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Risk analysis for Construction Projects in Pakistan

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Abstract: ***Managing risks in construction projects is documented as a very important management process to achieve the project objectives mainly time, quality, cost, safety and environmental sustainability. The research identifies and evaluates these risks and the existing risk management for construction works in Pakistan. Through literature review twenty seven risks were identified which were categorized into three hierarchical levels (country, market and project). The critical nature of these risks to construction projects was evaluated and ranked through a survey all over Pakistan. Analysis of the data showed that the risks at Country level are more critical than that at Market level and the latter are more critical than that in Project level. Survey revealed that top 10 critical risks in construction projects are: Cost Overrun, Corruption, Political Instability, Inflation and Interest rate, Government Influence on Disputes, Human Resource, Market Demand, and Change in Law, Justice Reinforcement, and Low Construction Productivity.***

I. INTRODUCTION

Risk and uncertainty are more wide spread in construction industry because of nature of construction activities, complexity of processes and organizations. Risk has multi-faceted conception. From construction industry point of view, it can be the possibility of happening of a specific event/factor or group of events/factors to the project which may take place during the entire process of construction [1]. In Pakistan very less research work on risk management in construction projects has been carried out. The reason being, Pakistan is a growing construction industry due to developing country [2] carried out a study taking into account the perception of contractors regarding risk factors. Choudhry and co authors in another study have suggested a Risk Management System in Construction Industry in Pakistan [3]. This research has incorporated the risk importance, application of management techniques along with barriers for applying risk management processes. In present research an endeavor has been made to identify and evaluate the potential risks which are faced by construction firms in a hierarchal level as per their importance. The scope of this research is confined to the construction industry of Pakistan which mainly covers key stakeholder i.e. sponsors /clients, consultants and contractors. Main focus is given to sponsors and contractors as they are the one who gets the major toll for risks. An endeavor has been made to include every category of firms/contractors regardless of the projects undertaken by them.

II. MATERIALS &METHODS

The research was distributed in four parts/phases which were performed through literature review, discussions and interviews along with a questionnaire survey. A three level classification for risks: (country, market and project) was used in order to ascertain the criticality of each level and correlation of risks at different levels/groups. Study follows with little modifications methodology adopted by Wang in another study [4]. Each risk has been given an alphabetical ID for ease of reference.

A questionnaire was chosen as the principal survey method from literature review as first step then a pilot survey was carried out in order to confirm the applicability of the questionnaire in home environments. Seven experts from different organizations were selected and questionnaire was distributed among them: two from clients, two from consultants and three from contractors were chosen for this purpose. This was pursued by interview with every individual participant ensuring 100 percent response. Respondents were having more than ten years of construction related experience in their relevant field. The questionnaire was modified many times from the feedback of these experts and a final questionnaire was developed to suit local environments. The questionnaire covers all major risks which can be encountered in construction projects specifically in the backdrop of Pakistan.

III. SELECTION OF GEOGRAPHICAL AREAS AND FIRMS

To conduct the survey four most developed areas of Pakistan Lahore, Karachi, Islamabad and Rawalpindi were selected [5]. Karachi being the only sea route is main financial and construction hub of Pakistan with an estimated population of 14.7 millions. Whereas Lahore is capital of Punjab province which is a financial and construction centre of Punjab having second maximum population of almost 8.3 million. Islamabad and Rawalpindi are major cities with joint population of approximately 3.2 million and both constitute third highest concentration of population in Pakistan. Besides this Islamabad is a Federal Capital city also. Keeping in view the geographical location of these areas, their population, industrial concentration as well as development ranking, it can safely presumed that these areas have considerable contribution in the construction industry of Pakistan, representing most of the population of the country.

Selected Sample Size. Acceptable sample sizes for various populations with different sampling errors for 95% confidence level are given in a study carried out by Dillman [6]. Keeping these factors in mind, sample size comes to be 96 therefore any sample near 96 is quite acceptable. Further taking into account the length of questionnaire and time required in completing it, a response of 87 respondents is fairly large and is assumed to be representative of population.

A total of 300 questionnaires were sent through courier, electronic mail and delivered in person. As contractors bear major toll for risks so more input was solicited from them,

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therefore, 210 (70%) questionnaires were distributed to contractors and 45 each to clients and consultants. Total valid responses received were 87 (29 percent). The category wise distribution is: 16 (Consultant), 17 (Client) and 54 (Contractors). Sixty (60) percent of all the respondents were having more than ten years of experience and the rest were having 3-10 years of experience of working in their respective fields in construction industry.

IV. UNDERSTANDING STATISTICAL TERMINOLOGIES

Statistical terminologies applied in the research have been taken from Choudhry and Kamal [7] and are described below:-

Statistical Hypothesis and Testing. When the hypothesis is supported by the sample data it is accepted as being true, however, when it is not supported by the sample data, it is rejected.

Null and Alternative Hypothesis. Null hypothesis can be described as the hypothesis which is to be tested for possible rejection on the assumption that it seems to be true, it is symbolized by Ho. Alternative hypothesis is the one which is accepted when the null hypothesis is rejected and is denoted by H1,H2,…Hn.

Type I and Type II Errors. Type I error is described as rejecting null hypothesis when it is in fact true and type II error is the accepting of null hypothesis when it is false. The possibility of having type I error is denoted by α and that of having a type II error is denoted by β.

Testing of Significance Levels. Significance level can be defined as "the probability taken as a standard for rejecting Ho, a null hypothesis, when Ho is supposed to be true" and test of Significance can be described as a "rule or procedure with the help of which sample results are used to ascertain whether null hypothesis will be accepted or rejected".

Data Analysis: In order to analyze the data Statistical Package for Social Sciences (SPSS-20) has been utilized. The research follows the usual significance level i.e. 0.05. To analyze the data statistical tools/ techniques used are described subsequently.

Normality Test The test for normality is essential in deciding the form of statistics to be implemented, as normal data distribution is an underlying assumption in many statistical testing. Normality can be assessed graphically or numerically.

Sample Population Mean / Relative Index (RI) Ranking can be based on Relative Index (RI) or population mean. It is summarized by Holt [8] that, when analyzing likert scale data to get ordinal sorting of the variables determined, mean response will produce the same results as RI. However, RI will also simultaneously generate relative indices where the maximum RI = 1.0, in contrast to maximum mean = N. In this research the ranking is based on sample population mean as it can produce similar results as Relative Index.

Kruskal-Wallis Test. A Kruskal-Wallis is known as nonparametric measure for comparing results for more than three groups. It is basically an extension of Mann-Whitney test. It is quite less sensitive to outliers hence was used for comparing the means of variables for testing the perceptions of each group i-e (Contractor, Client, and Consultant) regarding criticality of risks.

Spearman Rank Correlation Test. It is used when data does not follow normal distribution and is a nonparametric statistical test which is used to determine the strength and direction of association which exist among two variables.

Quartiles. Quartiles are often used to know the dispersion of data. Third quartile value is of significant importance or important meaning as it represents the 75% of the collected sample and reliable inference can be drawn while comparing the results about the perception of correspondents about a certain category.

V. RESULTS AND DISCUSSIONS

Statistical Package for Social Science (SPSS-20) is quite flexible and quite comprehensive statistical tool which can get and process data from different type of files and uses them to perform complicated statistical analysis which includes charts, trends, and tabulated reports. SPSS helps in calculations and to produce results, the subsequent part i.e. drawing quality inferences from these results depends upon the degree of knowledge and expertise of the researcher about statistics as a subject. The data was entered in Microsoft excel sheets progressively as and when questionnaires reply were received and checked for correctness and completeness and further analyzed through SPSS-20.

Statistical analysis and key findings of the survey are summarized subsequently.

Statistical Analysis

Normality Test. 'Shapiro Wilk normality test' was selected to check the normality of the collected data. We can find out, if the data is normally distributed or not, with the help of this test. It may also give the conclusion that further analysis should be parametric or non-parametric. The significance value comes to be 0.000 for all risks which are less than 0.05. This dictates that data is not normally distributed and further analysis should be based on non parametric tests.

Mean/Critical Index. Responses on the criticality of 27 risks having effects on the construction industry were solicited through likert scale 1-5, so that 1 represent "not critical" and 5 represent "exceptionally critical" as shown in Table 1.

Table- 1: Risk Rating Procedure

Rating	Risk criticality
1	Not critical at all
2	Slightly critical
3	Critical
4	Very critical
5	Exceptionally critical

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The critical level of the identified risks along with the mean and standard deviation (SD), placed in rank sequence is as shown in Table 2. The ranking has been done basing on the Mean Critical Index. Detail study of the result reveal that 21 from 27 identified risks have mean critical index in the range of 3 i.e. (Critical) and 5 i.e. (Exceptionally Critical). This means that respondents perceive about 75% of the risks identified critical or above in their grading. Top 11 critical risks include Cost Overrun, Corruption, Political Instability, Inflation and Interest rate, Government Influence on Disputes, Disputed sites, Human Resource, Market Demand, Change in Law, Justice Reinforcement, and Low Construction Productivity.

Table 2: Risk analysis on Mean Index bases

ID	Description	Total Index	Mean Index	Risk Ranking	Standard Deviation
C3	Cost overrun	375	4.31	1	0.736
A5	Corruption	358	4.11	2	0.784
A8	Political instability	352	4.05	3	0.901
C2	Inflation and interest rates	338	3.89	4	0.855
A4	Govt influence on disputes	327	3.76	5	0.715
E3	Disputed sites	322	3.70	6	0.823
B2	Human resource	318	3.66	7	1.032
A1	Approval and permit	313	3.60	8	0.739
A2	Change in law	305	3.51	9	0.791
A3	Justice reinforcement	294	3.38	10	0.825
D2	Low construction productivity	287	3.30	11	0.864
D3	Site safety	284	3.26	12	0.769
H1	Market demand	283	3.25	13	0.810
H2	Competition	281	3.23	14	0.694
D1	Improper design	274	3.15	15	0.755
D5	Improper project management	273	3.14	16	0.750
E2	Public Image	272	3.13	17	0.962
D6	Tight project schedule	270	3.10	18	0.850
G1	Force majeure	268	3.08	19	0.892
D4	Improper quality control	263	3.02	20	0.835
E1	Environment protection	242	2.99	21	0.769
A7	Quota allocation	239	2.75	22	0.918
B4	Corporate fraud	232	2.67	23	0.742
F2	Lack of coordination	228	2.62	24	0.633
J1	Artificial Shortage of materials	225	2.59	25	0.708
F3	Inadequate site information	220	2.53	26	0.745
A6	Expropriation	203	2.33	27	0.831

Risk analysis by Kruskal Wallis Test. Kruskal Wallis test is a non parametric test and is performed to check whether all stakeholders' i-e clients, consultants and contractors, have related perception regarding the critical level of each risk or otherw ise. It is shown in table 3 that all stakeholders have similar view about critical ranking of all risks except cost overrun, human resource and improper design.

If we observe the criticality value given by different groups as is shown at table 4 we come to few conclusions

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as established from Kruskal Wallis test also. Cost overrun has been placed by the contractor as the top risk which is quite obvious where as corruption is placed at third number indicating that contractors have accepted the corruption to a certain level. Placing of disputed sites at four by the client shows the concern about the criticality of this risk where as consultants and contractors are less bothered on this account. Human resource graded at five by the contractor showing the criticality of this risk and concern of this group, however the other parties are not much concerned about this factor. Similarly for competition and improper design the client group has shown more concern due to obvious interest.

Spearman Correlation. The result of Spearman rank correlation test shows that a positive correlation among the risk ranking of contractors, clients, and consultants exists due to significant statistical results obtained, as shown in Table 6. It can be deduced from the Kruskal-Wallis as well as Spearman rank correlation test results that though groups have difference of opinion on the perceptions of three individual risks out of twenty seven, but they all have the same opinion on risk ranking given by each other

Third Quartile Value The identified risks have been divided in three groups to include (1) country level (2) market level and (3) project level. Moreover quartiles usually divide population in four groups as shown in Figure 1. The third Quartile value is considered the most reliable and of important meaning in statistical testing.

Table 3: Risks Analysis by Kruskal Wallis

Type of risk	Chi-Square	Df	Significance
Approval and permit	3.163	2	.206
Change in law	1.865	2	.394
Justice reinforcement	2.774	2	.250
Government influence on disputes	1.367	2	.505
Corruption	5.975	2	.050
Expropriation	3.354	2	.187
Quota allocation	.883	2	.643
Political instability	.569	2	.753
Environment protection	1.849	2	.397
Lack of coordination	2.955	2	.228
Disputed sites	1.184	2	.553
Force majeure	2.772	2	.250
Human resource	9.794	2	.007
Corporate fraud	1.404	2	.496
Inflation and interest rates	.410	2	.815
Market demand	5.433	2	.066
Competition	3.688	2	.158
Low construction productivity	1.207	2	.547
Cost overrun	.130	2	.937
Improper design	7.282	2	.026
Artificial Shortage of materials	2.825	2	.243
Site safety	1.993	2	.369
Improper quality control	2.681	2	.262
Improper project management	1.102	2	.576
Public Image	1.603	2	.449
Inadequate site information	1.379	2	.502

Table 4: Grading of different groups by Mean Index

Risk ID	Description	Overall	Client	Consultant	Contractor
C3	Cost overrun	1	2	2	1
A5	Corruption	2	1	1	3
A8	Political instability	3	3	3	2
C2	Inflation and interest rates	4	6	5	4
A4	Govt influence on disputes	5	7	4	6
E3	Disputed sites	6	4	10	7
B2	Human resource	7	15	11	5
A1	Approval and permit	8	5	8	8
A2	Change in law	9	8	7	9
A3	Justice reinforcement	10	12	6	11

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D2	Low construction productivity	11	16	13	10
D3	Site safety	12	11	14	12
H1	Market demand	13	13	9	20
H2	Competition	14	9	15	16
D1	Improper design	15	10	21	17
D5	Improper project management	16	17	16	14
E2	Public Image	17	14	19	15
D6	Tight project schedule	18	22	12	18
G1	Force majeure	19	21	17	13
D4	Improper quality control	20	19	20	19
E1	Environment protection	21	18	22	21
A7	Quota allocation	22	20	18	25
B4	Corporate fraud	23	24	23	22
F2	Lack of coordination	24	25	24	23
J1	Artificial Shortage of materials	25	26	25	24
F3	Inadequate site information	26	23	26	26
A6	Expropriation	27	27	27	27

Table 5: Risk importance by Spearman Correlation

CORRELATIONS					
			CLIENT	CONSULTANT	CONTRACTOR
Spearman's rho	CLIENT	Correlation Coefficient	1.000	.865**	.930**
		Sig. (2-tailed)	.	.000	.000
		N	27	27	27
	CONSULTANT	Correlation Coefficient	.865**	1.000	.951**
		Sig. (2-tailed)	.000	.	.000
		N	27	27	27
	CONTRACTOR	Correlation Coefficient	.930**	.951**	1.000
		Sig. (2-tailed)	.000	.000	.
		N	27	27	27
**. Correlation is significant at the 0.01 level (2-tailed).					

The obtained value for third Quartile regarding Country Level is 3.70, which is the highest from other levels. It confirms already established fact that the Country Level has been rated as the top critical group. Market Level is the next group on the list of criticality with the 3rd Quartile value of 3.45. Project Level has the least third Quartile total of 3.26 which make it the lowest group in hierarchal level.

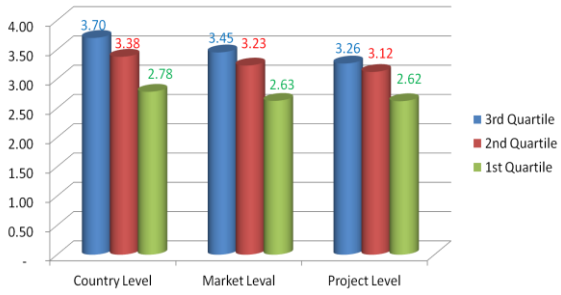

Fig 1: Quartile Value of Risk Criticalities

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Risk Influence Matrix

It has been drawn from above results, literature review, general wisdom, discussions and logical deduction, that there exists influence relationship among risks at different levels/groups. The country level risks being more dominant and at top level are influencing market and project levels risks, whereas the market level risks are influencing the project level risks [9, 10].

The comprehensive influence of risks at a higher level on the risks at one lower level, which may be called as the dormant risks are presented in table 4.9. It is therefore concluded that the risk mitigation plan should prioritize the risks according to supremacy, i.e. the dominant risks are required to be mitigated with top priority or in first step first over the dormant risks. The objective is to mitigate the effects of the dominant risks thereby reducing their influence on succeeding dormant risks, which will eventually diminish the effects of dormant risks automatically.

Consider the influence which human resources risk B2 (Market Level) is having over the cost overrun risk C3, (Project Level) represented by 'B2 C3'.It will give us the deduction that a skilled, experienced and competent employee will guarantee the availability of exact measurements, pricing of the Bill of Quantities (BOQ), correct contract schedule and timely work done which is quite true thus reducing the chances of cost overrun C3. Take the other example 'J1, C2 C3', which shows that both Risk J1 (artificial shortage of material) and Risk C2 (inflation and interest rates) are having influence on Risk C3 (cost overrun). It is also correct statement because artificial shortage of material will give rise to cost overrun. Similarly sudden change in inflation and interest rates by government will reduce the availability of required cash flow and delay in payments by the client etc. which in turn will cause cost overrun.

VI. CONCLUSION

Managing risks in construction projects saves time, effort and above all cost of the project. In developing countries like Pakistan where literacy rate is quite low; understanding of difficult terminologies, cumbersome techniques and long and hectic way of documenting the risks by contractors/project managers seems next to impossible. The cost of employing risk management professionals is too high. Due to this reason contractors/firms are scared of incorporating risk management systems in their corporations. The survey questionnaire has given an easy approach to risk management and has been well responded and appreciated by many firms and Practitioners It proved useful for getting the people involved in the mechanism of risk management by not only asking something but by giving them practical mitigation measures to comment or add upon. This study is a first step and gradually building on this would certainly enable us to a have a comprehensive document like risk management code for Pakistan.

Table 6: Risk Influence Matrix

		Country Level Risks										Market Level Risks					
		A1	A2/A3	A4	A5	A6	A7	A8	G1	E1	E2	B2	B4	J1	C2	H1	H2
Market Level Risks	B2		<								<						
	B4		<	<	<			<									
	J1		<					<	<								
	C2				<		<	<	<								
	H1								<								
	H2								<								
Project Level Risks	C3	◄	◄	◄		◄	◄	◄	◄			←	←	←	←		
	D1		◄						<			←				←	←
	D2	◄									◄	←					
	D3		◄		◄					◄		←					
	D4		◄		◄					◄		←					
	D5		◄	◄	◄							←					
	D6					◄					◄	←	←				
	F2													←			
	F3			◄	◄											←	

Note:

< Influence of Country Level Risks on Market Level Risks

◄ *Influence of Country Level Risks on Project Level Risks*

← *Influence of Market Level Risks on Project Level Risks*

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