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RESEARCH PAPER

Influence of Construction Risks on Cost Escalation of Highway-Related Projects: Exploring the Moderating Role of Social Sustainability Requirements

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Abstract

This study investigates the influence of three most influential construction risks, namely, design and documentation risks, site operations risks, and contract and management risks on cost escalation of highway projects with the moderation effect of social sustainability requirements. The data were collected from 210 professionals working in various highway projects in Pakistan through questionnaire survey. The data were analyzed using Barron and Kenny approach. The results obtained from the research validate that the selected construction risks are significant predictors of cost escalation in highway projects and should be mitigated appropriately. The results of analysis also imply that social sustainability requirements significantly enhance the positive relation of construction risks with the cost escalation. The project managers should cater to the social sustainability requirements during the early stages of the project to avoid subsequent variations that result in delaying of project and ultimately the cost escalations. This can be an essential contribution to the existing literature as many projects are prone to cost escalations due to social sustainability issues.

Keywords Social sustainability · Cost escalation · Construction risks · Highway projects · Developing country

1 Introduction

The role of the construction industry is pivotal in the economic growth, social development of a country, and other industrial sectors (Osei-Kyei and Chan 2017; Shehu et al. 2014). Construction projects have a gigantic impact on economy, environment as well as the society itself (Zuo et al. 2012; Maqsoom et al. 2020). Construction projects especially relating to the infrastructure face many risks that have a negative impact on the performance of the project (El-Sayegh and Mansour 2015). Several techniques have been utilized in past to identify the risks involved in construction industry that contributes to cost escalation in the projects as it is the most common problem faced in the industry (Shehu et al. 2014; Cheng 2014). Overall, the risk factors that have been reported to cause cost escalation in construction projects include design and documentation, labor and workforce, site operations, procurement, financial management, contract and management and communication and coordination-related issues (Zhao et al. 2016; Larsen et al. 2015). In an established study of highway projects, the primary factors that contribute

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to cost escalation are concluded to be design issues, site operations, and issues related to planning or management (Kaming et al. 1997).

Highway projects are rarely completed in the allocated budget (Larsen et al. 2015; Sovacool et al. 2014; Keeble 1988; Shen et al. 2007). In the modern day construction, cost escalation has been reported to be a frequent incident in highways and needs to be learned in more detail (Naoum and Egbu 2016; Olawale and Sun 2015; Masood et al. 2015). A study evaluated 258 highway projects of 20 different countries and showed that 90% of the projects have faced cost escalation (Flyvbjerg et al. 2003). In Uganda, the road project of Northern-by-pass required 200% additional budget (Mujabi et al. 2015) while it was 45% in Nigerian projects (Olatunji 2008) and 55% in Malaysian highway projects (Shehu et al. 2014). According to another study conducted by Olatunde, Alao (Olatunde and Alao 2017) in Malaysia, only 46.8% of publicly funded projects and 37.2% private projects were completed in the budget.

Cost escalation has been one of the major risk factors faced by the construction industry of developing countries especially Pakistan (Choudhry and Iqbal 2012; Razzaq et al. 2018; 2019; Tayeh et al. 2020). In a study of Batool, Abbas (Batool and Abbas 2017), it was revealed that construction projects in Pakistan faced 2.5 times more costs than originally anticipated. In a study of infrastructure development projects, it has been reported that projects in Pakistan are indebted twice of their original project cost, e.g., Nandi Pur power project has escalated from Rs. 32 Billion to 82 Billion while New Islamabad International Airport project cost arose to 2.7 times of planned project cost (Choudhry et al. 2014). Another example is Neelum Jehlum Hydropower project in Pakistan which has shown a drastic increase in the project cost and it escalated from Rs. 18 billion to over Rs. 500 billion (Razzaq et al. 2018). Similarly the Orange Line Metro train project has also faced a massive cost escalation of $1.5 Billion, a major factor to this was the delays and litigations due to conflicts of heritage protection (2017). One of the prime example of land acquisition-related issues emerged on a Leyari Expressway project at Karachi claiming the delay of north bound construction almost 15 years beside the major cost escalations of Rs23 bn (Razzaq et al. 2018). Moreover, Peshawar Islamabad Motorway project (M1) was initially started in 1993 and also remained one of the major delayed projects of Pakistan. The project connects the country capital Islamabad with Peshawar making it 155Km long and was finally completed in October 2007. Recently, the cost escalation has also been reported to be a major concern in the ongoing China Pakistan Economic Corridor (CPEC) one belt one road project. Issues of social sustainability such as land issues have been a major factor causing delays and cost escalation in implementation of these highway projects (Razzaq et al. 2018; 2017).

In the past, few studies have been carried out to illuminate the importance and benefits of sustainability in highway projects but there is a need to consider the increased cost that is incurred by sustainability requirements (Tsai and Chang 2012; Ozcan-Deniz and Zhu 2016; Tayeh et al. 2020). Some highway projects may pose extensive social sustainability requirements, the cost of which might exceed the actual **cost** (Gilchrist and Allouche 2005; Abid et al. 2020). It is concluded that highway projects pose a great social cost on the community and this aspect needs to be explored further as current studies are sporadic (Yu and Lo 2005; Brent and Labuschagne 2006; Banihashemi et al. 2017). Therefore, the current study has been carried out to fulfill the research gap that exists in the current literature regarding the influence of construction risks on cost escalation of highway projects. Also, the study analyzes the moderating role of social sustainability requirements over the relationship between construction risks and cost overrun in highway projects.

2 2. Literature Review

2.1 Theoretical Background

Theories on the factors affecting cost escalation are mainly divided into two source groups (Ahiaga-Dagbui and Smith 2014). The first group relating to the rolling wave planning, i.e., 'Evolution Theorist' suggests that major cost overruns in construction projects are due to the changing requirements of scope and description of work during the project life (Yap et al. 2018). The changes in the scope of projects have been identified to be the most critical contributor to cost escalation (Le Hoai et al 2008). These changes also contribute to the reciprocating the requirements of site operations that further add toward the cost overruns (Zhao et al. 2016).

The second group relates the issues of cost escalation toward the deficiencies in management, that is due to contributors of psychology and business strategy (Love et al. 2017). 'Psycho Strategists' is the term used for this school-of-thought. It lists the major contributors of cost escalation to be fraudulent techniques, over-optimistic estimates, and fallacies of planning (Flyvbjerg et al. 2002). Such issues later on contribute toward the enhancement of risks associated with management that can cause conflicts resulting in a change of partners. These risks can also trigger the contractual risks due to unclear specifications and responsibilities resulting in subsequent litigations and long delays which cause major deficiencies in fulfilling the social requirements of the projects (Brent and Labuschagne 2006)

2.2 Cost Escalation

Cost escalation has been predominantly defined in the literature as the ratio or difference between the actual cost and budgeted cost, i.e., a project is said to have a cost escalation if the actual cost incurred on the project exceeds the budgeted cost allocated for the project (Shehu et al. 2014; Flyvbjerg et al. 2003; Creedy et al. 2010). Wastage of limited resources is one of the main effects of cost escalations as over 75 % of the projects are financed through funds from the donor or through international loans (Mold 2012). The most common effect of a cost escalation is the requirement of additional resources as well as additional time delay due to reciprocating changes in the project (Pheng and Chuan 2006). The cost overruns and delays of the project not only cause issues of litigations but also result in long suspensions of work due to pending arbitrations (Amoatey et al. 2015).

There are many risk factors that have been reported to cause cost escalation in construction projects around the globe. A brief summary of these factors has been shown in Table 1.

2.3 Social Sustainability

Social sustainability can be reflected into the theory that the upcoming generations should be provided with an increased pool of social resources or at least the same amount as enjoyed by the current era (Keeble 1988). Social sustainability is supposed to cater for the basic human needs, ensure social justice, engagement of society, and human dignity (Littig and Griessler 2005). However, the humongous use of natural resources and the negative effects on the environment have been raising many flags on the newly conceived projects and activities of the construction industry (Ding et al. 2016). Several frameworks have been developed to emphasize the importance of sustainability and to incorporate sustainability in construction projects to ensure proper coordination between different construction phases and teams (Valdas-Vasquez and Klotz 2012; Kucukvar and Tatari 2013). But it has been noted that most of the efforts are largely concentrated toward the environmental dimension of sustainability (Ozcan-Deniz and Zhu 2016; Santos et al. 2017). Some of the commonly proposed measures include management of construction wastes, reduction in greenhouse emission reduction, improvement in energy infrastructure, and better water management (Parrish and Chester 2013; Xia et al' 2014; Yates 2014). Even the latest rigorous researches which narrate the impacts and benefits of sustainability have somehow missed the social dimension of sustainability (Santos et al. 2017). Though the aspect of social sustainability has been explored and its importance has been established to be incorporated in urban development (Weingaertner and Moberg 2014), the particular effects of social sustainability requirements have not yet been analyzed on cost escalation.

Table 1. Summary of cost escalation factors

Study	Country	Factors
Bing et al. (2005)	United Kingdom	Inexperience of contractor, variations in the prices of construction material, recurrent changes in design, unstable economy, bank loans and financing offered at a high-interest rate, and deceitful practices as well as kickbacks.
	United Kingdom	Changes in design, uncertainties/risks of the project, improper planning & scheduling, complications, and poor performance by the employed subcontractors.
Akinci and Fischer 1998	Developing countries	Substandard management, erroneous estimates of materials and financial stature of the employed contractor.
Enshassi et al. 2009	Ghaza	Design & documentation risks, labor and workforce risks, site operations risks, procurement risks, financial management risks, contract & management risks, and communication & coordination risks.
Le-Hoai et al. 2008	Vietnam	Poor supervision & management at the site, inefficient assistance in project management, owner's & contractors issues of finance and changes in design.
Amoatey et al. 2015	Ghana	Delay in interim payments, escalation of inflation, material price escalation, unavailability of funds, change orders, and poor capital market.
Rauzana (2016)	Indonesia	Errors in the estimation of budget, execution & reporting relationships and project documentation.
Kaliba et al. (2009)	Zamibia	Weather conditions, changes in scope, additional cost for environmental protection, delays in schedule, labor strikes, technical difficulties, escalation of prices, and regulatory authority pressures.
Gonzaiez et al. 2013	Chile	Improper planning and poor subcontracting practices.
Kaming et al. 1997	Indonesia	Design issues, site operations issues, and issues of planning or management.

3 Research Model and Hypotheses Development

The basic research model and hypotheses of the study are shown in Fig. 1. As the figure illustrates, the construction risks, i.e., design and documentation risks, site operations risk, and contract and management risks are taken as independent variables (IVs). Whereas, social sustainability requirement have been taken as a moderator between the relationships of IVs with the dependent variable of cost escalation.

The top contributor to cost escalation has been predominantly found the issues related to design changes in the global construction industry (Olawale and Sun 2015). It is very important to use the standardized design on a construction project to avoid changes in design. Any modification in the design will affect the budget allocated for the project, the volume, and type of required materials and the labor (Enshassi et al. 2009). Most common design and documentation risks causing cost escalation include frequent design changes, mistakes, and errors of design, incomplete design during tendering, poor design, delay in preparation of design, and construction drawing approvals (Kaming et al. 1997; Marzouk and EI-Rasas 2014; Olawale and Sun 2010). Also, other recent studies which have analyzed the design and documentation risks have identified that most critical items that contribute toward cost escalation are changes in specification, lack of coordination in different design stages, mistakes and errors in design, incomplete design, and delay in approvals of designs (Creedy et al. 2010; Assaf et al. 2017). Grounded on the above literature following hypothesis is formulated:

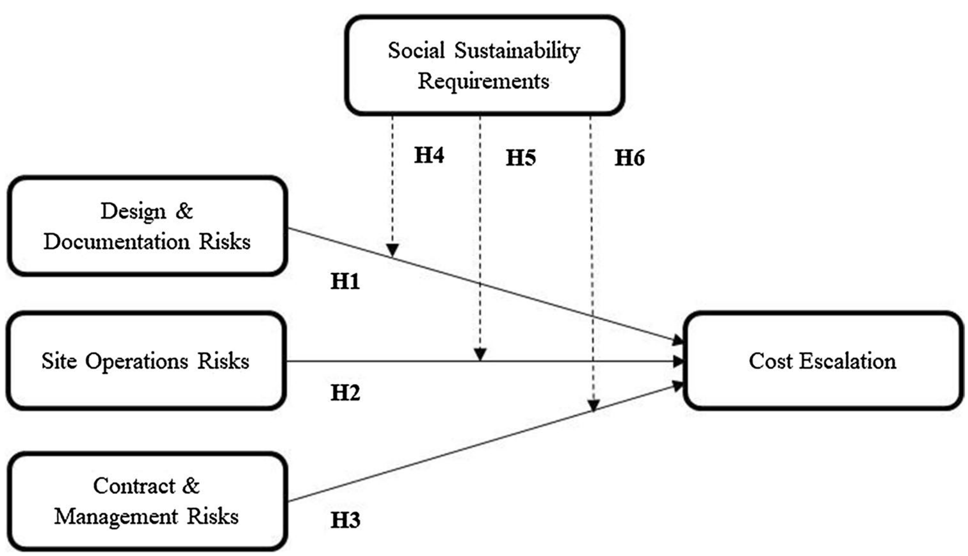
Hypothesis 1 *Design and documentation risks have a significant positive impact on cost escalation.*

Issues relating to site operations such as subcontracting issues and planning deficiencies have been identified as major sources of cost escalation (Gonzalez et al. 2013). The risks associated with poor productivity at site plays a key role in cost escalation of large-scale construction projects (Kaming et al. 1997). Improper planning and site management are also found to be critical contributor toward cost escalation among many such factors which may lead to an increase on cost of project more than the planned value (EI-Sayegh and Mansour 2015; Le-Hoai et al. 2008). The most critical site operational issues highlighted in the previous studies are the substandard site management and supervision, issues related to subcontractors, lack of experience, poor execution methods, unskilled workforce, poor planning and scheduling, inefficient communication, lack in coordination and mistakes in execution (Gonzalez et al. 2013; Gunduz et al. 2012; Akinci and Fischer 1998). Grounded on the above literature following hypothesis is formulated:

Hypothesis 2 *Site operations risks have a significant positive impact on cost escalation.*

Another critical and highly important criterion for the success of a project is its efficient management (Pheng and Chuan 2006). Disputes and changes in management have been ranked in the literature as most rigorous issues that have the ability to greatly affect cost escalation in a project (Larsen et al. 2015). Similarly, developing countries have reported delayed decision making of management as one of the key contributors to cost escalation (Subramani et al. 2014). Mistakes of contract leading to variations have also been identified to be a cause of 23.75% cost escalation in

Figure 1. Research Model



the construction project (Love et al. 2017). The issues of improper contract and management have been identified as one of the top risks that cause cost escalation in large-scale construction projects (Adam et al. 2017). In a meta-analysis of available literature, several risks related to contract and management have been identified to be most critical that contribute to cost escalation (Larsen et al. 2015). Grounded on the above literature following hypothesis is formulated:

Hypothesis 3 *Contract and management risks have a significant positive impact on cost escalation.*

After a detailed review of the available literature, it was found that sustainability requirements are highly recommended and need to be employed in all kinds of construction projects (Xia et al. 2014; Yates 2014,; Hill and Bowen 1997). It has also been highlighted that incorporating the requirements of sustainability into construction projects require additional costs and expenses that need to be considered in the projects (Tsai and Chang 2012). The social costs associated with the construction projects are quite high, and the social sustainability requirements have their effects in different phases of the projects that include inter alia: design and documentation, the operations in construction phase as well as the award of tender (Brent and Labuschagne 2006). As a result, the project partners need to integrate a comprehensive solution for incorporating the aspects of social sustainability in the projects (Shen et al. 2007).

Shen et al. (Shen et al. 2007) and Zuo et al. (Zuo et al. 2012), based on a meta-analysis of available literature, have listed some factors of social sustainability that are required to be incorporated in the construction projects which include: incorporating land used to protect current ecological growth, infrastructure capacity building of the community, security considerations in design deliberation, preservation of cultural and natural heritage, and health and safety considerations in project environment. One of the major barrios is implementing social sustainability into construction projects is the high capital costs associated with these implementations (Jensen et al. 2018). Incorporating social sustainability into the projects can significantly increase the costs of the project. This is due to the fact that special measures required for catering to the social sustainability requirements in project phases, e.g., design phase would require additional efforts, which results in additional scope. Similarly fulfilling the social sustainability requirements such as health and safety requirements will result in additional scope in site operations. Presumably, the contract and management aspect of the project would also grow more complex if it has to cater to the social sustainability requirements of construction projects. Special measures required to incorporating land use as per social sustainability requirements to protect current ecological growth can also result in additional land requirement. This requirement could enhance the budget requirement for the project. Grounded on the above literature following three hypotheses are formulated:

Hypothesis 4 *Social sustainability moderates the relationship between design and documentation risks and cost escalation.*

Hypothesis 5 *Social sustainability moderates the relationship between site operational risks and cost escalation.*

Hypothesis 6 *Social sustainability moderates the relationship between contract and management risks and cost escalation.*

4 Research Methodology

Based on the proposed research model, this study was conducted for the construction sector and various highway-related projects were part of it. A quantitative approach was used to extract the required data responses through a structured questionnaire. The questionnaire having a total of 37 questions comprised of multiple choice questions in order to study demographics of the sample population and closed ended questions in order to measure the items. The structured questionnaire was constructed on the basis of previously published research studies relating to cost escalation and the theoretical foundations that have been established in the past (Table 2). These items were anchored using a five-point Likert scale varying from a value of (1) for (Strongly Disagree) to a peak value of (5) for (Strongly Agree). The questionnaire was preliminarily shared with five specialists

Table 2. Measures of variables

Variable	Type	No. of questions	Adapted from
Design and documentation risks	Independent	5	(Assaf et al 2017)
Site operations risks	Independent	8	(Gunduz et al. 2012
Contract and management risks	Independent	8	(Larsen et al. 2015)
Social sustainability requirements	Moderator	5	(Shen et al. 2007;Zuo et al. 2012)
Cost escalation	Dependent	6	(Aibinu and Jagboro 2002)

of the industry for examination of content validity. The recommendations concerning changes in the selection of words and the overall layout were made in the questionnaire.

This research sample consisted of 210 responses received from various highway projects across the country. The study is a correlational research as it aims at discovering the association between the design and documentation risks, site operational risks, contract and management risks, cost escalation and social sustainability requirements. No artificial preparations were carried out for the collection of data; therefore, the setting of the study can be reflected as a non-contrived setting. The researcher had minimum interference during the data collection; therefore, the research can be classified as a field study. The data collection was performed once and analysis was based on one time data so the study can be labeled as a cross-sectional investigative study.

Based on published literature, design and documentation risks were measured through the items adapted from Assaf et al. (Assaf et al. 2017), items for site operations risks were adapted from Gündüz et al. (Gunduz et al. 2012) and the items for contract and management risks were adapted from the study of Larsen et al. (Larsen et al. 2015). Cost escalation in projects was measured through the items mentioned by Aibinu, Jagboro (Aibinu and Jagboro 2002), and the moderating effect was measured through the items adapted from Shen et al. (2007) and Zuo et al. (2012) for social sustainability requirements (Table 2).

An inscribed disclaimer was also made part of the structured questionnaire to certify confidentiality. Overall 350 survey questionnaires were distributed but the results of only 227 were received. These gathered responses of questionnaires had 17 instruments with incomplete or missing data, limiting the size of the sample to 210 (60% response rate) for the analysis of data. Statistical Package for the Social Sciences (SPSS) was employed to carry out the necessary computation of correlation and regression analysis for the study variables. The data were evaluated for reliability through Cronbach's Alpha check. The validity of data and its reliability was verified, as the results yielded values above the accepted norms, i.e., 0.7. Cronbach's Alpha test of reliability for the total sample of 210 respondents also yielded values exceeding the acceptable limiting value of 0.7 as shown in Table 3.

Table 3. Scale measurement for sample (*N*= 210)

Variable	Type	No. of items	Cronbach's Alpha
Design and documentation risks	IV	5	0.741
Site operations risks	IV	8	0.853
Contract and management risks	IV	8	0.813
Social sustainability requirements	MV	5	0.712
Cost escalation	DV	6	0.834
Overall reliability		32	0.809

5 Results

The varying characteristics of the respondents were recorded and displayed by frequency distribution through demographical statistics in SPSS 20 (Table 4). The gender statistics show that although females have recently been a part of the workforce in the industry, majority of the workforce in the highway projects is comprised of the male gender. Demographic distribution based on acquired academic qualification shows that the number of respondents with PhD qualification was quite low. The demographic distribution of professional experience shows that a higher ratio of respondents had an experience of more than 15 years. The categorization based on organization type shows that the private sector is more involved in the highway projects of the country. The categorization of organizational profile depicts that due to scarcity of clients in the industry, contractors and subcontractors have to work with a limited number of clients.

Descriptive analysis was carried out to give a statistical summary of all the variables in the study. The three independent variables termed as design and documentation risks, site operations risks, and contract and management risks provided mean values of 3.267, 3.485, and 3.226 along with the standard deviation values of 1.806, 1.005, and 1.006, respectively. The standard deviation value for dependent variable (cost escalation) is also pretty low at 0.963 with a mean value of 3.453. The results of the descriptive analysis for moderator variable of the research, i.e., social sustainability requirements depict a high mean value of 3.368 with a standard deviation value at 1.006 (Table 5). The values of Skewness and Kurtosis were also recorded for each variable. The Skewness values for independent variables were recorded at 0.251, -0.019, and 0.371. Skewness of cost escalation was recorded at -0.075 and social sustainability requirements at 0.770 (Table 5). The value for Kurtoses of design and documentation risks is 2.012, 1.017 for site operations risks and -2.538 for contract and management risks. Kurtoses values of cost escalation are 1.742 and social sustainability requirements is 2.321 (Table 5).

The skewness and kurtosis values for the construct variables were calculated to check the normality of the model. The values are between the acceptable ranges (1 to -1) for skewness and (3 to -3) for kurtosis (refer to results on Table 5); therefore, the results suggest that the data are normally distributed. The linear relationship between the variables is also verified through results of scatter plots that eliminate the chances of Type-II error. The data from

Table 4. Data characteristics

Characteristic		Frequency	Percent	Valid percent	Cumulative percent
Gender	Male	173	82.4	82.4	82.4
	Female	37	17.6	17.6	100
	Total	210	100	100	
Education	Diploma holders	24	11.4	11.4	11.4
	Bachelors	96	45.7	45.7	57.1
	Masters	72	34.3	34.3	91.4
	PhD Total	18 210	8.6 100	8.6 100	100
Experience	1–5 Years	36	17.1	17.1	17.1
	6–10 Years	42	20.0	20.0	37.1
	11–15 Years	36	17.1	17.1	54.3
	More than 15 Years total	96 210	45.7 100	45.7 100	100
Organization type	Private	86	40.9	40.9	40.9
	Government	42	20.0	20.0	60.9
	Semi-Government	38	18.0	18.0	78.9
	Municipalities total	44 210	20.1 100	20.1 100	100
Organizational profile	Client	12	5.7	5.7	5.7
	Contractor	82	39.0	39.0	44.7
	Consultant	48	22.8	22.8	67.5
	Subcontractor total	62 210	29.5 100	29.5 100	100

Table 5. Descriptive analysis

Variable	N	Min	Max	Mean	Standard skewness	Deviation	Kurtosis
Design and documentation risks	210	1.29	5.00	3.267	1.806	0.251	2.012
Site operations risks	210	2.01	4.9	3.485	1.005	-0.019	1.017
Contract and management risks	210	1.49	4.8	3.226	1.006	0.371	-2.538
Cost escalation	210	1.78	4.7	3.453	0.963	−0.075	1.742
Social sustainability requirement	210	1.73	4.9	3.368	1.006	0.770	2.321

Table 6. ANOVA results

	Sum of squares	df	Mean square	F	Sig.
Regression	180.807	3	60.269	47888.133 0.000	
Residual	0.259	206	0.001		
Total	181.067	209			

Predictors: DD, SO, CM ; Dependent Variable: CO

the questionnaire were also checked for heteroscedasticity. Further to this, the results of ANOVA also provided a low significance value of less than 0.05 (Table 6). These checks were carried out to ensure that the regression analysis can be carried out on the construct for gathered data.

The results of correlation analysis depict the values of the Pearson's correlation coefficients present between the variables of the research model which provide the degree of linear association between the variables. The correlation value between design and documentation risks and cost escalation is (0.588), between site operations risks and cost escalation is (0.510), whereas contract and management risks have a correlation value of (0.405) with the cost escalation. The value of correlation is (0.556) between social sustainability requirements and cost escalation (Table 7). Furthermore, all the correlations of the model are significant with a significance level of 0.05 as depicted by the 2-Tailed significance values of the results (Table 7). The test was carried out to check the degree of association between the variables without suggesting a causal relationship. The results indicated that there exists a correlation between the variables of the construct.

Barron and Kenny approach has been employed to perform a 12-step multiple regression to verify the moderation relationships. The results of the regression analysis for each hypothesis are summarized in Table 8. The regression

Table 7. Correlation analysis

		Design & Doc. risks	Site operations risks	Contract management risks	Cost escalation	Sustainability requirements
Design and documentation risks	Pearson	1	0.305 **	0.357 **	0.588 **	0.463 **
	Correlation		0.000	0.000	0.000	0.000
	Sig.(2Tailed) N	210	210	210	210	210
Site operations risks	Pearson		1	298**	.0.510 **	0.314 **
	Correlation			0.000	0.000	0.000
	Sig.(2Tailed) N		210	210	210	210
Contract and management risks	Pearson			1	0.405 **	0.455 **
	Correlation				0.000	0.000
	Sig.(2Tailed) N			210	210	210
Cost escalation	Pearson		.		1	0.556 **
	Correlation					0.000
	Sig.(2Tailed) N				210	210
Social sustainability requirements	Pearson correlation					1
	Sig.(2Tailed) N					210

Table 8. Summary of regression results (Barron & Kenny Approach)

	Model	Beta	R^2	Adjusted R^2	Sig
Step 1. Regress cost escalation on construction risks	Design and documentation risks	0.368	0.700	0.699	0.000
	Site operations risks	0.391	0.872	0.871	0.000
	Contract and management risk	0.197	0.779	0.770	0.000
Step 2. Regress social sustainability requirements on cost escalation	Design and documentation risks	0.562	0.316	0.312	0.000
	Site operations risks	0.812	0.661	0.659	0.000
	Contract and management risk	0.654	0.428	0.425	0.000
Step 3. Regress cost escalation on social sustainability requirements	Social sustainability requirements	0.754	0.569	0.567	0.000
Step 4. Regress cost escalation on the interaction effect of cost escalation and social sustainability requirements	(Design and documentation Risks * social sustainability requirements)	0.805	0.819	0.816	0.000
	(Site operations risks * social sustainability requirements)	0.866	0.707	0.706	0.000
	(Contract and management risks * social sustainability requirements)	0.745	0.765	0.763	0.000

coefficient (Beta value) for cost escalation on design and documentation risks comes out to be (.368) which implies that 1 unit change in design and documentation risks causes 0.368 unit change in cost escalation. The goodness of fit (R^2 value) is (0.700) which suggests that design and documentation risks explain 70% variation in cost escalation. The positive sign of beta suggests that only a unidirectional change is expected between the independent and dependent variable (Table 8). As the significance value is quite low (0.000 < 0.05), the first hypothesis (H1) of the study is accepted. Similarly, Beta values of site operations risks and contract and management risks regressed by the cost escalation are (0.391) and (0.197) with R^2 values of (0.872) and (0.779). With the low values of the sig (<0.05), these results indicate that the H2 and H3 of the study are also accepted.

To check the moderation effects of social sustainability requirements, Barron and Kenny approach utilized four steps to verify the moderating role on the relationship for each variable (Table 8). Step 1 verifies that IVs are predictors of DV. Step 2 verifies IVs are predictors of moderator and Step 3 verifies that the moderator is a predictor of DV. Step 4 verifies the interaction effects of IVs and moderating variable on the construct. The hypothesis of the study for the moderation effects of social sustainability requirements (H3, H4, and H6) are accepted as the results of the above-mentioned steps yield low sig. value of less than 0.05 (Table 8). The results of step 4 yield beta value of (0.805) for the interaction effect of social sustainability requirements with design and documentation risks. The moderation effect is indicated by the difference in beta values of step 1 and step 4, which shows an increase of 0.437 (.805–368). The results implicate that effects on cost escalation by design and documentation risks are significantly enhanced by the presence of moderating variable (social sustainability requirements). The moderation effect for site operation risks and contract and management risks are also significant with enhanced beta values by 0.475(.866–391) and 0.548(.745-.197), respectively. As clear from the results, the social sustainability requirements can highly increase the risks of cost overruns by acting as a moderator between the relationship of all the IVs and cost overrun (DV). However, the results also indicate that the moderating affect is most significant for cost overrun due to contact and management risks. This moderation effect is relatively lower for the cost overrun due to site operation risks. The cost overrun due to design and documentation risks is the one that is least moderated by the social sustainability requirements. However, it is pertinent to mention here that the moderation effect is still at a highly significant value for all the independent variables.

6 Discussions

Hypothesis 1 *Design and documentation risks have a significant positive impact on cost escalation of construction projects. (Accepted)*

Risks associated with the design and documentation such as changes in design and the specifications, mistakes and errors in design, incomplete design during the tendering, lack of coordination between the design teams and the prepared construction drawings, delays in preparation of design drawings and subsequent delay in its approval can significantly contribute to increase in project costs (Olawale and Sun 2015; 2018**).** An unclear and discursive design can significantly contribute toward the cost escalation of highway-related projects. Highway projects should opt for the design as per the codes and standards, that are acceptable in the industry (Marzouk and EI-Rasas 2014). Changes and enhancements in the design cause cost escalation in the project by initiating requirements of additional material and additional workforce.

Hypothesis 2 *Site operations risks have a significant positive impact on cost escalation of construction projects. (Accepted)*

Risks associated with operations at the site are also one of the key contributors toward the cost escalation of highway projects (Le-Hoai et al. 2008). The complex nature of modern day construction and the advent of latest technologies in highway projects which requires an advanced skill set to use them has increased the vulnerability of highway projects toward site operations (El-Sayegh and Mansour 2015). The issues of weak site management, improper construction methods, unavailability of labor technical staff, mistakes in construction and substandard works, quality issues, material shortage and lack of productivity at site significantly contribute toward the hazards and cost escalation of construction projects **(**Olawale and Sun 2015; Abid et al. 2020**).**

Hypothesis 3 *Contract and management risks have a significant positive impact on cost escalation of construction projects. (Accepted)*

The risks concomitant with the contract and management of construction project greatly attribute to the escalation of project cost in construction environments (Gonzalez et al. 2013; Akinci and Fischer 1998). The issues like poor criteria for award of contract, delays in decision making, additional restrictions from controlling authorities, unclear specifications of the contract and its poor interpretation, conflicts and changes in management and communication gap between the project partners are some of the major risk factors that need to be addressed in the highway projects. A well-documented contract and efficient management of projects can significantly add to the success of project (Akinci and Fischer 1998; Kaliba et al. 2009).

Hypothesis 4–6 *Social sustainability requirements act as moderator for the relationship between design and documentation risks, site operations risks, and contract and management risk with cost escalation. (Accepted)*

Social sustainability requirements such as security design deliberations and design provisions to cater for infrastructure capacity building of neighboring communities play a key role toward increasing the costs of highway projects. Similarly design changes required to protect current ecological growth can contribute significantly to cost escalations (Tsai and Chang 2012).

Incorporation of social sustainability requirements has a major influence on the site operations of a highway project. It has also been mentioned in previous studies (Banihashemi et al. 2017) that in order to achieve sustainability in the project it is imperative to carry out the site operations of the construction project with special considerations. The issues in achieving such targeted site operations have been reported to be the unavailability of experience and trained professionalrements such as changes in alignment to protect ecological growth, additios to carry out the desired tasks (Tabassi and Bakar 2009) and these issues can be reduced by taking appropriate steps like training of the workman involved and implementing special practices at the site which requires additional costs.

The effects of social sustainability requinal provisions of infrastructure capacity building of the community, preservation of cultural and natural heritage, and even the provisions of safety and security considerations require substantial efforts in contract and management of the projects (Yu and Lo 2005). Incorporating these requirements in the contract and management of the project has a significant effect on the cost escalation. The contract and management of project hence plays a vital role in achieving the social sustainability requirements in the context of infrastructure development and construction projects.

6.1 Managerial Implications

This research study has a variety of managerial implications. Construction companies that give critical importance to the budget constraints of their projects can utilize the research results to check the contributing impacts of construction risks toward the cost escalations of the highway projects. The managers can then try to mitigate these risks individually by implementing special policies and measures in different phases of the projects to minimize the cost escalation of the projects. Furthermore, since the effects of social sustainability requirements have been analyzed while investigating the effects of construction risks contributing to the cost escalation, managers can thus utilize the results of this study to allocate the additionally required budgets appropriately in different phases of the project to incorporate social sustainability requirements. As depicted by the results of the study, managers should be aware that the impacts of contract and management risk of the projects would be highly enhanced by the needs to incorporate the social sustainability requirements of the community. The results indicate that the social sustainability requirements can highly enhance the effects of contract and management risk of the projects. It is therefore required by the project managers as well as the owners to incorporate additional contingency reserve in the project for mitigating these risks. This increase in probability of increase in cost overrun can be attributed to additional measures required in contract and management of projects to incorporate social sustainability requirements. All the aspects of social sustainability that have been recommended to be incorporated in construction projects increase the risks associated with contract and management of the projects. Social sustainability requirements such as incorporating land use to protect current ecological growth and preservation of cultural and natural heritage would not only require additional management tasks but could also result in increased contractual requirements. Similarly, requirements of health and safety considerations in project environment and security considerations in design deliberation would be add-ons in the contractual requirements as well as management tasks.

Similarly, in order to carry out operations in line with the social sustainability requirement special measures and additional workforce would be required in managing site operations and project execution that could have an incremental effect over the budget requirements of the project. Infrastructure capacity building requirements such as construction of additional interchanges or providing measures such as cattle creeps would increase the budget requirements of site operations. Considerations of health and safety requirements also require increase in site operations tasks. Correspondingly, heritage preservation if required would also result in additional cost in carrying out the site operations. On the other hand, the managers also need to cater for the additional requirements in the documentation and design of the projects as the social sustainability requirements would require modifications and improvements in the generic designs being followed in the construction industry resulting in requirement of additional costs as well as time requirements. This additional cost and time requirement could be a result of corresponding change in design to incorporate land use for protecting current ecological growth. Security considerations in design deliberations would also require amendments in project design resulting in additional capital requirements. Similarly, infrastructure capacity building of the community with steps like providing additional interchanges, service roads etc. would result in increased design scope, causing additional costs.

Conclusively, the most important phase for catering the social sustainability requirements is during the initiation phase when feasibility studies are being carried out. This requires the involvement of stakeholders during the process of decision making of the project. If the social sustainability requirements are envisaged in the early stage of project conception, the chances of cost overrun in later stages of projects can be significantly reduced. Stakeholders need to identify the social sustainability requirements of the project before the project budget is finalized so that these additional requirements can be effectively addressed.

7 Conclusion

This research highlights the importance of the most commonly faced construction risks that contribute toward the cost escalation of highway projects. The three categories of construction risks, i.e., design and documentation risks, site operations risks, and contract and management risks have been found to be major contributor to cost escalation contributors and their role has been identified as critical. Therefore, the industry professionals should focus on mitigating these risks in order to control the cost escalations being faced in the construction industry. Furthermore, the effect of social sustainability requirements in the presence of the construction risks has been recognized as a moderator that tends to increase the cost for executing the highway projects. Therefore, apart from mitigating the construction risks that contribute toward increased cost, there is a need to recognize the role of social sustainability requirements toward cost escalations of projects.

Additionally, the increased demands of expenditure due to the requirements of social sustainability need to be appropriately addressed by means of increased capital investments, additional funds supply or enhanced operational costs. Community friendly highways that contribute toward the social sustainability requirements by preserving the existing culture and natural heritage are generally preferred by the general public as well as by freighters. Correspondingly, projects that contribute toward the capacity building and improvements in the surrounding community even with exceeding the budget requirements are considered to be a prize jewel for the development of the country. Protecting ecological growths of the surrounding community through land use policy is another aspect that offers a valid justification for exceeding budget requirements of the development projects. However, these requirements should be addressed in the inception stages of the project so that appropriate budget can be allocated in the start to cater for such needs.

7.1 Limitations and Suggestion for Future Directions

This study has been conducted on highway projects located in Pakistan. Nevertheless, a larger sample size including highway projects from other countries might provide further generalizable results. Furthermore, the framework of research is restricted to comprehend the impact of only three most critical construction risks that contribute toward the cost escalations of the projects. The results provide a solid base for proving the role of social sustainability and its impacts on the highway projects. In addition, effects of other dimensions of sustainability can also be checked for the moderating role over the relationship between risks and cost escalation.

Appendix 1: Regression Tables

See Tables 9, 10, 11, 12, 13 and 14

Table 9. Regression Analysis: H1

Model	Beta	t	F	R^2	Adjusted R^2	Sig
Design and documentation risks	.368	2.779	567.09	.700	.699	.000

Table 10. Regression analysis: H2

Model	Beta	t	F	R^2	Adjusted R^2	Sig
Site operations risks	.391	4.189	239.08	.872	.871	.000

Table 11. Regression analysis: H3

Model	Beta	t	F	R^2	Adjusted R^2	Sig
Contract and management risks	.197	2.098	316.07	.779	.770	.000

Table 12. Regression analysis: H4

	IV	DV	beta	F	t	R^2	Adjusted R^2	Sig.
Step 1	Design and documentation risk	Cost overrun	.368	456.09	2.779	.700	.699	.000
Step 2	Design and documentation risk	Social sustainability requirements	.562	782.09	3.709	.316	.312	.000
Step 3	Social sustainability requirements	Cost overrun	.754	412.09	3.711	.569	.567	.000
Step 4	Design and documentation risk * Social sustainability requirements	Cost overrun .	805	312.87	5.098	819	.818	000

Table 13. Regression analysis: H5

	IV	DV	beta	F	t	R^2	Adjusted R^2	Sig.
Step 1	Site operations risks	Cost overrun	.391	543.08	4.189	.872	.871	.000
Step 2	Site operations risks	Social sustainability requirements	.812	312.09	4.189	.661	.659	.000
Step 3	Social sustainability requirements	Cost overrun	.754	412.09	3.711	.569	.567	.000
Step 4	Site operations risks * social sustainability requirements	Cost overrun	.866	312.87	7.081	.707	.706	.000

Table 14. Regression analysis: H6

	IV	DV	beta	F	t	R^2	Adjusted R^2	Sig.
Step 1	Contract and management risks	Cost overrun	.197	264.06	7.009	.779	.770	.000
Step 2	Contract and management risks	Social sustainability requirements	.654	981.89	4.189	.428	.425	.000
Step 3	Social sustainability requirements	Cost overrun	.754	412.09	3.711	.569	.567	.000
Step 4	Contract and management risks * social sustainability requirements	Cost overrun	.745	341.87	9.079	.765	.763	.000

Compliance with ethical standard

Conflict of interest The authors declare that they have no conflict of interest

References

Bing L, Akintoye A, Edwards PJ, Hardcastle C (2005) The allocation of risk in PPP/PFI construction projects in the UK. International Journal of Project Management 23(1):25–35

Cheng Y-M (2014) An exploration into cost-influencing factors on construction projects. Int J Proj Manag 32(5):850–860

Choudhry RM, Iqbal K (2012) Identification of risk management system in construction industry in Pakistan. J Manag Eng 29(1):42–49

El-Sayegh SM, Mansour MH (2015) Risk assessment and allocation in highway construction projects in the UAE. J Manag Eng 31(6):04015004

Flyvbjerg B, Skamris Holm MK, Buhl SL (2003) How common and how large are cost overruns in transport infrastructure projects? Transport reviews 23(1):71–88

Kaliba C, Mundia M, Kanyuka M (2009) Cost escalation and schedule delays in road construction projects in Zambia. Int J Constr Proj Manag 27(5):522–531

Kaming PF, Olomolaiye PO, Holt GD, Harris FC (1997) Factors influencing construction time and cost overruns on high-rise projects in Indonesia. Constr Manag Econom 15(1):83–94

Keeble BR (1988) The Brundtland report:'Our common future.' Med War 4(1):17–25

Larsen JK, Shen GQ, Lindhard SM, Brunoe TD (2015) Factors affecting schedule delay, cost overrun, and quality level in public construction projects. J Manag Eng 32(1):04015032

Maqsoom A, Wazir SJ, Choudhry RM, Thaheem MJ, Zahoor H (2020) Influence of perceived fairness on contractors' potential to dispute: moderating effect of engineering ethics. J Constr Eng Manag 146(1):04019090

Masood R, Ali M, Shafique F, Shafique MA, Zafar B, Maqsoom A, Ullah Z (2015) Investigating the delay factors of construction projects in metropolitan city of a developing country. J Civ Eng Archit Res 2(9):947–955

Mujabi S, Otengei SO, Kasekende F, Ntayi JM (2015) Determinants of successful implementation of donor-funded projects in Uganda. Int J Soc Econom 42(12):1139–1154

Naoum SG, Egbu C (2016) Modern selection criteria for procurement methods in construction: a state-of-the-art literature review and a survey. Int J Manag Proj Bus 9(2):309–336

Olatunde NA, Alao OO (2017) Quantitative appraisal of cost and time performance of construction projects in public and private universities in Osun State, Nigeria. J Eng, Des Technol 15(5):619–634

Olatunji OA (2008) A comparative analysis of tender sums and final costs of public construction and supply projects in Nigeria. J Financ Manag Prop Constr 13(1):60–79

Olawale Y, Sun M (2015) Construction project control in the UK: current practice, existing problems and recommendations for future improvement. Int J Proj Manag 33(3):623–637

Osei-Kyei R, Chan AP (2017) Implementing public–private partnership (PPP) policy for public construction projects in Ghana: critical success factors and policy implications. Int J Constr Manag 17(2):113–123

Razzaq A, Thaheem MJ, Maqsoom A, Gabriel HF (2018) Critical external risks in international joint ventures for construction industry in Pakistan. Int J Civ Eng 16(2):189–205.

Rauzana A (2016) Cost overruns and failure in construction projects. IOSR Journal of Business and Management 18(10):80–83

Shehu Z, Endut IR, Akintoye A, Holt GD (2014) Cost overrun in the Malaysian construction industry projects: a deeper insight. Int J Proj Manag 32(8):1471–1480

Shen LY, Li Hao J, Tam VWY, Yao H (2007) A checklist for assessing sustainability performance of construction projects. J Civ Eng Manag 13(4):273–281

Sovacool BK, Gilbert A, Nugent D (2014) An international comparative assessment of construction cost overruns for electricity infrastructure. Energy Res Soc Sci 3:152–160

Zhao X, Hwang B-G, Gao Y (2016) A fuzzy synthetic evaluation approach for risk assessment: a case of Singapore's green projects. J Clean Prod 115:203–213

Zuo J, Jin X-H, Flynn L (2012) Social sustainability in construction–an explorative study. Int J Constr Manag 12(2):51–63