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Identification of Major Risk Events for Construction Industry

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Abstract
The construction industry is subjected to more risk than many other industries. One of the major parameters in every aspect of the project management life cycle is cost, and can be termed as one of the key variable of a project and have major impact on project success. Construction projects having many risk events that leads project to cost overruns. This study focused towards the identification and assessment of major risk events, causing overrun in construction projects of Pakistani construction industry. Study conducted with the identification of risk events by the literature review,156 risk events were identified by the literature after through questionnaire surveys and some statistical techniques, 156 risk events were shortlisted to 40 and were denoted as major risk events. Project cost overruns was also found out with the help of questionnaire surveys. Assessment of the events was done on the basis of risk score that is product of probability and impact.

Keywords
Construction Industry, Cost Overrun, Risk, Major Risk Events.

1. Introduction

Construction is a highly risk oriented industry with a low reputation for dealing with risks. Risk in the construction is unavoidable because of the complex dynamic environment (Sharma & Gupta, 2019). Risk management is a comprehensive way response on any risk starting with identification (Sarvari et al., 2019). There is a gap in identification of risk event in construction industry (Nabawy et al., 2021). In Pakistan construction industry, it is common to see a construction project not being successful in achieving its goals of completion within the estimated cost. It has been found out that every other project in this industry have overruns in terms of cost. As construction projects are unique, similarly the risks in every other project are also unique (Sarvari et al., 2019). The Risk identification can also be termed as one of the key factor of project success (Simanjuntak & Suryaningrum, 2020). Construction projects are always exposed to many risk factors, they can internal risk or external risks (Soliman, 2018). Construction industry has become one the most unsafe industry because of its dynamic and complex environment and high probability of risk involvement (Tsoukalis & Chassiakos, 2019). Construction industry has much risk but the dealing with those risks was not up to the mark. The art of encountering and mitigating these risks has not been ideal with respect to construction industry and thus provides way for large-scale failures such as uncertain project completion delays, operational and quality requirements abiding failures, and cost over runs (Hameed & Woo, 2007). Azhar et al. (2008), within Pakistan, the construction sector though not being utilized to its full capacity is still a major constituent of the country's economy and plays a major part in its sustained development. It can be seen that many contractors, however, have compiled a series of yardsticks that they apply when they have to deal with risk. These yardsticks generally rely on their experience and judgmental power. Cost limitations if not fulfilled and until otherwise, a project can't be considered completely successful (Elhag et al., 2005). In order to know the cost overrunscaused by the particular risk events. This study focused on to the identification of risk events through the literature review. After the identification, 2 questionnaire surveys were performed in the construction industry and to get the consensus of construction industry experts on these events on the basis of frequency (likelihood of events) and impact (consequences of events).

2. Settings or Methods or Materials and Methods

The methodology of this study was divided into three different phases. Phase-I is about identification of the risk events and Phase-II is about the prioritization of the events and Phase-II is about the prioritization of the events and Phase-III is about the assessment of the events.

2.1 Phase-I

In Phase-I an extensive literature was studied in order to identify the risk events related to construction industry. Phase 1 started with extensive literature review that covered all aspects of projects including risk management. The research material includes different journal papers, conference papers, review papers, MS and PhD thesis. Study was more focused towards different identification of risk factors and risk management techniques Different risk events under category of Environmental, Site Location, Labor, Equipment, Owner, Design, Consultant, Contractor, Management, Financial, Political, Schedule, External, Organizational and Legal risks were identified as it can be seen in Table 1. A questionnaire survey was also conducted with local construction industry experts having minimum of 10 years' experience in order to identify risk events related to local construction industry. So with the help of literature and the survey, a total of 156 risk events were identified and on the basis of these risks Questionnaire 1.0 was made. After that, Questionnaire 1.0 was distributed among the industry experts for the identification of risk events related to the construction industry of Pakistan. The Questionnaire that was used had two parts namely. Part A "Respondent's Information" and Part B "Risk Events Detail". Part A comprises personal information of expert i.e. name, e-mail address, contact number, present position in company, work experience, years in this organization, highest qualification etc. While the part B comprises an extensive list of 156 risk events obtained through detailed literature review. The rating scale of this survey was divided into three characterizations, these are (YES), (NO) and (MAY BE). If a respondent feels it is important then he will mark the particular event as (YES). If he feels it is not important, then he mark it as (NO), and if the respondent is not sure about it then he marked it as (MAY BE). The "mode" technique was used in order to see repetitive values for each risk event and to assign that value to that particular even. The events having (YES) and (MAY BE) were considered for the next phase.

Table 45. No. of Risk Events in Phase-I

S No.	Risk Category	Numbers of Events
		Phase-I
1	Environmental	05
2	Site Location	05
3	Labor	06
4	Equipment	10
5	Owner	12
6	Design	09
7	Consultant	09
8	Contractor	15
9	Management	20
10	Financial	15
11	Political	06
12	Schedule	03
13	External	19
14	Organizational	12
15	Legal	10
TOTAL		**156**

2.2 Phase-II

In Phase-II of the study another questionnaire interview was performed assisted by Delphi technique with industry experts having minimum 15 years' experience in construction industry. The purpose of this interview was to assess the events on the basis of their risk scores. The questionnaire of this survey had two parts same as the questionnaire 1, but the number of events for this questionnaire were 78 under category which can be seen in Table 2.

The rating scale is also changed now. It is now in the form of risk matrix in which probability and impact values. The values for probability are in between 1 to 3 and for impact it is same. The individual marked the value of probability and impact against each risk events. Risk score was calculated against each risk event by multiplying the value of

probability and impact. On the basis of risk score the risk events were categorized into major and minor risk events. If a risk event has got a value of 6 to 9 then it is said to be a major event and if an event has a value of less than 6 then it said to be minor events. The risk matrix can be seen in Table 3.

Table 46. No. of Risk Events in Phase-II

S No.	Risk Category	Numbers of Events
		Phase-II
1	Environmental	01
2	Site Location	03
3	Labor	04
4	Equipment	06
5	Owner	06
6	Design	05
7	Consultant	03
8	Contractor	10
9	Management	07
10	Financial	06
11	Political	03
12	Schedule	03
13	External	06
14	Organizational	08
15	Legal	07
TOTAL		**78**

Table 47. Risk Matrix

	IMPACT →		
FREQUENCY ↓	1(LOW)	2(MODERATE)	3(HIGH)
1(LOW)	(1) LOW-LOW	(2) LOW-MOD	(3) LOW-HIGH
2(MODERATE)	(2) MOD-LOW	(4) MOD-MOD	(6) MOD-HIGH
3(HIGH)	(3) HIGH-LOW	(6) HIGH-MOD	(9) HIGH-HIGH

2.3 Phase-III

Phase-III of the study is also done with the help of questionnaire survey. This questionnaire has three parts. The first part is respondent and the project details. In respondents details it is same as the previous ones but in the project details things were asked are actual cost of the project, estimated cost of the project, start date and finish date of the project and type of project. Second part that is risk event detail has changes now. There are 40 risk events in this questionnaire under suitable category that can be seen in Table 4. The rating scale for this questionnaire was also dependent of probability and impact, but the values of probability are from 1 to 5 and for the impact it from 1 to 10 which can be seen in Table 5. After the third survey, risk score was calculated against each risk event and after that. In this survey cost overrun was also asked from respondents in order to see how many projects have cost overruns by these risk events.

3. Results

3. 1 Results of Phase-I

As it was discussed in the identification part 156 risk events were identified and categorized into 15 different risk categories and from them Questionnaire 1 was made and distributed among construction industry experts this questionnaire was sent to 20 construction industry experts having minimum 10 years of experience and from 20, 15 gave response, which yields a response rate of 75 %. After the Phase-i of the study the number of events were shortlisted to 78.

3. 2 Results of Phase-II

Same strategy followed by Phase-II in which 78 events were present in Questionnaire 2 Delphi technique was also used in this Phase. The total number of experts approached were 30having minimum of 20 years' experience in construction industry and from them 25 gave response, which yields a response rate of 83.33 %. Risk score was calculated by multiplication of Probability and impact given by each respondent against each risk events which can be seen in Graphical form in Figure 1, in which it can be seen 40 risk events were scoring 6 or more than 6 and were considered as major risk events.

Table 48. No. of Risk Events in Phase-III

S No.	Risk Category	Numbers of Events
		Phase-III
1	Environmental	00
2	Site Location	01
3	Labor	01
4	Equipment	01
5	Owner	01
6	Design	02
7	Consultant	03
8	Contractor	07
9	Management	04
10	Financial	03
11	Political	02
12	Schedule	03
13	External	04
14	Organizational	03
15	Legal	05
TOTAL		**40**

Table 49. Risk Matrix for Phase-III

RISK MATRIX		Potential Impact on Cost									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Chances of Occurrence	**1**	1	2	3	4	5	6	7	8	9	10
	2	2	4	6	8	10	12	14	16	18	20
	3	3	6	9	12	15	18	21	24	27	30
	4	4	8	12	16	20	24	28	32	36	40
	5	5	10	15	20	25	30	35	40	45	50

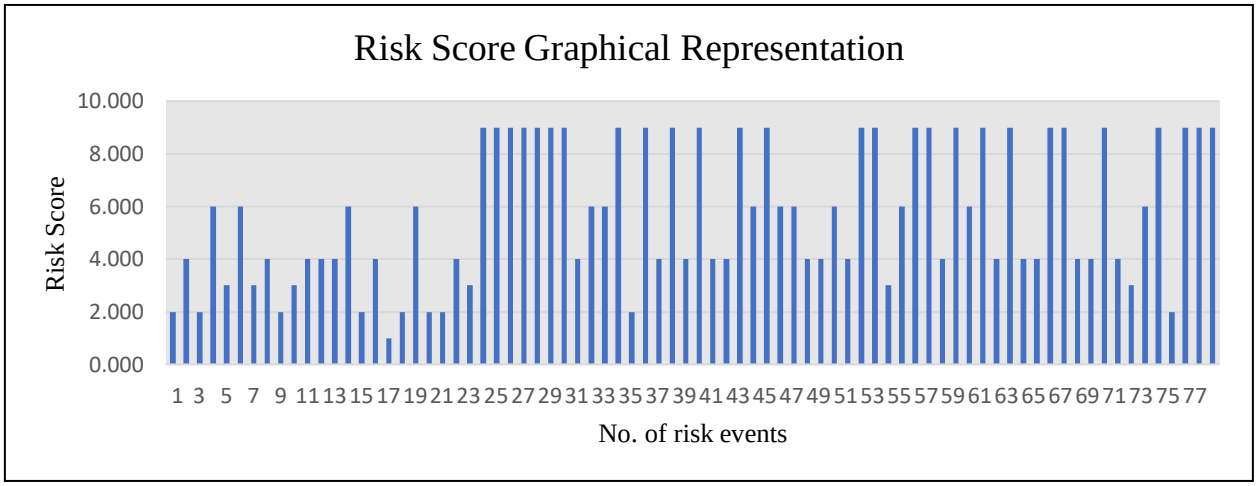

Fig 52. Risk Score in Phase-II

3. 3 Results of Phase-III

In phase-III of this study the questionnaire was sent to 150 construction industry experts and in which 101 were respond, which yields a response rate of 67.67 %. Some other things were also asked in Phase-III of the study including the experience, designations Pakistan Engineering Council (PEC) category, type of client whether public or client, type of project which include infrastructure, residential, commercial, educational and industrial. Starting with the experience. Respondents were approached to give their involvement with the organization ranging from under 5 years to over 30 years. Since for assessing the implications of risk events on project cost performance a genuine perceptive from experienced personals in local construction industry were required. Table 6 shows their percentage distribution.

Table 50. Percentage Distribution of Experience of Respondents

Experience of Respondents (Yrs.)	No. of Respondents	Percentage (%)
Less than 5	31	29.52%
5-10	24	23.76%
11-20	18	17.82%
NA	28	27.72%

3.3.1 DESIGNATION OF THE RESPONDENTS

The working background of the respondents is very influential shown by the information, got from the survey. Therefore, present positions of the respondents were required. In this survey, the targeted respondents were project-based peoples like planning engineer, chief engineer, project managers, project engineers, chief executive officer, executive engineer, owner representative and site engineer as shown in Table 7.

3.3.2 PEC CLASSIFICATION/ CATEGORY

PEC affiliation of the firm inclusion really helps in collecting sound data from the firms. There are seven different categories of firms responded in this study with their percentage distribution as shown in Table 8. However, 39.60 % respondents did not mention their PEC Category of firms.

3.3.3 TYPE OF CLIENT

To show whether the project was publicly or privately owned, the respondents were required to provide the information. Most of the projects were privately owned with percentage of 53.47 % and remaining were public projects as shown in Table 9.

3.3.4 TYPE OF PROJECTS

It was necessary to mention the type of the building project in the Questionnaire survey. The most common categories involved residential buildings, educational buildings, commercial buildings and industrial buildings as shown in Table 10.

3.3.5 CLASSIFICATION BASED ON AREA

The respondents were required to give the location of the project. the details are shown in Table 11.

Table 51. Designations of the Respondents

Present Position of Respondents	No. of Respondents	Percentage (%)
Project Manager	8	7.92
Project Engineer	17	16.83
Planning Engineer	6	5.94
Executive Engineer	6	5.94
Site Engineer	14	13.86
Chief Engineer	4	3.96
Owner Representative	6	5.94
Chief Executive Officer	6	5.94
NA	34	33.66

Table 52. PEC Classification / Category

PEC Classification / Category	No. of Experts	Percentages (%)
CA	4	3.96
C1	8	7.92
C2	5	4.95
C3	14	13.86
C4	29	28.71
CB	1	0.99
NA	40	39.60

Table 53. Type of Clients

Type of Clients	No. of Projects	Percentage (%)
Private	54	53.47
Public	47	46.53

Table 54. Type of Projects

Type of Projects	No. of Projects	Percentage (%)
Residential	34	33.66
Educational	15	14.85
Commercial	22	21.78
Industrial	6	5.94
Infrastructure	24	23.76

Table 55. Project Location

Province	No. of Projects	Percentage (%)
Sindh	46	45.54
KPK	24	23.76

Punjab	8	7.92
Balochistan	12	11.88
Islamabad	9	8.91
NA	2	1.98

3.3.6 PROJECT COST OVERRUN

The actual and estimated cost for each project was asked in order to calculate the real cost overrun occurred on these projects. In order to categorize the projects in terms of how much cost overrun actually occurred, projects were split into two ranges of overrun. One with a range of 0-25 million and another with a range of 26-50 million overruns as shown in Table 12.

Table 56. Project Cost Overrun

Project Cost Overrun (millions)	No. of Projects	Percentage (%)
0-25	80	79
26-50	21	21

Figure 2 shows the graphical representation of the cost overrun percentages which were got as the result of questionnaire 3 survey. The minimum value of cost overrun percentage was (0%) while the maximum was (66.67%).

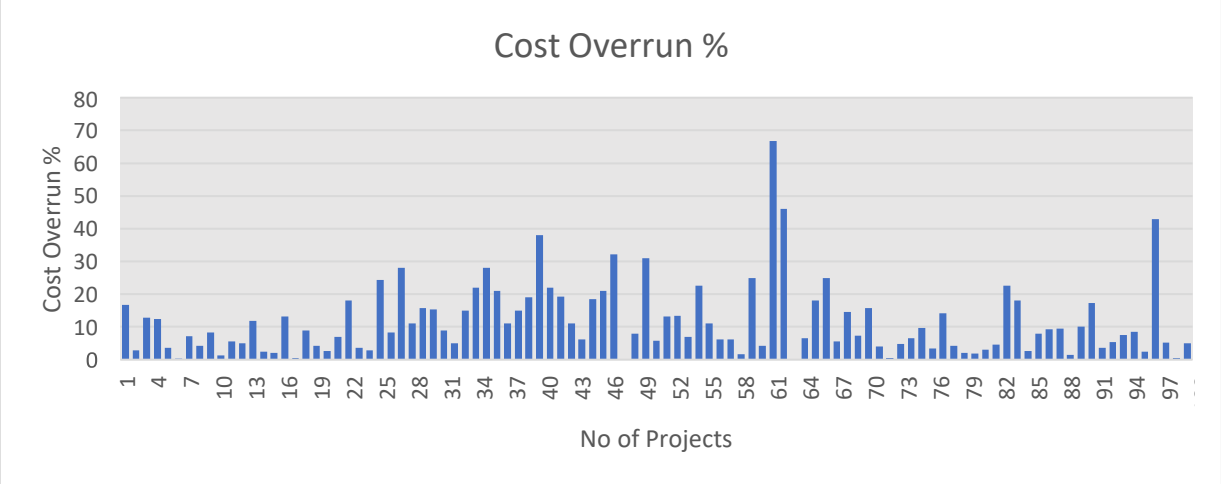

Fig 53. Cost Overrun %

Below Table 13 shows all the shortlisting of risk events in combine form. Initially the events were 156 in Phase-I, in Phase-II they were 78 and in last Phase of the study which is Phase-II they were shortlisted to 40 which were also denoted as major risk events of the construction industry.

4. Discussion

Identification of major risk events for construction has great importance because neglecting the risk events caused many failures in terms of cost time and quality. Similar studies have been conducted in the including Kartam & Kartam (2001) in which they considered 26 major risk events for the Kuwait construction industry. It was depicted by Zou et al. (2007) in which he identified 85 risk factors for the construction industry of china, out of which 10 were selected as major risk factors. Yuan et al., (2018) identified 16 risk events in for construction industry. Following these same strategies followed in this study in which it was started with the identification of risk events for construction industry after that prioritization of those events were performed with the help of questionnaire surveys meanwhile shortlisting of the risk events were also ongoing and at the end 156 risk events were shortlisted to 40 and were considered as major risk events for Pakistani construction industry.

Table 57. Combined Result of All Surveys

S No.	Risk Category	Numbers of Events	Numbers of Events	Numbers of Events
		Phase-I	**Phase-II**	**Final**
1	Environmental	05	01	00
2	Site Location	05	03	01
3	Labor	06	04	01
4	Equipment	10	06	01
5	Owner	12	06	01
6	Design	09	05	02
7	Consultant	09	03	03
8	Contractor	15	10	07
9	Management	20	07	04
10	Financial	15	06	03
11	Political	06	03	02
12	Schedule	03	03	03
13	External	19	06	04
14	Organizational	12	08	03
15	Legal	10	07	05
TOTAL		**156**	**78**	**40**

5. Conclusions

From the above survey and their results, it can be concluded that most of the risk events were belonged to management initially followed by contractor at second place, but after the final survey it can be seen that the maximum number of major risk events were belong to contractors. It can also be seen that environmental related risk events were the only category which has some risk events initially but at the end no major risk events were belong to that side.

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