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Structural model of cost overrun factors affecting Pakistani construction projects

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ABSTRACT

Cost overruns are a global challenge to successfully completing construction projects. Cost overrun has a substantial impact resulting in most construction projects failing to be completed. Several factors have contributed significantly to the industry's decline. The factors were discovered in the literature, assessed, and applied to the construction industry in Pakistan. This study scrutinized and identified the relationships between the factors causing cost overruns in the Pakistani construction industry using the Partial Least Squares Structural Equation Modelling (PLS-SEM) approach. The structural model was created and tested with Smart-PLS software using data from a questionnaire survey of 131 construction practitioners. Six constructs were used to categorize the factors. The model identifies 21 critical factors in Pakistani construction projects, with resource management ranking first. Contract management issues can also contribute significantly to project cost overruns. Model assessment results indicate that the developed model has a substantial power of explaining the factors of cost performance while R^2 value showed that 45.7% variance is explained by the model. The model developed model will serve as a jumping-off point for academics, researchers, and practitioners in developing a cost-control system. It is suggested that establishing an efficient and effective contract management protocol among stakeholders throughout the design and supervision stages is extremely beneficial for improving project cost performance and significantly reducing time overruns.

1. Introduction

The primary goal of any construction project is to have it finished within the budgetary constraints, timeline requirements, and quality requirements that were established [1]. Therefore, it is imperative that all parties involved in construction projects pay close attention to guarantee that the projects are finished in a safe manner as well as in a timely, affordable, and high-quality manner. When it comes to construction projects, it is notoriously difficult to achieve these three objectives. One of the most significant challenges that the construction industry is currently confronted with is the phenomenon of construction projects running over budget, which has a consequential effect on the Gross Domestic Product (GDP) of the country [2]. The ability to complete a project while staying within the financial constraints outlined in the contract is one of the most important indicators of the project's level of success. This essential matter will have an effect on how successfully the project is completed. Because insufficient attention is paid to construction cost management, the majority of construction projects do not meet their time- and cost-related goals. This has a detrimental impact on the efficiency with which construction projects are completed. The cost overruns have been a basis of contention. Several earlier studies have found evidence of significant cost overruns in infrastructure projects, such as Norwegian road projects [3], US road projects [4], and Australian transport infrastructure. These cost overruns have been documented in a number of countries [5]. Cantarelli et al. [6] demonstrated the significance of the problem of cost overruns by conducting research into it by analysing more than 250 transportation projects from a variety of countries. According to the findings of [7], the likelihood of the project's tangible costs being high in comparison with the estimated costs is 86% for any randomly selected project. Rail projects had a cost overrun that was 45% higher than what was planned, while road projects had an overrun that was 20% higher than what was planned. The study analysed 169 different construction projects for roads and developed regression models; the models revealed that cost overruns occur in every single one of the projects (i.e. sixty-six percent of projects were underestimated, while twenty-four percent were overestimated). The variance flanked by the estimated costs and the definite costs ranged from 39 percent all the way up to 98 percent, with an average difference of 14.6 percent. 54% of Qatar's new construction projects were completed over budget, and 72% were behind schedule, while 50% of the country's maintenance projects were completed over budget and 50% were behind schedule [8]. The construction industry is well-known among all industries in Pakistan, accounting for approximately 9% of GDP and 6% of employment. The construction industry is also well-known in other countries [9]. The problem of costs going up and up and up for Pakistani construction projects is becoming increasingly serious [10]. These overruns are the result of a number of factors, each of which needs to be evaluated [11]. Therefore, this study is currently being conducted to use structural equation modelling to address issues related to cost overruns in Pakistani construction projects.

2. Causes of Cost Overrun in Construction Projects

A construction project should always be finalized within the budget that was agreed upon to be considered a successful completion. However, construction projects usually experience substantial cost overruns regularly [12]. The term "cost overrun" refers to an unexpected increase in the total cost of a project that was originally budgeted for the project. The project's stakeholders were not prepared for this increase [13]. According to [14], a cost overrun is any expenditure that is used up in any undertaking that is greater than the contract sum agreed upon by the client and the contractor. There are a few different names for it, including budget increase, budget overrun, and cost growth [15]. It refers to any expenditure on a project activity that could put a stakeholder's financial well-being in jeopardy [16]. There is a wide range of potential causes for cost overruns to occur while the project is being carried out. The factors that lead to cost overruns on construction projects have been the focus of an investigation by several scholars from various nations all over the world. According to the results of a survey of Indonesian contractors, the three primary factors contributing to cost overruns are incorrect resource takeoff, rising raw material costs, and environmental laws [17]. In Malaysian construction projects, it is not uncommon for there to be cost overruns that range from five percent to ten percent of the total contract amount. The majority of these cost overruns are caused by a lack of workers, a lack of skilled labour, poor project management, fluctuating raw material prices, a lack of raw materials, a lack of equipment and spare parts, client-requested acceleration, modifications to the project's scope or material specifications, construction errors, and fluctuating raw material prices. Other contributing factors include awarding contracts to the bidder with the lowest price and awarding contracts to the lowest bidder [18]. According to the findings of an examination into the aspects that influence to cost overruns on building projects in Nigeria, the primary contributors are cost variation, a lack of financial control on the job site, poor contract management, insufficient prior experience on the part of the contractor, and the application of an estimation method that is incorrect [19]. The majority of cost overruns in infrastructure projects are brought on by design mistakes, fluctuations in the cost of materials, insufficient project planning, changes in project scope, and redesign changes [20]. The findings of [21] show that project uncertainty, the presence of corruption and fraud in building projects, and rising prices are the most important factors that affect the costs of construction projects in the Nigerian industry. Numerous factors, including low labour productivity, rising material costs, and high equipment have been linked to cost overruns in China [22]. The costs of projects in the UAE are significantly impacted due to design variability, inaccurate cost projections, financial constraints of the owner, and an inappropriate procurement method [23]. In Oman, the cost of the project is seriously affected by client-driven scope changes, poor contractor management and planning, and low-quality consultant drawings [24]. In the construction industry, common risk factors that can lead to cost overruns include fluctuations in the prices of raw materials, procurement policies that prioritize the lowest bidder, government policies that do not adequately account for inflation, errors and omissions in the original contract, inaccurate time and cost estimates, additional work, and changes in design, as well as the financial challenges that contractors must face [11].

Lack of quick decision-making even during planning phase of the project, poor project timeframes and management, rising material and equipment costs, ineffective contract management, rework caused by oversights or inaccurate work, land acquisition issues, poor estimate or estimate techniques, and a long period between setup are noted as basic issues of cost overrun faced worldwide [25]. According to[26], the most significant problem with wastewater projects is the lowest bidder procurement method. In addition, the most significant problems with wastewater projects include scope changes, high indirect costs, and a lack of design detail during budgeting [27]. Haslinda et al. [28] reported that deferred payment costs and political insecurity are common issues of cost overrun. Pre-construction budgeting and content cost planning, inaccurate quantity take-off calculations, and inflation-affected material costs as serious issues [29].

Negatively affecting construction activities as a result of ignorance, disagreements between construction stakeholders, and obtuseness on the part of the project manager, cost overruns are serious problems that have had a negative impact [30]. According to [31], the terrain and the weather are the two factors that have the most significant impact on the infrastructure projects in Jordan. In the West Bank and Palestine, residential construction projects' cost-effectiveness was examined by [32]. According to the authors' research, the top five reasons for cost overruns are contract experience; inadequate time for the estimate; incomplete drawings, and fluctuating material prices. The primary factors contributing to cost overruns are alterations made to the project's scope, inadequate management, and inadequate drawings [24]. Poor cost performance in Saudi Arabian construction projects has also been attributed to the lowest bidder selection, design modifications, inadequate planning, and payment delays [33]. For the past seven decades, neither the accuracy of cost estimates nor the rate of price inflation has improved [7]. Pakistan, much like other nations around the world, is experiencing a severe problem with cost overruns affecting the ongoing development projects. Several Pakistani researchers have been looking into the issue of construction projects running over their budgets. According to [34], cost overruns can be attributed to fluctuations in prices as well as high costs associated with equipment. The most significant contributors to cost overruns in Sindh Province construction projects are delays in decision-making, fluctuations in the prices of materials, inadequate site management, problems with contractor payment, and natural disasters [10]. Problems that frequently lead to cost overruns include unpredictable raw material prices, unstable manufacturing costs, high machine costs, a low bidder procurement procedure, delays between the design and acquisition phases, additional work, and an unsupportive government [34].

Zeb et al. [35] reported that cost overruns in construction projects can be traced back to equipment breakdowns, a lack of equipment maintenance, an inadequate number of pieces of equipment, equipment performance and efficiency, and an absence of modern pieces of equipment. In Pakistan's construction industry, cost overruns occur due to the client experiencing financial difficulties, errors in proper estimation, flaws in drawing, delays in acquiring client approval, the client's poor planning, incompetent contractor performance, ineffective consultant supervision, and communication difficulties between the parties [10].

According to [36], the primary factors of cost overruns are bribery and corruption, as well as late payments from owners, financial difficulties for contractors, insufficient security, change orders, and general market inflation. To determine which issues require the most immediate attention, SEM was used to investigate the chain of events that led to the various cost overrun factors. A comprehensive study of the published research compiled the list of 55 cost overrun factors that are most frequently encountered, which is in Table 1.

Table 1

The Factors Causing Cost Overrun in Construction Projects

Construct	Item Code	Item Description	Reference
Contract Management	CM01C	Unsuitable construction methods	[37]; [38]; [39]; [40]; [41]; [28]; [42]
	CM02C	Inadequate planning and scheduling	[43]; [37]; [38]; [44]; [45]; [40]; [41]; [28]; [42]; [46]; [47]; [24]
	CM03C	Poor Contract management	[37]; [40]; [28]; [42]; [46]; [25]; [24]
	CM04C	Mistakes and discrepancies in contract document	[37]; [38]; [39]; [28]
	CM05C	Policy of lowest cost bidding policy	[38]; [42]
	CM06C	Bureaucracy in tendering method	[48]; [40]
	CM07C	Inadequate monitoring and control	[38]; [40]; [49]; [21]
	CM08C	Fraudulent practices and kickbacks	[50]; [38]; [40]; [21]
	CM09C	Mode of financing, bonds and payments	[37]
	CM10C	Economic instability	[42]
	CM11C	Inappropriate overall organizational structure	[28]; [49]
	CM12C	Lack of constructability	[40]
	CM13C	Delay in obtaining permits from governmental agencies	[42]
	CM14C	Inaccurate Site investigation	[40]
	CM15C	Unforeseen ground condition	[34]; [37]; [39]; [40]; [41]; [28]; [42]; [46]; [49]; [51]
Client Responsibilities	CR01C	Unnecessary interface by owner	[37]; [38]; [39]; [44]; [40]; [28]; [42]; [52]
	CR02C	Financial difficulties of owner	[43]; [44]; [40]; [28]; [42]; [46]; [53]; [21]; [54]; [3]; [55]
	CR03C	Delay in progress payment by owner	[38]; [48]; [44]; [28]; [42]; [56]; [55]
	CR04C	Slow decision-making by owners	[28]; [42]; [10]; [46]; [56]; [49]; [25]; [54]; [24]
	CR05C	Change in the scope of the project	[43]; [37]; [38]; [39]; [44]; [45]; [40]; [42]; [10]; [56]; [24]
	CR06C	Unrealistic contract duration imposed	[37]; [38]; [40]; [40]; [28]; [46]; [54]; [51]
Design and Project Management	DPM01C	Frequent changes in design	[48]; [45]; [41]; [42]; [10]; [46]; [56]
	DPM02C	Delay in inspection and approval of completed works by consultant	[37]; [38]; [48]; [39]; [44]; [40]; [42]
	DPM03C	Mistakes and Errors in design	[34]; [48]; [44]; [42]; [46]; [47]

	DPM04C	Delay in Design	[42]; [53]; [21]; [52]; [47]; [57]; [24]
	DPM05C	Complicated design	[39]; [40]; [42]; [54]; [57]
	DPM06C	Inaccuracy in cost estimation	[56]; [25]
	DPM07C	Poor project management on site	[34]; [40]; [42]; [56]
	DPM08C	Poor financial control on site	[42]; [56]; [49]
Information and Communication	ICT01C	Lack of coordination between parties	[38]; [48][39]; [44]; [41]; [57]
	ICT02C	Lack of communication between parties	[37]; [38]; [40]; [28]; [42]; [46]; [49]
	ICT03C	Slow information flow between parties	[45]
Resource Management	RM01C	Shortages of materials	[37]; [45]; [40]; [28]; [42]; [53]; [54]
	RM02C	Late delivery of materials on site	[38]; [48]; [39]; [44]; [45]; [41]
	RM03C	Fluctuation of prices of materials on site	[43]; [38]; [44]; [45]; [10]; [53]; [49]; [25]; [21]; [55]
	RM04C	Poor Quality of materials	[37]; [39]; [41]; [28]
	RM05C	Shortage of labour on site	[38]; [48]; [44]; [45]; [42]
	RM06C	Low productivity of labour	[37]; [38]; [48]; [40]; [28]; [42]; [57]
	RM07C	Shortage of technical personnel (skilled labour)	[44]; [28]; [42]; [49]; [51]; [57]
	RM08C	Relationship between management and labour	[48]; [40]; [42]
	RM09C	Lack of modern Equipment	[38]; [40]; [42]
	RM10C	Delay in Material procurement	[38]; [42]; [56]
	RM11C	High cost of machinery and its maintenance	[42]
	RM12C	Financial difficulties faced by contractors	[38]; [48]; [39]; [44]; [45]; [40]; [42]; [10]; [46]; [53]; [54]; [55]
Site Management	SM01C	Poor Supervision on site	[37]; [38]; [45]; [40]; [28]; [42]; [10]; [46]; [49]; [51]; [57]
	SM02C	Lack of experience of contractor	[42]; [24]
	SM03C	Mistakes during execution of works	[37]; [28]; [42]; [46]
	SM04C	Incompetency of subcontractors	[37]; [40][28]; [42]
	SM05C	Number of projects going on at same time	[58]
	SM06C	Waste on site	[40]; [54]
	SM07C	Schedule Delay	[50]; [46]; [25]
	SM08C	Delay payment to supplier /subcontractor	[44]; [42]; [49]
	SM09C	Contractual claims, such as, extension of time with cost claims	[34]; [42]; [57]
	SM10C	Poor site management	[37]; [38]; [45]; [40]; [28]; [42]; [10]; [46]; [49]
	SM11C	Problem with neighbours	[37]; [28]

3. Hypothetical Model of Failure Factors of the Pakistan Construction Industry

After determining and categorizing all of the groups, as well as making an effort to define all of the associated factors for each group, a hypothetical model is created to evaluate the factors that are the primary contributors to the inefficiency of the Pakistani construction sector. Fig. 1 depicts a hypothetical connection between the factors discussed and cost overruns in construction projects. As in Fig. 1, the model for the proposed study takes into account cost overruns as a dependent variable. Individual latent variables for each of the six groups/constructs include design and project management, contract management, strategic planning, site management, client obligations, and information and communication.

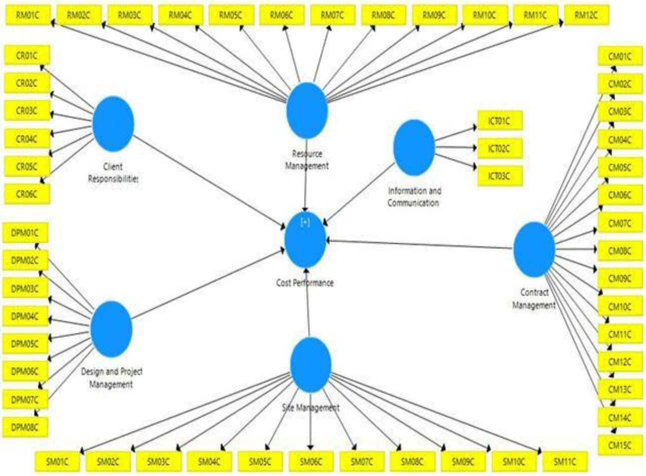
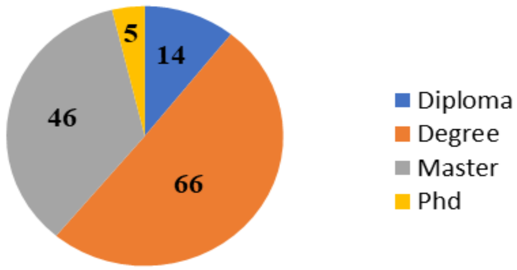


Fig. 1. Hypothetical model

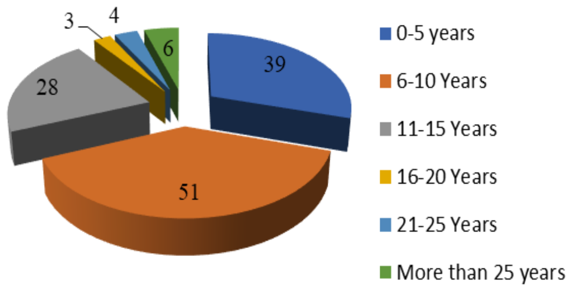
4. Research Methodology

The utilization of a questionnaire allowed for the collection of quantitative data. This survey aimed to understand the perspectives of construction practitioners who work in Pakistan regarding the reasons for budget overruns. The responses of the practitioners were recorded using a Likert scale with five points, with one representing "Not Significant," two denoting "Slightly Significant," three denoting "Moderately Significant," four denoting "Very Significant," and five denoting "Extremely Significant." Random questionnaires were distributed to stakeholders handling construction projects in Pakistan. These individuals were included in the study. Through the use of structural equation modeling, the information obtained from the completed surveys was analyzed. SEM is an iterative process that looks at the connections between the variables that go into a model [59]. The inner (structural) model and the outer (measurement) model are the two main parts of the SEM model. Covariance-based SEM (CB-SEM) and Partial Least Squares SEM (PLS-SEM) are the two ways that SEM can be carried out. PLS-SEM is primarily utilized in exploratory research for theory development, in contrast to the CB-SEM, which is used to either support or refute the established theory. PLS-SEM is the method that is preferred over these two techniques because it is not as stringent as these other methods because it does not impose any distribution assumptions, and the produced model can be both reflective and formative. In addition to this, the PLS methodology is suitable for use in the analysis of conceptual frameworks that contain multiple dependent variables. PLS-SEM is becoming more commonplace as a trustworthy method of data analysis, and its application in scientific and commercial research is on the rise. SEM can be utilized for different applications including decision support systems, forecasting models, risk analysis, and more. For instance, Doloi et al. [60] analyzed delays in Indian construction projects by using SEM. Memon [61] implemented SEM in Malaysia to determine the reasons for potential project cost overruns. Khahro et al. [62] used PLS-SEM to study green procurement issues. Liu et al. [63] investigated how the success of a design-build project was influenced by design-related risk using structural equation modelling. In Cambodia, SEM was utilized to determine service quality as well as customer satisfaction [64]. SEM was developed by Rahman et al. [65] to explain the factors that cause and contribute to shifts in the UAE construction industry. SEM was utilized by [66] to develop a model for the process of bid decision-making. Due to its adaptability, SEM has recently gained a lot of popularity among scientists. Since this study focused on developing a model of cost factors based on an exploratory study; hence it adopted the PLS-SEM approach.

As a point of reference for determining the appropriate size of the sample, the "10 times rule," which states that the number of observations ought to be 10 multiples of the largest amount of arrowheads referring to a latent variable was utilized [67]. The existing model incorporates seven latent variables, which reveals that the least sample size required for the investigation is seven times ten, which is seventy different examples. In the course of gathering information for this study, a total of 250 construction industry professionals were polled, and the responses of 140 of those professionals were positive. As a consequence of this, 131 of these forms were analyzed for data, and 9 of those forms were rejected because they were either incomplete or lacked necessary information. There were a total of 46 responses from contractor organizations, 44 from consultant organizations, and 41 from client organizations that did receive the data analysis questionnaire forms. As can be seen in Fig. 2, the participants have been managing construction projects for several years, during which time they have accumulated a wealth of technical expertise.



(a) Academic qualification



(b) Working experience of the respondent

Fig. 2. Demographic information of the respondents

As can be seen in Fig. 2, the vast majority of people who responded to the survey hold degrees in engineering. In addition to that, the respondents in this survey have a wealth of experience working in the field of construction. There are a variety of positions, such as director, project manager, and engineer that are held by participants in the projects.

5. Assessment of PLS-SEM

The measurement model and the structural model are the two stages that make up the evaluation process for the PLS model. Evaluations are made regarding the correctness of the measurement model as well as the appropriateness of the associations among latent variables and the variables that are being measured [67]. The degree of correlation between the indicators and the latent variable is described by the estimation model. In addition to that, it has been verified that the measuring tools are accurate [68]. Model discriminant tests and convergent reliability of the test are the two types of model fit validity tests that can be performed [59]. To determine whether or not the measurement mode is reliable for converging data, there are several factors that must be considered. Convergent validity is typically established through the utilization of the parameters composite reliability (CR), average variance extracted (AVE), and characterize item loading. In general, the latent variables have to be able to account for at least fifty percent of the differences in the exogenous variables (i.e. the square of the loadings). Therefore, metrics with outer loadings that are higher than 0.7 are considered to be adequate [69]. There is no need to include loading values that are negative in the analysis [70]. The elimination of notions with negative loading or attributes with loading lower than 0.7 is accomplished through an iterative process during convergent validity testing. It is only possible to delete one element from each construction during one cycle of the process. Using the Composite Reliability (CR) and Average Variance Extracted (AVE) metrics, one can arrive at this conclusion [71-72]. A CR value of at least 0.7 is required to validate the construct and the indicators that are associated with it [73]. The model has iterated a total of twelve times to achieve the necessary level of convergent validity. Table 2 displays the outcomes obtained from putting the measurement model through its paces using the PLS algorithm.

Table 2

Convergent validity of mode

Construct	Item Code	Loading	CR	AVE	Loading	CR	AVE
Contract Management	CM01C	0.484	0.878	0.329	Omitted	0.834	0.503
	CM02C	0.689			0.633		
	CM03C	0.489			Omitted		
	CM04C	0.578			Omitted		
	CM05C	0.4			Omitted		
	CM06C	0.665			0.727		
	CM07C	0.602			0.657		
	CM08C	0.558			Omitted		
	CM09C	0.671			0.763		
	CM10C	0.482			Omitted		
	CM11C	0.584			Omitted		
	CM12C	0.595			Omitted		
	CM13C	0.648			0.729		
	CM14C	0.575			Omitted		
	CM15C	0.496			Omitted		
Client Responsibilities	CR01C	0.719	0.808	0.414	0.79	0.804	0.508
	CR02C	0.713			0.743		
	CR03C	0.645			0.671		
	CR04C	0.637			0.635		
	CR05C	0.554			Omitted		
	CR06C	0.576			Omitted		
Design and Project Management	DPM01C	0.463	0.809	0.349	Omitted	0.788	0.554
	DPM02C	0.676			0.732		
	DPM03C	0.505			Omitted		
	DPM04C	0.667			0.802		
	DPM05C	0.595			0.694		
	DPM06C	0.598			Omitted		
	DPM07C	0.545			Omitted		
	DPM08C	0.646			Omitted		
Information and Communication	ICT01C	0.91	0.815	0.599	0.907	0.816	0.6
	ICT02C	0.726			0.732		
	ICT03C	0.665			0.724		
Resource Management	RM01C	0.737	0.798	0.256	0.736	0.783	0.547
	RM02C	0.541			0.774		
	RM03C	0.854			Omitted		
	RM04C	0.677			Omitted		
	RM05C	0.358			Omitted		
	RM06C	0.507			Omitted		
	RM07C	0.546			Omitted		
	RM08C	0.359			Omitted		
	RM09C	0.428			Omitted		
	RM10C	0.532			Omitted		
	RM11C	0.335			Omitted		
	RM12C	0.452			0.707		
Site Management	SM01C	0.593	0.834	0.318	Omitted	0.779	0.542
	SM02C	0.465			Omitted		
	SM03C	0.562			0.693		

	SM04C	0.479	Omitted
	SM05C	0.622	0.685
	SM06C	0.511	Omitted
	SM07C	0.64	Omitted
	SM08C	0.641	Omitted
	SM09C	0.696	0.824
	SM10C	0.445	Omitted
	SM11C	0.479	Omitted

Table 2 shows that certain components were redacted from each iterative process since factor loading values were lower than the threshold values for model assessment. This led to the elimination of several items from each iteration. During this process, a total of 28 of the 55 elements were taken out of consideration, and the remaining 20 factors were considered significant after twelve iterations of PLS algorithms. After the model was evaluated, a test of its discriminant validity was carried out. Discriminant validity was carried out [65, 69] for a better comprehension of how each construct is distinct from the others. Examining the correlations among measures and searching for any possible commonalities among the constructs is what's needed to establish discriminant validity. The variable correlation can be measured by using an indicator that a latent variable explicates more of its variance than that other latent variable, and this indicator is regulated by the square root of the average variance (AVE) of each variable. Both a cross-loading analysis that made use of the generated construct scores and an average variance analysis that made use of a comparison of latent variable correlations were utilized in this research project so that discriminant validity could be evaluated. Table 3 displays the findings of the cross-loading analysis that was performed.

Table 3

Analysis of cross-loadings of factors

Item Code	Contract Management	Client Responsibilities	Design and Project Management	Information and Communication	Resource Management	Site Management
CM02C	0.663	0.392	0.516	0.409	0.345	0.484
CM06C	0.727	0.29	0.405	0.375	0.254	0.474
CM07C	0.657	0.258	0.423	0.288	0.302	0.41
CM09C	0.763	0.287	0.452	0.35	0.299	0.409
CM13C	0.729	0.258	0.363	0.382	0.256	0.535
CR01C	0.327	0.79	0.373	0.25	0.264	0.348
CR02C	0.275	0.743	0.266	0.202	0.318	0.279
CR03C	0.309	0.671	0.272	0.21	0.228	0.258
CR04C	0.241	0.635	0.231	0.165	0.258	0.211
DPM02C	0.417	0.282	0.732	0.455	0.361	0.477
DPM04C	0.492	0.339	0.802	0.38	0.343	0.473
DPM05C	0.448	0.303	0.694	0.428	0.22	0.455
ICT01C	0.455	0.34	0.498	0.907	0.266	0.539
ICT02C	0.365	0.076	0.406	0.732	0.26	0.364
ICT03C	0.341	0.198	0.414	0.665	0.158	0.355
RM01C	0.218	0.255	0.255	0.138	0.736	0.254
RM02C	0.304	0.287	0.348	0.214	0.774	0.357
RM12C	0.377	0.274	0.341	0.31	0.707	0.365
SM03C	0.424	0.166	0.344	0.369	0.391	0.693
SM05C	0.474	0.329	0.54	0.466	0.258	0.685
SM09C	0.522	0.375	0.51	0.418	0.329	0.824

As can be seen in Table 3, the factors that belong to a conceptual framework have a higher loading than the factors that belong to other constructs. Given that each of these variables is consistent with the constructs they are linked to, this is a strong endorsement. True discriminant validity requires that the square root of the AVE for each construct be better than the correlation of the two constructs. Table 4 shows the value of the square root of the AVE in this instance rather than the diagonal correlation matrix because it is more appropriate.

The interrelationships of the constructs are presented in Table 4, with an emphasis on the square root of AVE. The size of diagonal entries in corresponding rows and columns compared to off-diagonal elements is a demonstration of the discriminant validity, which states that these diagonal elements are higher [74]. Following the validation that the results of the evaluation are reliable, the structural model is examined empirically. The results of the structural model developed by SmartPLS are depicted in Fig. 3, which can be found here.

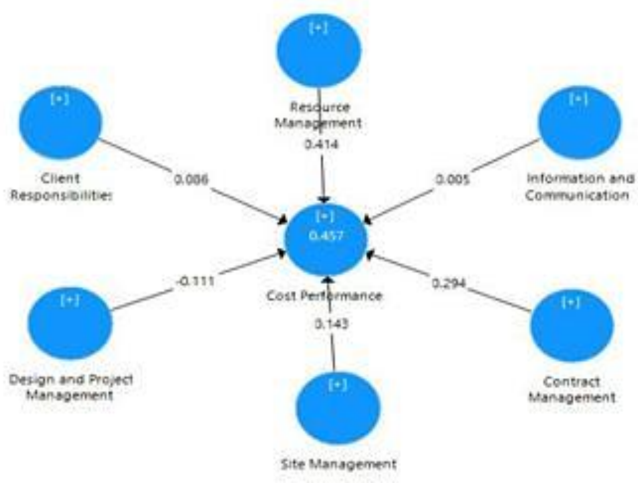


Fig. 3. Result of the structural model

Table 4

Latent variable correlations (Fornell-Larker Criteria)

Construct	AVE's Square Root					
Client Responsibilities	0.712					
Contract Management	0.411	0.709				
Design and Project Management	0.411	0.603	0.744			
Information and Communication	0.298	0.503	0.561	0.775		
Resource Management	0.369	0.407	0.428	0.301	0.74	
Site Management	0.397	0.643	0.628	0.562	0.443	0.737

6. Structural Model Assessment

Once the measurement has proved to be fit, the structural model is evaluated. Fig. 2 shows the effects of the structural model generated with SmartPLS.

A value of 0.26 or higher for the endogenous R2 is considered to be significant. R2 is regarded as having poor strength if its value is less than or equal to 0.02, while R2 with a value that is greater than or equal to 0.13 but less than or equal to 0.26 is regarded as having moderate strength [75]. The R2 value for the endogenous variable, cost overrun, is shown to be 0.457 in Fig. 3. This value indicates that the model has a substantial ability to explain the events that have occurred. In addition to this, the model illustrates that the core reason for cost overruns is problems associated with resource management. Contract management is the 2nd imperative factor that contributes to cost overruns in Pakistani construction works after the initial estimate of labour and materials. Construction project success relies on contract management.

Besides these, Bootstrapping test was carried out to assess the strength of the paths and test their significance on the dependent variable i.e. cost performance. The results obtained for bootstrapping with 5000 samples are presented in Table 5.

Table 5

Bootstrapping Analysis (Path analysis and Hypothesis Test)

Constructs	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics (|O/STDEV|)	P Values
Client Responsibilities -> Cost Performance	0.086	0.095	0.063	1.364	0.173
Contract Management -> Cost Performance	0.294	0.298	0.083	3.537	0
Design and Project Management -> Cost Performance	-0.111	-0.102	0.099	1.126	0.26
Information and Communication -> Cost Performance	0.005	0.02	0.1	0.046	0.963
Resource Management -> Cost Performance	0.414	0.413	0.076	5.427	0
Site Management -> Cost Performance	0.143	0.132	0.115	1.248	0.212

From Table 5, it can be observed that the resource management path is the more effective path with a 0.414 path value. This means that proper resource management is essential for improving cost performance in a construction project. Further, resource management and contract management are reported as the key role player criteria with a high significance level to achieve successful construction projects with improved cost performance.

7. Assessment of the Overall Model

The model's effectiveness and its capacity for explanation were evaluated using the Goodness of Fit (GoF) guide. R^2 and the arithmetical mean of the mean communality of all endogenous variables are used in the calculation of the GoF value [76]. This is utilized to calculate the overall predictive capacity of the model. The value of GoF falls somewhere between 0 and 1. The GoF cut-off values were found by plotting the various R2 effect sizes and using a communality value of 0.50 as the starting point for the analysis. The benchmark values are GoFsmall (0.10), GoFmedium (0.25), and GoFLarge (0.36). In this particular investigation, the GoF was found by applying the equation developed by [76].

$$GoF = \sqrt{AVE \times RSquare}$$

$$GoF = \sqrt{(0.542 \times 0.457)}$$

$$GoF = 0.498$$

According to the equation, the GoF value is 0.498. This demonstrates that the model that was developed has a high capacity for the explanation. The findings of the study will make it possible for Pakistani construction professionals to take the appropriate steps to resolve issues and finish projects within budget.

8. Conclusion

In Pakistan, the construction industry has had to overcome many difficulties. Cost overruns are one of the biggest issues facing the construction sector. Following a review of the literature, 55 common causes of cost overruns were identified and divided into six categories. These six areas of concern were contract management, site management, design and project management, resource management, client obligations, and information and communication. This article examined the connection between these constructs and cost overrun using the PLS-SEM method. The study's conclusions indicate that resource management significantly affects project costs in Pakistan's construction sector. Project costs are significantly impacted by contact management as well. By establishing an effective and efficient communication protocol between contractual parties during both the design and supervision stages, cost overruns can be avoided. It is important to promote and advance electronic communication in the construction sector while also upholding a high standard of openness and clarity.

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