To calculate S_j^i The five-point scales for α and β, this will be converted into numerical (Likert scale) scales as shown in Table 1.

Tables 1: Numerical conversion for the rating attributes

α , β	
Ratting Attributes	**Numerical Conversion**
0	0.0
1	0.2
2	0.4
3	0.6
4	0.8
5	1.0

After obtaining index score for each risk factor, standard deviation and coefficient of variation of each risk factor are also determined. Subsequently, a ranking of risk factors is done based on Index score.

IV.RESULT AND DISCUSSION

Analysis of Data:

Total twenty-Six respondents have filled up the questionnaire. Subsequently, for analysis of responses following steps are followed:

i. Responses were converted into numerical values based on their rating attributes. A sample is shown in Table 2.
ii. After that mean of numerical values of all Twenty Six responses is determined.
iii. Then, Standard deviation and coefficient of variation for each risk factor are determined.
iv. Afterwards, Index Score for each risk is calculated by using RI Method.

Table 2: Conversion of response into numerical values (Questionnaire 1)

Types of Risks	**Probability level of the risk Occurrences (α)**		**Degree of impact or the level of loss if the Risk occurs (β)**		**Significance Score**
	Rating attribute in Lickert Scale	**Numerical Value**	**` Rating attribute in Lickert Scale**	**Numerical Value**	
Financial Risk					
Loss due to Fluctuation of interest rate	1	0.2	0	0	0
Low credibility of shareholder and lender	4	0.8	4	0.8	0.64
Change in bank formalities and lenders	1	0.2	0	0	0
Loss due to rise in fuel prices	2	0.4	1	0.2	0.08
Insurances risk	0	0	0	0	0

Default by subcontractors	3	0.6	3	0.6	0.36
Inadequate Cash Flow	4	0.8	4	0.8	0.64
Inflation, Availability of foreign currency & Exchange Rate change	1	0.2	2	0.4	0.08
Taxes and burdens	3	0.6	3	0.6	0.36
Inexperience when pricing tenders	4	0.8	5	1.0	0.8
Legal Risk					
Breach of contract by project partner	2	0.4	1	0.2	0.08
Lack of enforcement of legal judgment	3	0.6	3	0.6	0.36
Improper verification of contract document	4	0.8	4	0.8	0.64
Uncertainty and unfairness of court justice	1	0.2	2	0.4	0.08
Management Risk					
Change of top management	4	0.8	4	0.8	0.64
No past experience in similar project	3	0.6	3	0.6	0.36
Short tender time	1	0.2	2	0.4	0.08
Internal management problem	3	0.6	3	0.6	0.36
Improper project feasibility study	4	0.8	4	0.8	0.64
Poor relation and disputes with partner	5	1.0	5	1.0	1
Team work	5	1.0	5	1.0	1
Time constraint	3	0.6	3	0.6	0.36
Project delay	4	0.8	3	0.6	0.48
Political Risk					
Cost increase due to changes of Govt policies	4	0.8	4	0.8	0.64
Loss incurred due to political changes	4	0.8	5	1.0	0.8
Loss due to bureaucracy for late approvals	5	1.0	5	1.0	1
War and Civil disorders	5	1.0	5	1.0	1
Problems with Licenses	5	1.0	5	1.0	1
Technical Risk					
Accidents on site	3	0.6	3	0.6	0.36
Design changes	3	0.6	3	0.6	0.36
Equipment failure	3	0.6	3	0.6	0.36
Errors in design drawings	3	0.6	3	0.6	0.36
High degree of difficulty in construction	4	0.8	4	0.8	0.64
Incompetence of transportation facilities	3	0.6	3	0.6	0.36
Industrial disputes	4	0.8	4	0.8	0.64
Materials shortage	3	0.6	3	0.6	0.36
Obsoleteness of building equipment	3	0.6	3	0.6	0.36
poor quality of procured materials	3	0.6	3	0.6	0.36
Unknown site physical conditions	3	0.6	3	0.6	0.36

Following government standards and codes	3	0.6	3	0.6	0.36
Wastage of materials by workers	2	0.4	3	0.6	0.24
Site distance from urban area	4	0.8	4	0.8	0.64
Surplus materials handling	1	0.2	2	0.4	0.08
Architect Vs Structural Engineer dispute	3	0.6	3	0.6	0.36
Shortage of skillful workers	4	0.8	4	0.8	0.64
Insufficient Detailing	4	0.8	4	0.8	0.64
Environmental Risk & Natural Risk					
Any adverse impact on project due to climatic conditions	4	0.8	4	0.8	0.64
Any impact on the environment due to the project	4	0.8	4	0.8	0.64
Earthquake	5	1.0	5	1.0	1.0
Fire	5	1.0	5	1.0	1.0
Collapse and Land Slide	5	1.0	5	1.0	1.0
Inclement Weather	5	1.0	5	1.0	1.0
Floods	3	0.6	3	0.6	0.36
Social Risk					
Resettlement and rehabilitation of people	3	0.6	3	0.6	0.36
Problems due to adjacent or nearby projects	4	0.8	4	0.8	0.64
Local people support for the project	2	0.4	2	0.4	0.16

Above calculation is shown in table 3.

Table 3: RISK ANALYSIS

S.N	INTERVIEW NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	Total	MEAN(m)	SD(s)	C.O V
A	**Financial Risk**																														
1	Loss due to Fluctuation of interest rate	0	0.04	0.48	0.04	0.04	0.2	0	0.16	0.16	0.12	0.04	0.36	0.08	0.24	0.16	0.16	0.36	0.36	0.08	0.36	0.36	0.04	0.16	0.16	0.24	0.16	**4.56**	**0.1754**	**0.1313**	**0.7487**
2	Low credibility of shareholder and lender	0.64	0	0.24	1	0.64	0.08	0	0.36	0.08	0.24	0.36	0.64	0.24	0.36	0	0.12	0.24	1	0.24	0.8	0.8	0.36	0.04	0.04	0.s04	0.16	**8.72**	**0.3354**	**0.3069**	**0.9150**
3	Change in bank formal	0	0	0.32	0.04	0.08	0.36	0	0.36	0.08	0.04	0.04	0.36	0.08	0.16	0	0.16	0.04	0.04	0.64	0.24	0.24	0.08	0.04	0.04	0	0.12	**3.56**	**0.1369**	**0.1558**	**1.1377**

	ities and lenders																													
4	Loss due to rise in fuel prices	0.08	0.04	0.6	0.64	0.8	0.64	0.36	0.64	0.16	0.04	0.36	0.48	0.16	0.24	0.64	0.16	0.24	1	0.64	0.16	0.16	0.36	0.16	0.04	0.04	0.64	**9.48**	**0.3646**	**0.2705**	**0.7418**
5	Insurances risk	0	0.04	0.32	0.36	0.48	0.36	0	0.36	0	0	0.16	0.64	0	0.16	0.48	0.08	0.08	0	0.16	0.36	0.48	0.36	0.36	0.04	0	0.6	**5.88**	**0.2262**	**0.2060**	**0.9111**
6	Default by subcontractors	0.36	0.36	0.48	0.64	0.36	0.8	0	0.64	0.24	0.04	0.36	0.48	0.36	0.64	0.48	0.16	0.16	0.36	0.36	0	0	0.36	0.48	0.64	0	0.6	**9.36**	**0.3600**	**0.2268**	**0.6300**
7	Inadequate Cash Flow	0.64	0.36	0.48	0.64	0.8	0.48	0.04	0.64	0.16	0	0.48	0.48	0.64	0.64	0.48	0.36	0.04	1	0.24	0.4	0.24	0.64	0.36	0.36	0.04	0.8	**11.44**	**0.4400**	**0.2542**	**0.5777**
8	Inflation, Availability of foreign currency & Exchange Rate	0.08	0	0.24	0.36	0	0.24	0.64	0.64	0.04	0	0.04	0.64	0.36	0.36	0.64	0.04	0	0.64	0.04	0.32	0.32	0.36	0.16	0.16	0.2	0.6	**7.12**	**0.2738**	**0.2321**	**0.8476**

	change																													
9	Taxes and burdens	0.36	0.8	0.6	0.64	0.16	0.8	0	0.64	0.04	0.64	0.36	0.64	0.04	0.64	0.64	0.16	0.64	1	0.64	0.16	0.6	0.16	0.64	0.64	0	0.8	**12.44**	**0.4785**	**0.2875**	**0.6008**
10	Inexperience when pricing tenders	0.8	0	0.64	0.64	0.64	1	0.64	0.64	0.24	0.16	0.36	0.36	0.64	0.16	0.64	0.24	0.36	1	0.64		0.64	0.64	0.64	0.64	0	0.32	**13.16**	**0.5062**	**0.2618**	**0.5173**
B	**Legal Risk**																													
1	Breach of contract by project partner	0.08	0.04	0.32	1	0.36	0.64	0.64	0.64	0.36	0	0.48	0.36	1	0.64	0.16	0.48	0.04	1	0.24	0.8	1	0.64	0.16	0.36	0.4	0.24	**12.08**	**0.4646**	**0.3097**	**0.6665**
2	Lack of enforcement of legal judgment	0.36	0.04	0.32	0.64	0.16	0.36	0.64	0.64	0	0	0.36	0.36	0.36	0.48	0.36	0.48	0	0	0.24	0.24	0.32	0.36	0.48	0.36	0	0	**7.56**	**0.2908**	**0.2062**	**0.7093**
3	Improper verification of contra	0.64	0.04	0.36	0.36	0.64	0.36	0.64	0.64	0.04	0	0	0.64	0.36	0.36	0.64	0.24	0.04	1	0.36	0.36	0.24	0.64	0.04	0.16	1	0	**9.8**	**0.3769**	**0.2927**	**0.7766**

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4	Uncertainty and unfairness of court justice	0.08	0.04	0.6	0.36	1	0.16	0	0.08	0	0.12	0.04	0.48	0.36	0.36	0.16	0.64	0.16	1	0.36	0	0	1	0.36	0.36	0	0	**7.72**	**0.2969**	**0.3158**	**1.0635**
C	**Management Risk**																													
1	Change of top management	0.64	0.36	0	1	0.36	0.36	0.16	0.64	0.04	0.04	0.16	0.8	0.08	0.24	0.24	0.36	0.16	0.04	0.36	0.36	1	0.36	0.64	0.64	0.04	0.08	**9.16**	**0.3523**	**0.2889**	**0.8199**
2	No past experience in similar project	0.36	0.64	0.36	0.64	0.16	0.64	0.64	0.36	0.16	0.64	0.36	0.48	0.24	0.24	0.64	0.36	0.64	0.36	0.64	0.36	0.16	0.64	0.64	0.24	0.36	0.36	0.04	0.48	**10.84**	**0.4169**	**0.1877**	**0.4501**
3	Short tender time	0.08	0	0	0.16	0.16	0.64	1	0.36	0.16	0.04	0.64	0.36	0.24	0.36	0.64	0.64	0.08	0.16	0.04	0.36	0.64	0.64	0.36	0.36	0.04	0.08	**8.24**	**0.3169**	**0.2637**	**0.8320**
4	Internal management	0.36	0.16	0.48	0.36	0.64	0.36	0.04	0.36	0.64	0.36	0.16	0.48	0.64	0.48	0.48	0.16	0.36	1	0.16	0.04	0.36	0.36	0.64	0.64	0.04	0.04	**9.8**	**0.3769**	**0.2338**	**0.6203**

	problem																													
5	Improper project feasibility study	0.64	0	0.32	0.64	0.36	0.64	0.64	0.36	0.64	0.64	0.16	0.48	0.48	0.64	0.64	0.64	1	0.36	0.16	0.36	0.16	0.64	0.64	0.04	0.04	**11.8**	**0.4538**	**0.2435**	**0.5366**
6	Poor relation and disputes with partner	1	0.04	0.48	0.2	0.36	1	0.16	0.16	0.36	0	0.36	0.64	0.48	0.64	0.64	0.36	0.04	0.64	0.04	0.16	0.24	1	0.16	0.04	0.04	**9.88**	**0.3800**	**0.3089**	**0.8129**
7	Team work	1	1	0.48	0.16	0.36	0.36	0.64	0.36	0.64	0.36	0.36	0.64	0.24	0.64	0.64	0.8	0.64	1	0.36	0.36	0.8	0.64	0.64	0.16	0.04	0.04	**13.36**	**0.5138**	**0.2733**	**0.5318**
8	Time constraint	0.36	0.8	0.24	0.16	0.64	0.36	0.64	0.16	1	1	0.36	0.48	0.16	0.48	0.64	0.36	1	0.16	0.64	1.6	0.24	0.48	0.36	0.16	0.04	0.04	**12.56**	**0.4831**	**0.3593**	**0.7438**
9	Project delay	0.48	0.64	0.36	0.64	1	1	0.64	0.36	1	1	0.36	0.64	0.36	0.64	0.64	1	1	0.64	0.64	0.48	0.64	0.64	0.16	0.04	0.04	**15.68**	**0.6031**	**0.2813**	**0.4664**
D	**Market Risk**																													
1	Competition from other	0.48	0.04	0.32	0.36	0.36	0.36	0.36	0.36	0.24	0.04	0.36	0.36	0.24	0.36	0.64	0.04	0.08	0.36	0.24	0.24	0.48	0.36	0.16	0.16	0.64	1	**8.64**	**0.3323**	**0.2057**	**0.6190**

	similar projects																													
2	Fall short of expected income from project	0.24	0.04	0.36	0.36	1	0.36	0.16	0.36	0.16	0.04	0.16	0.36	0.36	0.36	0.64	0.16	0.08	1	0.16	0.16	0.4	0.48	0.36	0.36	0.16	1	**9.28**	**0.3569**	**0.2704**	**0.7575**
3	Increase of resettlement costs	0.24	0.04	0.08	0.36	0.36	0.64	0	0.16	0.08	0.16	0.16	0.36	0.24	0.36	0.64	0.48	0.24	0.36	0.64	0.16	0.2	0.64	0.16	0.16	0.36	1	**8.28**	**0.3185**	**0.2312**	**0.7261**
4	Increase of labour costs	0.04	0.04	0.48	0.64	0.16	1	0.04	0.16	0.36	0.04	0.36	0.36	0.24	0.64	0.64	0.36	0.04	0.36	0.64	0.16	0	0.36	0.36	0.24	1	1	**9.72**	**0.5116**	**0.3001**	**0.5867**
5	Increase of materials price	0.04	0.04	0.64	0.64	0.48	1	0	0.04	0.48	0.64	0.36	0.36	0.24	0.64	0.64	0.48	0.64	1	0.64	0.36	0.32	0.48	6.4	0.48	1	1	**19.04**	**0.7323**	**1.1700**	**1.5977**
6	Inadequate forecast about market demand	0.8	0.04	0.36	0.64	1	0.16	0.16	0.04	0.08	0.4	0.16	0.48	0.48	0.64	0.64	0.36	0.36	0.64	0.48	0.64	0.4	0.64	0.64	0.48	0.64	1	**12.36**	**0.4754**	**0.2600**	**0.5470**

7	Local protectionism	0.64	0.04	0.48	0.36	0.36	0.16	0	0.04	0.64	0.48	0.04	0.36	0.36	0.36	0.64	0.36	0.08	0.16	0.24	0.08	0.32	0.64	0.04	0.04	0.16	1	**8.08**	**0.3108**	**0.2499**	**0.8041**
8	Unfairness in tendering	0.64	0.04	0.48	0.36	0.64	0.36	1	0.04	0.16	0.04	0.16	0.36	0.16	0.64	0.64	0.64	0.04	1	0.64	0.16	0.4	0.64	0.64	0.48	0	1	**11.36**	**0.4369**	**0.3058**	**0.7000**
E	**Political Risk**																														
1	Cost increase due to changes of Govt policies	0.64	0.04	0.48	0.64	0.36	1	0.16	0.16	0.16	0.36	0.04	0.36	0.16	0.48	0.24	0.36	0.36	1	0.36	0.64	0.64	0.36	0.36	0.36	0.24	0.8	**10.76**	**0.4138**	**0.2537**	**0.6130**
2	Loss incurred due to political changes	0.8	0.04	0.16	0.36	0.36	1	0.16	0.16	0.16	0	0.36	0.36	0.04	0.36	0.04	0.16	0	0.16	0.36	0.04	0.36	0.36	0.16	0.16	0.16	0.36	**6.64**	**0.2554**	**0.2277**	**0.8914**
3	Loss due to bureaucracy	1	0.04	0.48	1	0.36	0.64	0.16	0.16	0.36	0.24	0.04	0.64	0.16	0.64	0.16	0.64	0.16	0.36	0.36	0.16	0.48	0.36	0.64	0.48	0.64	1	**11.36**	**0.4369**	**0.2806**	**0.6423**

	for late approvals																													
4	War and Civil disorders	1	0.04	0.12	0.36	1	0.64	0	0.04	0	0	0.36	0.64	0.64	0.64	0.04	0.04	0	1	0.04	0.64	0.32	0.04	0.64	0.48	0.64	0.04	**9.4**	**0.3615**	**0.3445**	**0.9530**
5	Problems with Licenses	1	0.04	0.48	0.64	0.36	0.16	0	0.04	0	0.04	0.36	0.36	0.64	0.36	0.36	0.8	0.04	0.36	0.04	0.36	0.6	0.04	0.36	0.24	1	0.48	**9.16**	**0.3523**	**0.2897**	**0.8224**
F	**Technical Risk**																														
1	Accidents on site	0.36	0.04	0.24	0.16	0.04	0.64	1	0	0.16	0	0.16	0	0.24	0.24	0.64	0.48	0.04	0.36	0.04	0.04	1	0.04	1	1	0.36	1	**9.28**	**0.3569**	**0.3608**	**1.0110**
2	Design changes	0.36	0.04	0.16	0.04	0.04	0.64	1	0.08	0.16	0.04	0.36	0	0.08	0.36	0.64	0.48	0.04	0.36	0.04	0.36	0.48	0.04	0.36	0.36	0.36	0.36	**7.24**	**0.2785**	**0.2406**	**0.8642**
3	Equipment failure	0.36	0.36	0.48	0.12	0.04	0.36	0.64	0.16	0	0	0.36	0.64	0.24	0.24	0.48	0.64	0.04	0.36	0.04	0.36	0.36	0.04	0.36	0.36	0.36	0.36	**7.76**	**0.2985**	**0.1922**	**0.6441**
4	Errors in design	0.3	0.3	0.2	0.1	0.3	0.3	0.64	0.0	0.0	0	0.1	0.4	0.0	0.3	0.4	0.3	0.0	1	0.0	0.1	0.4	0.0	0.1	0.1	0.36	0.1	**7.12**	**0.2738**	**0.2226**	**0.8130**

	drawings	6	6	4	6	6	6		8	4		6	8	8	6	8	6	4		4	6	8	4	6	6		6			
5	High degree of difficulty in construction	0.64	0.04	0.24	0.32	0.64	0.64	0	0.36	0.16	0.04	0.16	0.48	0.08	0.48	0.48	0.36	0	0.04	0.24	0.36	0.36	0.24	0.36	0.36	0.64	0.36	**8.08**	**0.3108**	**0.2022**	**0.6508**
6	Incompetence of transportation facilities	0.36	0	0.32	0.16	0.36	0.36	0.16	0.16	0.04	0	0.36	0.36	0.24	0.36	0.48	0.32	0	0.04	0.36	0.04	0.48	0.36	0.16	0.16	0.36	0.16	**6.16**	**0.2369**	**0.1505**	**0.6350**
7	Industrial disputes	0.64	0	0.12	0.16	0.04	0.64	0	0.16	0	0	0.16	0.36	0.24	0.24	0.48	0.36	0.04	0.16	0.36	0.08	0.36	0.36	0.36	0.36	0.64	0.36	**6.68**	**0.2569**	**0.1982**	**0.7714**
8	Materials shortage	0.36	0.16	0.24	0.36	0.16	0.16	0	0.16	0.04	0.24	0.36	0.48	0.36	0.24	0.48	0.6	0.04	1	0.16	0.24	0.32	0.16	0.64	0.64	0.36	0.64	**8.6**	**0.3308**	**0.2272**	**0.6870**
9	Obsoleteness of building equipment	0.36	0.16	0.16	0.36	0.16	0.36	0	0.36	0.04	0.08	0.36	0.36	0.08	0.24	0.64	0.16	0.16	0.64	0	0.04	0.36	0.04	0.64	0.64	0.36	0.64	**7.4**	**0.2846**	**0.2132**	**0.7491**

10	poor quality of procured materials	0.36	0.16	0.16	0.36	0.16	0.36	0	0.16	0	0.08	0.16	0.48	0.24	0.64	0.64	0.4	0.36	0.64	0.36	0.36	0.64	0.36	0.64	0.64	0.36	0.64	**9.36**	**0.3600**	**0.2073**	**0.5757**
11	Unknown site physical conditions	0.36	0.16	0.12	0.64	0.64	0.64	0.64	0.16	0.04	0	0.04	0.36	0.12	0.36	0	0.36	0.16	1	0.04	0.16	0.48	0.04	0.36	0.36	0.36	0.36	**7.96**	**0.3062**	**0.2486**	**0.8118**
12	Following government standards and codes	0.36	0.16	0.32	0.64	0.36	0.36	0.36	0.04	0.04	0.04	0.16	0.36	0.08	0.36	0.16	0.04	0.04	0.16	0.04	0.04	0.48	0.04	0.36	0.36	0.36	0.36	**6.08**	**0.2338**	**0.1685**	**0.7206**
13	Wastage of materials by workers	0.24	0.16	0.16	0.36	0.04	0	0	0.04	0.16	0.36	0.36	0.48	0.08	0.36	0.2	0.64	0.04	0.36	0.64	0.36	0.48	0.36	0.16	0.16	0.24	0.16	**6.6**	**0.2538**	**0.1789**	**0.7046**
14	Site distance from urban area	0.64	0.16	0.08	0.64	0.64	0.36	0.16	0.04	0.04	0.04	0.16	0.36	0.24	0.24	0.08	0.36	0.36	0.64	0.64	0.64	0.48	0.36	0.16	0.16	0.64	0.16	**8.48**	**0.3262**	**0.2207**	**0.6766**
15	Surplu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.	0	**5.**	**0.21**	**0.196**	**0.9271**

	s materials handling	.08	.16	.08	.04	.04	.64		.04	.04		.36	.36	.16	.24	.64	.36	.04	.04	.24	.16	.6	.04	.36	.36	08	.36	**52**	**23**	**8**	
16	Architect Vs Structural Engineer dispute	0.36	0	0.24	1	0.04	0.64	0	0.04	0.04	0	0.16	0.36	0.12	0.48	0.36	0.36	0.36	0.36	0.64	0.64	0.48	0.36	0.64	0.16	0.36	0.16	**8.36**	**0.3215**	**0.2482**	**0.7719**
17	Shortage of skillful workers	0.64	0.36	0.48	0.04	0.64	0.36	0.64	0.04	0.36	0.04	0.16	0.48	0.32	0.48	0.64	0.36	0.04	0.64	0.64	0.64	0.64	3.6	0.36	0.16	0.64	0.16	**13.556**	**0.5215**	**0.6534**	**1.2528**
18	Insufficient Detailing	0.64	0.36	0.36	0.36	0.64	0.36	0.64	0.04	0.16	0.04	0.16	0.36	0.36	0.48	0.64	0.6	0.04	0.64	0.24	0.64	0.64	0.16	0.36	0.36	0.64	0.36	**10.28**	**0.3954**	**0.2065**	**0.5222**
G	**Environmental Risk & Natural Risk**																																
1	Any adverse	0.6	0.0	0.0	0.1	1	0.6	0.16	0	0.0	0.2	0.1	0.3	0.2	0.4	0.2	0.1	0.0	0.6	0.2	0.4	0.6	0.1	0.1	0.1	0.64	0.1	**7.86**	**0.3023**	**0.2514**	**0.8317**

	impact on project due to climatic conditions	4	4	4	8		4			4		6	6	4	8	4	6	4	4	4	8		6	6	6		6					
2	Any impact on the environment due to the project	0.64	0.04	0.04	0.36	1	1	0	0	0	0.2	0.04	0.48	0.08	0.36	0.24	0.16	0.04	0.04	0.36	0.16	0.32	0.36	0.16	0.16	0.64	0.16	**7.04**	**0.2708**	**0.2776**	**1.0254**	
3	Earthquake	1	0.04	0.16	0.2	1	1	0	0	0	0	0.04	0.48	0.16	0.64	0	0.8	0	1	0.16	0.16	0.24	0.16	0.36	0.6	1	0.48	**9.68**	**0.3723**	**0.3734**	**1.0029**	
4	Fire	1	0.04	0.16	0.2	0.64	0.64	0	0	0.16	0	0.16	0.64	0	0.64	0.24	0.8	0	0.64	0.16	0.08	0.32	0.16	0.36	0.6	1	0.48	**9.12**	**0.3508**	**0.3129**	**0.8919**	
5	Collapse and Land Slide	1	0.04	0.16	0.2	0.64	0.64	0	0	0	0	0.16	0.48	0	0.64	0	0.8	0.04	1	0.16	0.08	0.36	0.16	0.2	0.6	1	0.48	**8.84**	**0.3400**	**0.3400**	**1.0000**	
6	Inclement Weather	1	0.04	0.12	0.24	1	0.36	0	0	0.04	0	0.04	0.48	0	0.64	0.36	0.16	0	0.36	0.16	0.08	0.48	0.16	0.2	0.6	1	0.48	**8**	**0.3077**	**0.3155**	**1.0254**	

7	Floods	0.36	0.04	0.12	0.2	1	0.64	0	0	0	0	0	0.48	0	0.64	0	0	0	1	0.16	0.08	0.48	0.16	0.2	0.6	0.36	0.48	**7**	**0.2692**	**0.3037**	**1.1281**
H	**Social Risk**																																	
1	Resettlement and rehabilitation of people	0.36	0	0.04	0.24	1	0.24	0.16	0.16	0	0	0	0.36	0.08	0.48	0.24	0.64	0	0.36	0.16	0.8	0.8	0.24	0.36	0.36	0.36	0.18	**7.62**	**0.2931**	**0.2640**	**0.9008**
2	Problems due to adjacent or nearby projects	0.64	0	0.36	0.16	0.24	0.08	0.16	0.16	0.04	0	0.04	0.36	0.08	0.36	0.24	0.16	0.04	0.36	0.16	0.36	0.48	0.24	0.16	0.16	0.64	0.12	**5.8**	**0.2231**	**0.1741**	**0.7803**
3	Local people support for the project	0.16	0	0.04	0.24	0.36	0.36	0.36	0.16	0.04	0.08	0.04	0.36	0.24	0.36	0.24	0.36	0.04	0.36	0.08	0.24	0.32	0.12	0.36	0.36	0.16	0.48	**5.92**	**0.2277**	**0.1376**	**0.6042**

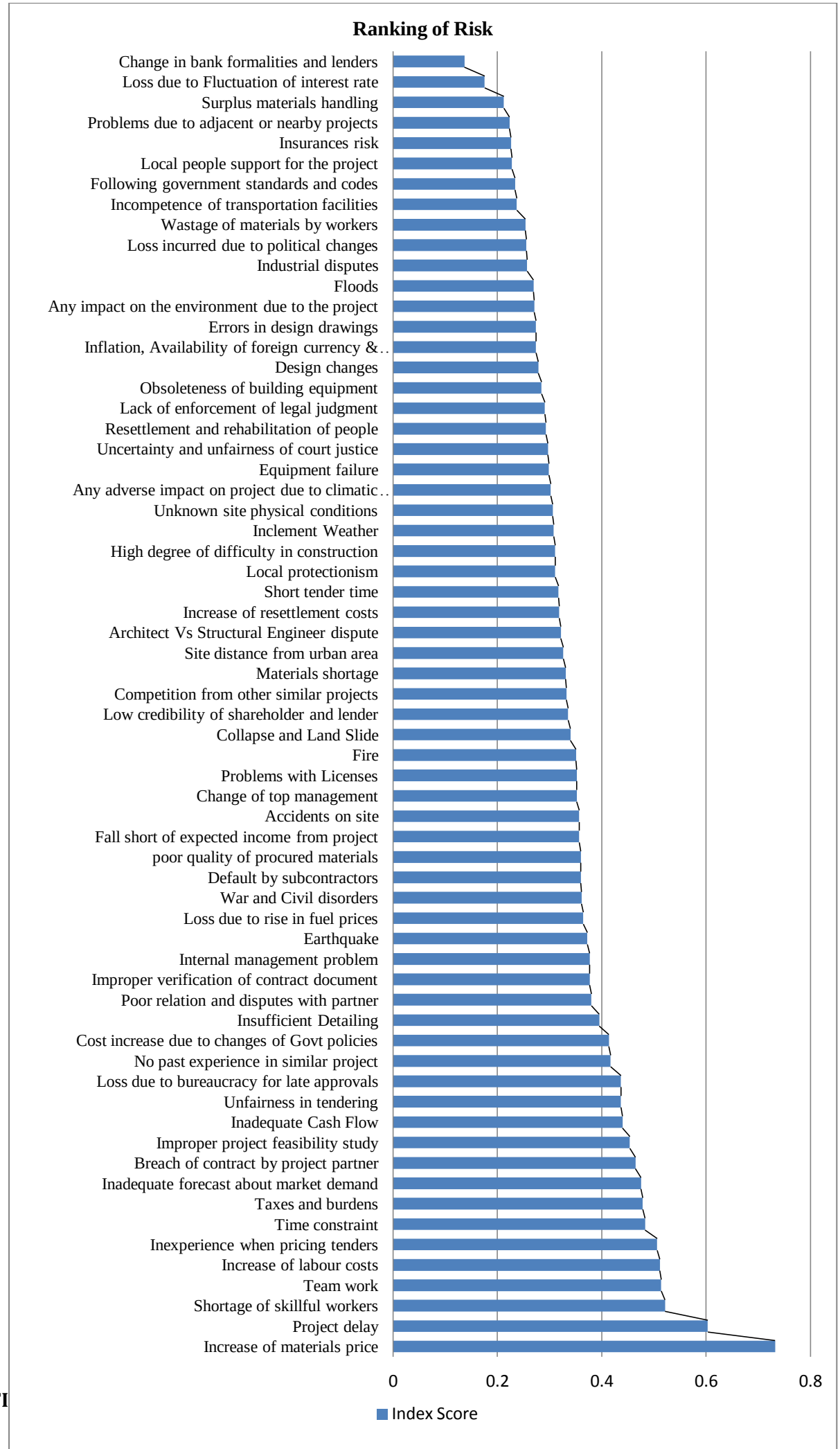
Based on Index Score, ranking of risk factors is done in descending order. It is shown in Table 4.
With respect to the magnitude of risk index, an average Index Score of 0.25 (Medium likelihood of occurrence 0.5 × medium level of impact 0.5) can be regarded as high as per (AS/NZS4360, 2004).
It is determine that out of 64 risk factors considered, 53 are having a risk index score of 0.25 or more and hence they are significant risks for building construction industry.

Table 4 Ranking of Risk

S .No	Sub Risk	Risk Category	Index Score	Rank order
1	Increase of materials price	M.R	**0.7323**	1
2	Project delay	MGMT.R	**0.6031**	2
3	Shortage of skillful workers	TECH.R	**0.5215**	3
4	Team work	MGMT.R	**0.5138**	4
5	Increase of labour costs	M.R	**0.5116**	5
6	Inexperience when pricing tenders	F.R	**0.5062**	6
7	Time constraint	MGMT.R	**0.4831**	7
8	Taxes and burdens	F.R	**0.4785**	8
9	Inadequate forecast about market demand	M.R	**0.4754**	9
10	Breach of contract by project partner	L.R	**0.4646**	10
11	Improper project feasibility study	MGMT.R	**0.4538**	11
12	Inadequate Cash Flow	F.R	**0.4400**	12
13	Unfairness in tendering	M.R	**0.4369**	13
14	Loss due to bureaucracy for late approvals	TECH.R	**0.4369**	13
15	No past experience in similar project	MGMT.R	**0.4169**	14
16	Cost increase due to changes of Govt policies	TECH.R	**0.4138**	15
17	Insufficient Detailing	TECH.R	**0.3954**	16
18	Poor relation and disputes with partner	MGMT.R	**0.3800**	17
19	Improper verification of contract document	L.R	**0.3769**	18
20	Internal management problem	MGMT.R	**0.3769**	18
21	Earthquake	E&N.R	**0.3723**	19
22	Loss due to rise in fuel prices	F.R	**0.3646**	20
23	War and Civil disorders	TECH.R	**0.3615**	21
24	Default by subcontractors	F.R	**0.3600**	22
25	poor quality of procured materials	TECH.R	**0.3600**	22
26	Fall short of expected income from project	M.R	**0.3569**	23
27	Accidents on site	TECH.R	**0.3569**	23

28	Change of top management	MGMT.R	**0.3523**	24
29	Problems with Licenses	TECH.R	**0.3523**	24
30	Fire	E&N.R	**0.3508**	25
31	Collapse and Land Slide	E&N.R	**0.3400**	26
32	Low credibility of shareholder and lender	F.R	**0.3354**	27
33	Competition from other similar projects	M.R	**0.3323**	28
34	Materials shortage	TECH.R	**0.3308**	29
35	Site distance from urban area	TECH.R	**0.3262**	30
36	Architect Vs Structural Engineer dispute	TECH.R	**0.3215**	31
37	Increase of resettlement costs	M.R	**0.3185**	32
38	Short tender time	MGMT.R	**0.3169**	33
39	Local protectionism	M.R	**0.3108**	34
40	High degree of difficulty in construction	TECH.R	**0.3108**	34
41	Inclement Weather	E&N.R	**0.3077**	35
42	Unknown site physical conditions	TECH.R	**0.3062**	36
43	Any adverse impact on project due to climatic conditions	E&N.R	**0.3023**	37
44	Equipment failure	TECH.R	**0.2985**	38
45	Uncertainty and unfairness of court justice	L.R	**0.2969**	39
46	Resettlement and rehabilitation of people	S.R	**0.2931**	40
47	Lack of enforcement of legal judgment	L.R	**0.2908**	41
48	Obsoleteness of building equipment	TECH.R	**0.2846**	42
49	Design changes	TECH.R	**0.2785**	43
50	Inflation, Availability of foreign currency & Exchange Rate change	F.R	**0.2738**	44
51	Errors in design drawings	TECH.R	**0.2738**	44
52	Any impact on the environment due to the project	E&N.R	**0.2708**	45
53	Floods	E&N.R	**0.2692**	46
54	Industrial disputes	TECH.R	**0.2569**	47
55	Loss incurred due to political changes	TECH.R	**0.2554**	48
56	Wastage of materials by workers	TECH.R	**0.2538**	49
57	Incompetence of transportation facilities	TECH.R	**0.2369**	50
58	Following government standards and codes	TECH.R	**0.2338**	51
59	Local people support for the project	S.R	**0.2277**	52
60	Insurances risk	F.R	**0.2262**	53

61	Problems due to adjacent or nearby projects	S.R	**0.2231**	54
62	Surplus materials handling	TECH.R	**0.2123**	55
63	Loss due to Fluctuation of interest rate	F.R	**0.1754**	56
64	Change in bank formalities and lenders	F.R	**0.1369**	57


Ranking of Risk
Change in bank formalities and lenders
Loss due to Fluctuation of interest rate
Surplus materials handling
Problems due to adjacent or nearby projects
Insurances risk
Local people support for the project
Following government standards and codes
Incompetence of transportation facilities
Wastage of materials by workers
Loss incurred due to political changes
Industrial disputes
Floods
Any impact on the environment due to the project
Errors in design drawings
Inflation, Availability of foreign currency &..
Design changes
Obsoleteness of building equipment
Lack of enforcement of legal judgment
Resettlement and rehabilitation of people
Uncertainty and unfairness of court justice
Equipment failure
Any adverse impact on project due to climatic..
Unknown site physical conditions
Inclement Weather
High degree of difficulty in construction
Local protectionism
Short tender time
Increase of resettlement costs
Architect Vs Structural Engineer dispute
Site distance from urban area
Materials shortage
Competition from other similar projects
Low credibility of shareholder and lender
Collapse and Land Slide
Fire
Problems with Licenses
Change of top management
Accidents on site
Fall short of expected income from project
poor quality of procured materials
Default by subcontractors
War and Civil disorders
Loss due to rise in fuel prices
Earthquake
Internal management problem
Improper verification of contract document
Poor relation and disputes with partner
Insufficient Detailing
Cost increase due to changes of Govt policies
No past experience in similar project
Loss due to bureaucracy for late approvals
Unfairness in tendering
Inadequate Cash Flow
Improper project feasibility study
Breach of contract by project partner
Inadequate forecast about market demand
Taxes and burdens
Time constraint
Inexperience when pricing tenders
Increase of labour costs
Team work
Shortage of skillful workers
Project delay
Increase of materials price
0
0.2
0.4
0.6
0.8
Index Score

V. CONCLUSION

In this study, identifying the risk factors faced by construction industry is based on collecting information about construction risks, their cost and remedial procedures that may be done to prevent or moderate the risk property. Risk analysis techniques were investigated too. However, the purpose of severity and allowance of these risk factors was the main result of this research on the basis of a survey with industry practitioners owning strong experience and knowledge of construction projects, 64 key risks were highlighted on a comprehensive assessment of their likelihood of occurrence and level of impacts on project objectives.

VI. REFERENCES

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