Identification of Factors Affecting Cost Performance of Construction Projects

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Abstract-Construction projects are measured in terms of cost, quality and time. Project success is related to completion of projects within a specified budget. Khyber Pakhtunkhwa (province of Pakistan) is facing project management related issues such as cost overrun. Cost is among the most important contemplations throughout the project management life cycle. It can be looked upon as one of the most significant parameters of a project and the driving force for its success. In order to point out the significant factors that cause cost overrun of construction projects. In this paper, a total of 31 factors are selected. Data is in the form of feedback from construction practitioners and subject matter experts. The statistical tools such as mean and relative importance index are used to identify significant factors related to cost.

Keywords-Construction projects, Cost Overrun, Khyber Pukhtunkhwa, Factors, Mean, Relative Importance Index.

I. INTRODUCTION

Cost overrun occurs when the final project cost surpasses the original estimations [i]. Cost overrun is a very common phenomenon and is practically associated with nearly all projects in any industry. This tendency is more severe in developing countries like Pakistan, where these overruns sometimes exceed 99% of the estimated cost [ii]. The major causes of cost overrun arise due to client actions, such as financial instability, making slow decision and lack of involvement in the planning phase of the project [iii]. The other causes include delays in funding, poor site management, revision of project scope and lack of resources[iv].

To date, agriculture sector construction is the second largest contributor to Pakistan economy. It contributions considerably lead to socioeconomic development. Construction industry contributes more than 2.4 percent of the total GDP [ii]. However, it suffers due to lack of investment in infrastructure development. The construction projects suffer cost overrun due to change in scope of project, fluctuation in prices of key materials, inappropriate government policies and lack of proper planning [v]. More than 90 percent of projects get over budgeted or completely abandoned due to either lack of funds or mismanagement at different levels. Poor site management, corruption, political interest and extra work contributes to cost overrun [vi]. Hence, special consideration is required to overcome the issues of cost overrun, although numerous researchers identify significant factors that cause cost overrun, but their significance level varies from region to region [ii, vi,ix]. This paper highlights the factors that adversely affect the cost of construction projects in the Khyber Pakhtunkhwa, a province of Pakistan.

II. LITERATURE REVIEW

Cost is among the key considerations throughout the project management lifecycle. Regardless of its recognized importance, it is not infrequent to see a construction project dwindling to accomplish its objectives within the identified cost.

Cost overruns are critical for both developing and developed countries. The authors in [x] concluded that the major causes of cost overrun in Pakistan are incompetent consultants, price escalation, exchange rate fluctuation, approval issues, weather related issues, and permit approval process. A case in point, the authors in [xi] identified cost related risks in their study. The identified risks are stern schedule of project, inappropriate planning, design variation, and error in cost estimation.

The authors in [xii] have done study related cost risk to the West Rail project of Hong Kong. The study suggested fifteen (15) risks concerned with project cost. The factors are divided into three groups: resource factors, management factors and parent factors. Escalation material prices are related to resource factors, imprecise budget cost and supplier or subcontractor's failure is related to management factors, where as excessive interface for project management is related to parent factors.

The study of the authors in [ii] about Pakistan construction industry concludes that instability of raw material prices, high cost of machineries, low bid, poor site management, and changes in government policies related to construction sectors and associated fields are responsible for cost overrun. The authors in "[xiii]

holds ineffective communication between project team responsible for negative impacts such as low productivity, cost and time overruns, and inadequate design specifications. The authors in [xiv] showed that in longer term lowest bid is not necessarily the most economical solution. It affects the project in terms of cost overrun and time delay.

The authors in [xv] discussed top three factors affecting construction cost. These factors have significant effect on the project cost, which includes cash flow problem, financial instability, ineffective site management, lack of supervision, and lack of communication among parties. According to the authors in [xvi] the causes of poor cost estimation are related to documentation, design, project management, financial resource management and contract administration.

The above literature concludes that the level of importance of factors affecting cost of construction projects varies. It is difficult to identify the factors that have significant effect on project cost. This research is conducted to highlight the factors that have substantial effect on cost performance of construction projects in Khyber Pakhtunkhwa, a province of Pakistan. The analysis method deployed in this research includes cronbach alpha test, Analysis of Variance (ANOVA), Arithmetic Mean and Regression Analysis. The analysis methods are explained in methodology and data analysis section in detail.

III. METHODOLOGY

Keeping supply chain perspective in view, a total of 31 factors are identified and selected for this research. Table I shows the 31 identified factors. Factors identification is done through literature review. The selected factors are finalized in consultation with academic and construction experts. For effective cash flow risks and benefits sharing among the major participants are very important [xvii]. Implementing continuous improvement in construction projects increases the profitability. Reducing waste is basically evaluated by assessing input and final project outcomes [xvii]. No blame culture is extremely important when the project is complex and unachievable. It aids in decision-making, team building and improve cost performance. Incorrect implementation of joint working or partnering will have disastrous effects on the cost performance of the project [xix]. With trust, the company can share sensitive information freely with no fear to their suppliers and clients. This helps them to solve many problems related to their clients and supplier, which results in better quality and cost control of material [xx].

As first hand and reliable information was not available with any government and private organization. A questionnaire based on 31 selected factors is designed. The questionnaire is designed into four main sections. As shown in Table II, each section has independent and different types of questions. Additionally, the respondent is asked to share their experience relating to these factors (e.g., how weather affected the cost of their project, any incident they faces related to terrorists activities, situation in which the government policies affected project cost).

TABLE I
CONSTRUCTION SUPPLY CHAIN FACTORS

S. No	Factors	S. No	Factor
1	Planning Commission Proforma 1 (PC-1)	17	Trust with supplier
2	Funding	18	Communication
3	Procurement Unit of Contractors	19	Problem Solving
4	Financial capability of Contractor	20	Risk Allocation
5	Management team of Contractor	21	Continuous Improvement
6	Communication Infrastructure	22	Incentive Mechanism
7	Escalation of Material Prices	23	Pain and Gain Sharing
8	Technical Person Availability	24	Performance Measurement
9	Cash Flow	25	Joint Working
10	Shortage of Material/ Equipment	26	No Blame Culture
11	Law and Order Situation	27	ISO Certification
12	Low Bid	28	Benefit Shared
13	Weather Condition	29	Mutual Objective
14	Bureaucracy and Political Influence	30	Government Policies
15	Terrorism	31	Inflation
16	Regulatory Authorities		

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TABLE I
QUESTIONNAIRE SECTIONS

Sections	Description
1	Questions related to Respondent Qualification and Demography
2	Questions related to Company Information
3	Questions related to external and internal factors with weightage 1-9
4	Questions relating internal and external factors to cost, quality and time

The questionnaire was sent to respondents through

mails, emails, by hands. In some instances interviews and discussion session were held with groups of senior construction practioners. A total of One hundred and fifty (150) questionnaires were distributed. Hundred and ten (110) were received out of which Nine (9) were discarded due to insufficient information. The profile of the respondents of the received questionnaire is shown in Table III. The youngest respondent as shown in Table III holds 9-year practical experience.

TABLE III
RESPONDENTS PROFILE

S.No	Organization	Designation	Experience
1	Contractors of Class A and B	Quantity Surveyors	12-15 years
2	UET Peshawar	Professors (Academic Experts)	9-13 years
3	Peshawar Development Authority (PDA)	Executive and General Director	18-23 years
4	Contractor of Class A and B	General Director	17-21 years
5	Irrigation Department Peshawar	Civil Engineers	16-18 years

The maximum number of receiving responses belongs to medium and large firms as shown in Table IV. CA and CB category contractors are placed in large firms, whereas C1 and C2 category contractors are termed as medium firms. This CA, Pakistan Engineering Council (PEC) does CB, C1 and C2 categorization. The categorization criteria are based on the number of completed projects and project budget.

Table IV
RESPONSES CATEGORIZATION

S.No	Organization	Number of Responses
1	Large Construction Firms	35
2	Medium Construction Firm	25
3	Small Construction Firm	15
4	Government Organization	15
5	Private Organization	11
	Total	**101**

Upon receiving the responses, the data was streamlined via Microsoft Excel. The filtered data is subjected to cronbach alpha and ANOVA tests.

Cronbach alpha (α) test is deployed to check the reliability of the collected data. Reliability is at low level and not acceptable when Cronbach α is less than 0.3. Reliability is at a highly acceptable level when Cronbach α is more than 0.7. To check the reliability of the data it is transferred to SPSS software. The reliability based on Cronbach alpha (α) test is 0.801, which shows that the data is highly reliable and valid for analysis.

Additionally, the respondents involved in the study are from different organization having different designation and experience. Hence, it is important to check whether their opinions are same or different about the factors affecting the cost of construction projects. For this aim, One Way ANOVA test is conducted with the help of SPSS software. The test is conducted on randomly four questionnaires from each category of respondents. The summary of ANOVA results and the respondent categorization is shown in Table V.

TABLE V
ONE WAY ANOVA TEST RESULTS

S.No	Category	F	P Value
1	Contractors – Government official	1.558	0.216
2	Contractors – Academic experts	2.287	0.082
3	Contractors – Private organization	2.448	0.067
4	Private organization-Academic Experts	2.737	0.070
5	Government officials – Private organization	1.978	0.121

All the values of ***"P"*** are greater than 0.05, so it is concluded that the test is insignificant and opinions of all the respondents are same about factors affecting the cost of a construction project.

I. Data Analysis

First the dependency of factors on the criteria (cost) is evaluated with the help of regression analysis. The Table VI shows the model summary (ANOVA) of regression analysis. The value of ***"P"*** is less than 0.05; the test is significant, highlight the factors affecting cost. The Table VII shows the t-test and P-values results for each factor depends on cost. Values less than 0.05 shows significant effect on the cost, while greater than 0.05 implies less significance. The data is analyzed by two different methods. One is method of measure of central tendency i.e., Arithmetic Mean (AM) while the other is Relative Importance Index (RII).

TABLE VI
ANOVA RESULTS

S.No	Model	Sum of Squares	Mean Square	F	Sigma
1	Regression	48.163	2.833	3.566	0.023[a]
2	Residual	07.945	0.794		
	Total	56.107			

Where "a" is independent variable and "b" is dependent variable (time)

Arithmetic Mean (AM) is one of the best ways to calculate the average value of data, because it gives

equal importance to all of the data under analysis. Equation 1 shows the generalized form for AM.

$$AM = \sum W/N \quad (1)$$

Where

$\sum W$ = Summation of weights assigned
N = Numbers of responses to that factor

The relative importance index is the statistical methods used to quantify the data. The weight of each factor from different responses are summed and divided by the product of highest weight and the number of respondents –[xxi]. The general formula is shown in below equation:

$$RII = \text{Sum of weights } (Y1 + Y2 + Y3 + \ldots + Yn) / Wx N \quad (2)$$

Where, Y = Weights given to each factor by the respondents and will range from 1 to 9.

If '1' is less significant and '9' is extremely significant.

W = highest weight (i.e., 9 in this case), and N = total number of respondents.

As shown in Table VII, the results of these two methods were same. Escalation of material prices, inflation and terrorism are highly significant by RII and the arithmetic mean. No blame culture and ISO certification is on the lower side.

Table VII
Factors Ranking

Statistical Measures				Regression Analysis	
Ranking	**Factors**	**RII**	**Mean**	**t- Test**	**P-value**
1	Escalation of Material prices	0.9074	8.17	3.631	0.005
2	Inflation	0.8889	8.00	2.888	0.016
3	Terrorism	0.8667	7.80	-2.792	0.019
4	Financial Capability of Contractor	0.8556	7.70	-3.388	0.007
5	Cash Flow	0.8519	7.67	2.793	0.019
6	Low Bid,	0.8111	7.30	-1.076	0.028
7	Shortage of Material/Equipment	0.800	7.20	2.2614	0.047
8	Technical Person Availability	0.7852	7.07	0.255	0.197
9	Management Team of Contractor	0.7778	7.00	0.092	0.121
10	Funding	0.7704	6.93	0.179	0.033
11	Continuous improvement	0.763	6.87	0.363	0.023
12	Bad Weather	0.7556	6.80	-1.156	0.012
13	Procurement Unit of Contractor	0.7481	6.73	0.235	0.043
14	PC-1 Preparation	0.7444	6.70	0.455	0.037
15	Problem Solving	0.7333	6.60	-0.578	0.043
16	Risk Allocation	0.7296	6.57	0.247	0.010
17	Law and Order Situation	0.7222	6.50	0.028	0.021
18	Bureaucracy and Political Influence	0.7185	6.47	-0.777	0.043
19	Performance Measurement	0.7037	6.33	0.910	0.044
20	Government Policies	0.7037	6.33	-0.832	0.041
21	Communication	0.6926	6.23	0.851	0.040
22	Communication Infrastructure	0.6889	6.20	0.137	0.038
23	Mutual Objective	0.6741	6.07	-0.423	0.037
24	Trust with supplier	0.663	5.97	-0.115	0.037
25	Joint working	0.6148	5.53	-0.673	0.033

26	Regulatory Authority	0.6074	5.47	-1.029	0.031
27	Incentive Mechanism	0.600	5.40	0.694	0.030
28	Pain and Gain sharing	0.563	5.07	1.130	0.475
29	Benefit shared	0.5407	4.87	0.800	0.612
30	No blame Culture	0.5185	4.67	1.301	0.561
31	ISO certification	0.4111	3.70	-1.315	0.401

V. Results and Recommendations

The five most significant factors affecting the cost of a construction projects are graphically depicted in Fig. 1. The most significant factor based on both mean and RII is an escalation of material prices. The AM value for escalation of material prices is 8.17, while RII value is 0.9074. The regression analysis with ***"P"*** value of 0.0178 shows escalation of material prices has significant effect on the cost of construction projects. The risk of escalation of material prices can be mitigated through the early purchase of materials that are subject to escalation risk. However, commitment to early supply material with corresponding suppliers may resolve price escalation issue. In addition, the other possible solution is to treat the escalation as an allowance in subcontracts. Duel surcharges in pricing agreement and delaying construction project until prices become stable are another way to force client for proper funding. Buy material in bulk to take advantage of discount and to avoid escalation risk.

Inflation is a second significant factor with both AM and RII value of 8. In regression analysis, the "P" value of inflation is 0.016, which is less than 0.05. Inflation reduces the time value of money. Entire project exceeds allocated budget due to expensive material, costly labor and equipment. Contractor should include inflation clauses in the contract.

The third most significant factor is terrorism. The mean value of terrorism is 7.8 whereas RII value is 0.867. The "P" value in regression analysis for terrorism is 0.0191. It highlights the significance of terrorism on the cost performance. Due to terrorist activities, the number of check posts has increased on major routes. This not only causes traffic congestion, but also interrupts the daily supplies and routine work on the construction site. Trucks containing materials have to wait for hours at a single check posts for security clearance. The government needs to focus on these issues and relax the policy related to security reason for the contractors and suppliers.

With a AM value of 7.7 and RII 0.856, financial capability is the fourth most significant factor. In regression analysis, the "P" value is 0.0294, which is less than 0.05. If the financial capability of the contractor is strong, materials, and the equipment's can be purchased/hired on time. Skilled and sufficient number of labor may be hired, which may decrease lead-time of the project and saves money. Inversely, if the financial capability of the contractor is not that strong, the project won't be completed in pre-assumed span of time. Contractor has to bear penalties, which directly affect the cost of the project.

To mitigate such risk, one need to develop trust with supplier and communicate openly and share the pain and gain with the supplier.

Cash flow with a mean value of 7.67 and an RII value of 0.852 is a fifth significant factor. Its regression value is 0.0362, showing importance. Cash flow is the movement of money through the various parts of construction projects. Effective flow has a positive influence on the outcome of the project. The cash flow is highly affected by low bids, incorrect estimates, poor management, and inadequate budget. Corrective control is not exercised in time, and the scope of work increases drastically. For better cash flow, the contractor needs to constantly audit the project. Double-check the estimate for any mistakes. Keep in view the trend of inflation and escalation of material prices. Penalties might be the solution to compel project managers to achieve project goals on time.

Factors such as problem solving, risk allocation, government policies, and PC-1 preparations are the intermediate significant factors. These factors might be most important for time and quality but not for cost. "ISO Certification" turned out to be the least significant factors. In addition, neither contractors nor their suppliers are interested in getting ISO certification. The government is also not keen to have ISO certified contractors on board. Hence, the cost and tedious paper work with no genuine return is the main reason practioners do not opt for these certifications.

VI. Conclusions

The study is carried out to identify major factors causing cost overruns in construction projects of Khyber Pukhtunkhwa. Five significant factors affecting cost of a construction project were selected on the basis of mean, and RII. These factors are an escalation of material prices, inflation, and terrorism, financial capabilities of the contractor, and cash flow. Results of the study reveal that considerable attention is required to build a policy to ensure reduction in impacts of identified factors for infrastructure development in Khyber Pukhtunkhwa. The findings of this study and the methodology are useful for research in construction

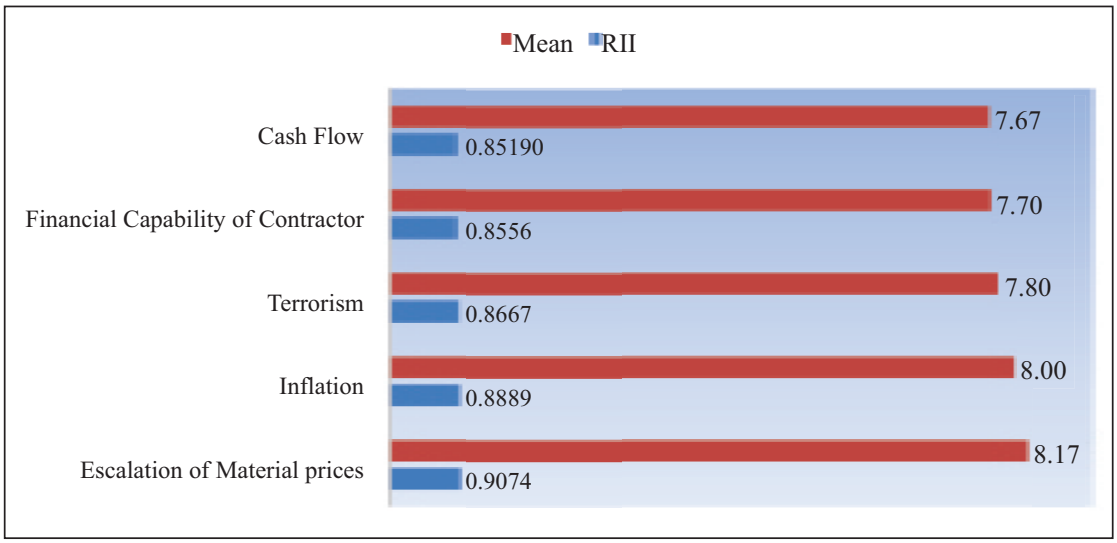

Fig. 1. Significant Factors

domain. Furthermore, the study can aid professionals in taking proactive measures for reducing cost overruns construction projects. Both contractor and government agencies can save exchequer money by improving and implementing laws related to construction environment. Since a key contribution of this study is development of a framework to address project overruns related issues, several other research areas for future work can spin-off from this study. Notably, opportunities exist to integrate our analysis with other project management methodologies such as risk assessment, supplier-supplier relationship, and inventory management etc; to contribute to the knowledge in the field of project management. Finally, although the developed methodology was applied specifically to Khyber Pukhtunkhwa, the same methodology can be implemented to other regions of Pakistan.

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