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Analysis of Causes and Effects of Time Overrun in Construction Projects in Kaski District

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Abstract

Construction projects frequently experience time overruns which often leads to cost escalation, disputes, and reduced project performance. This study aims to identify and analyze the major causes and effects contributing to schedule delays in Kaski district. From an extensive literature review, a total of 84 causes of time overrun were identified and categorized into seven groups related to: client/consultant, contractor, design, labor, material and equipment, external, and others (technical, contractual, legal). Similarly, 18 effects of time overrun were also identified for analysis. The study demonstrates the Relative Importance Index (RII) method was employed to rank the identified causes and effects based on their significance. Exploratory Factor Analysis (EFA) was conducted to group the 18 effects into distinct factors using the KMO test, Bartlett's test of sphericity, eigenvalues, and varimax rotation. Confirmatory Factor Analysis (CFA) was then performed on the top five causes from each group and on the 18 effects of time overrun. Model fitness was evaluated using indices such as CMIN/df, CFI, IFI, TLI, SRMR, and RMSEA. Based on the responses of 75 respondents, following were the five most significant factors of causes of delays: frequent changes in project scope, adverse weather conditions, financial difficulties of contractors, bureaucratic delays in government approvals, delay in decision making by clients. Top five effects of delays were: cost overrun, legal claims & litigation, extension of overhead costs, disputes among stakeholders, inflation and price escalation impact. This study provides a validated structural framework that enhances the understanding of the dynamics of time overruns. The study concludes by emphasizing the need for better planning, communication, resource management, and coordination among project stakeholders to minimize time overruns in construction projects within Kaski District.

Keywords: *Time Overrun, Relative Importance Index (RII), Exploratory Factor Analysis (EFA), Confirmatory Factor Analysis (CFA), SDGs 9, SDGs 11, Kaski District*

1. Introduction

In Nepal, the construction sector has expanded rapidly in recent years, especially in districts such as Kaski, where urbanization and infrastructure development have intensified due to demand and strategic geographical.

The construction sector provides a major contribution to the Gross Domestic Product (GDP) of the country and also employment opportunities to the unemployed (Famiyeh et al., 2017). Despite this growth, the industry continues to meet important challenges in distributing projects on time that hinders the successful and timely delivery of projects. Among these, time overrun or project delay, is one of the most common and important problems that affect construction projects. This is originally referred to the failure to complete a project within the employee plan, which can have serious consequences (Assaf & Al-Hejji, 2006). These include increased costs, low quality, legal disputes, poor stakeholders and in some cases project abandonment. Delay in construction projects not only affects immediate stakeholders, but also prevents widespread regional development, especially when public infrastructure projects are involved. Project delivery on time is needed for maintaining budgetary discipline, achieving stakeholder satisfaction, and ensuring the intended socio-economic benefits from the projects.

Numerous studies have examined how common time overruns are in both public and private construction projects in Nepal. In their evaluation of road construction projects in Bharatpur, Dhakal (2021) found that bureaucratic inefficiencies, political interference, financial difficulties, labor payment delays, and poor communication were the main causes of delays (Awasthi, 2023). Along with longer project timelines, these difficulties also resulted in significant cost overruns, inefficient use of materials, price escalation, and a decline in stakeholder confidence. Similarly, Bhattarai (2023) highlighted in a national study the critical delay factors that have harmed construction performance, including inadequate project planning, poor monitoring and evaluation, frequent design changes, shortages of materials and equipment, and political instability (Bhattarai, 2023).

Similar patterns of delay causes have been noted within the particular context of the Kaski district. Once construction has started, incomplete project planning frequently results in major design changes that require work stoppages until the updated designs are approved (Famiyeh et al., 2017). Furthermore, decision-making procedures in Nepal frequently involve a number of government agencies and stakeholders, which leads to bureaucratic hold-ups that further impact project progress. Financial difficulties are another major factor; contractors frequently experience delayed client payments, restricted credit availability, and rising material costs as a result of inflation, which forces them to temporarily or permanently stop work. Furthermore, even well-managed projects can be disrupted by political instability because it often results in unexpected policy changes, shifting regulations, and external political pressure. Kaski district's difficult topography, monsoonal rains, landslides, and ongoing seismic activity are some of the environmental factors that cause project delays and occasionally put work on hold for certain periods of time.

Time overruns have a variety of effects. Due to the extended use of labor, machinery, equipment, and administrative supervision, project delays raise costs. According to Seman (2023), when the project takes longer than scheduled timeline, contractors faces high overhead costs, penalties for breach of contract, and inflation-driven material price increases. They also have to pay more interest on borrowed funds. Additionally, delays have a negative impact on the quality of construction work. Because they are frequently under extreme pressure to make up lost time, contractors may sacrifice quality and safety procedures in an effort to accelerate completion, which can lead to substandard infrastructure that is vulnerable to long-term maintenance problems. Furthermore, tense relationships between consultants, clients, and contractors frequently develop, resulting disputes, legal claims and in some cases project termination (Seman et al., 2023).

Although time overrun is a known problem in the construction sector, there is limited local research that examines their basic causes and specific effects in the Kaski district. Even though numerous studies have evaluated delay factors at the national level or within specific projects, only few studies have offered a thorough district-level analysis that considers the particular social, economic, and environmental circumstances affecting

Kaski. Delays in critical infrastructure projects within this district not only result in resource wastage and missed development opportunities but also risk undermining the district's role in driving national economic growth. Since the region continues to invest in infrastructure and development, it is important to understand why the project is delayed and their effects so that we can improve the performance of the project and ensure efficient use of public and private resources.

In order to address the gap, the present study aims to analyze the causes and effects of time overrun in construction projects within the Kaski district. To further these objectives, the study will identify, categorize, and analyze the main causes and results of time overruns in construction projects in the Kaski district, and also find the relative importance index (RII) for key delay factors and their impact on construction projects. Here, Table 1 depicts the tabulation work on recent study based on cost-and-effect analysis of construction projects.

Table 1: Literature table for relevant research

Reference (Year)	Methodology	Major Causes (Delay Factors)	Major Effects
(Abbasi et al., 2020)	Interviews + literature	Contractor financial instability, owner cash-flow issues	Work stoppage, schedule extension
(Gondia et al., 2019)	ML prediction	Design changes, resource shortages, weak scheduling	Early detection of delays, mitigation support
(Fashina et al., 2021)	Contractor survey	Payment delays, cost estimation errors, design changes	Cost overrun, slow progress, disputes
(Çevikbaş et al., 2022)	Delay-analysis method	Inaccurate schedules, incomplete documentation	Better delay attribution, fewer disputes
(Memon et al., 2023)	Survey + literature	Delayed approvals, subcontractor issues, poor planning	Cost increase; recommends governance improvement
(Pal et al., 2023)	Systematic review	Poor monitoring, manual reporting delays	Schedule slippage; recommends automated monitoring
(Koirala & Shahi, 2024)	Exploratory survey	Adverse weather, poor supervision, slow mobilization	24–514% delay, extended completion
(Giri et al., 2025)	Survey/case study	Poor planning, contractor inefficiency, funding delays	Cost increase, disputes, slow progress

2. Materials and Methods

2.1 Research design

A convergent mixed-methods design was used in this study, where both quantitative and qualitative data were collected simultaneously, analyzed separately, and then merged during interpretation. Therefore, the proposed framework of research methodology is shown in Figure 1 below:

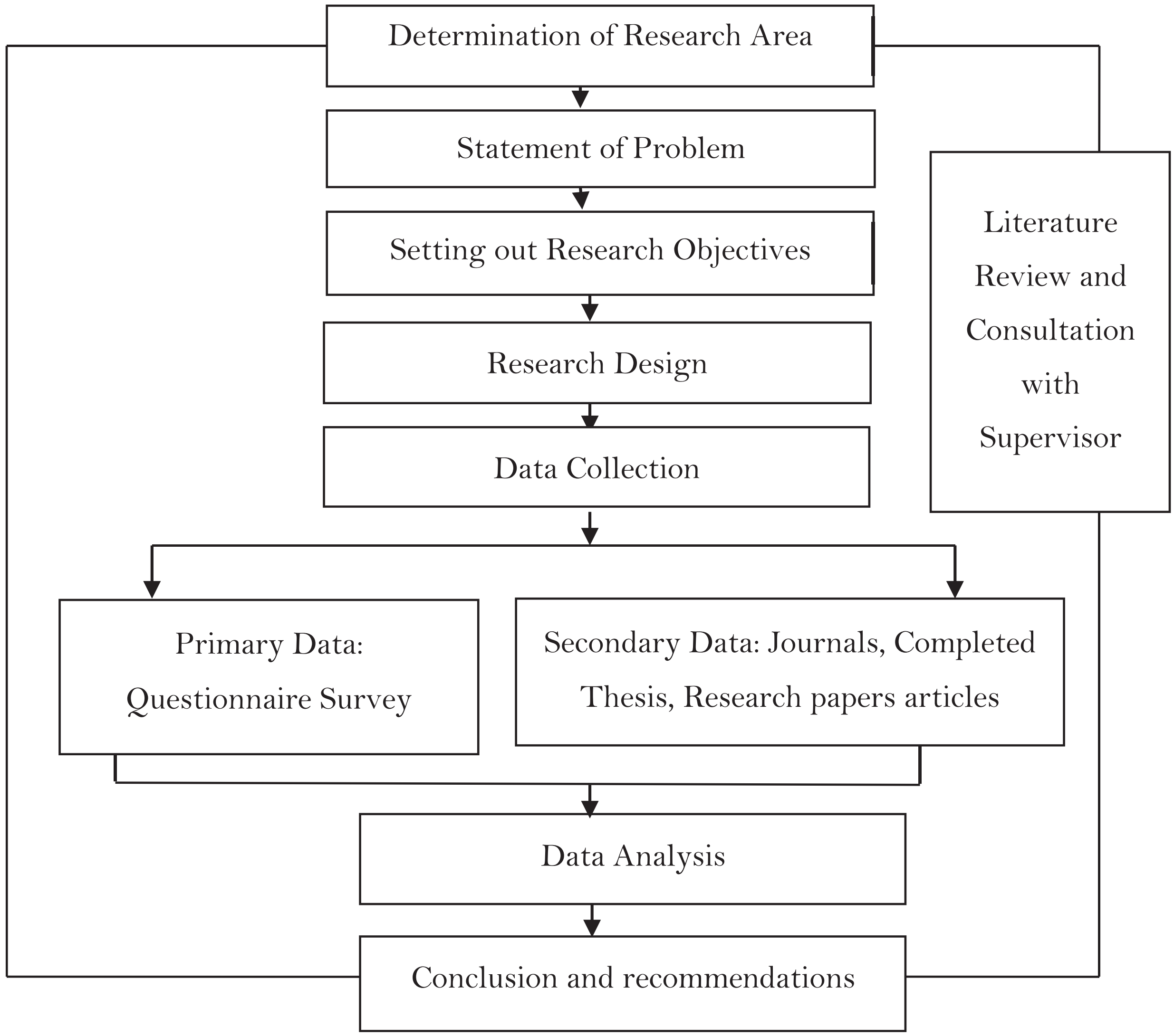

Figure 1: Structure of research methodology

2.2 Study population

The study area is Kaski district, one of the seventy-seven districts of Nepal, located in Gandaki Province in the western part of the country. The district, with Pokhara as its district headquarter, covers an area of 2,088.25 square km with its altitude ranging from 450 meters the lowest land to 8091 meters the highest point in the Himalaya range and lies between 28 ° 6 0 to 28 ° 360 N and 83 ° 400 to 84 ° 120 E (Rimal et al., 2018). Here, Figure 2 illustrates the study area where the current study is employed.

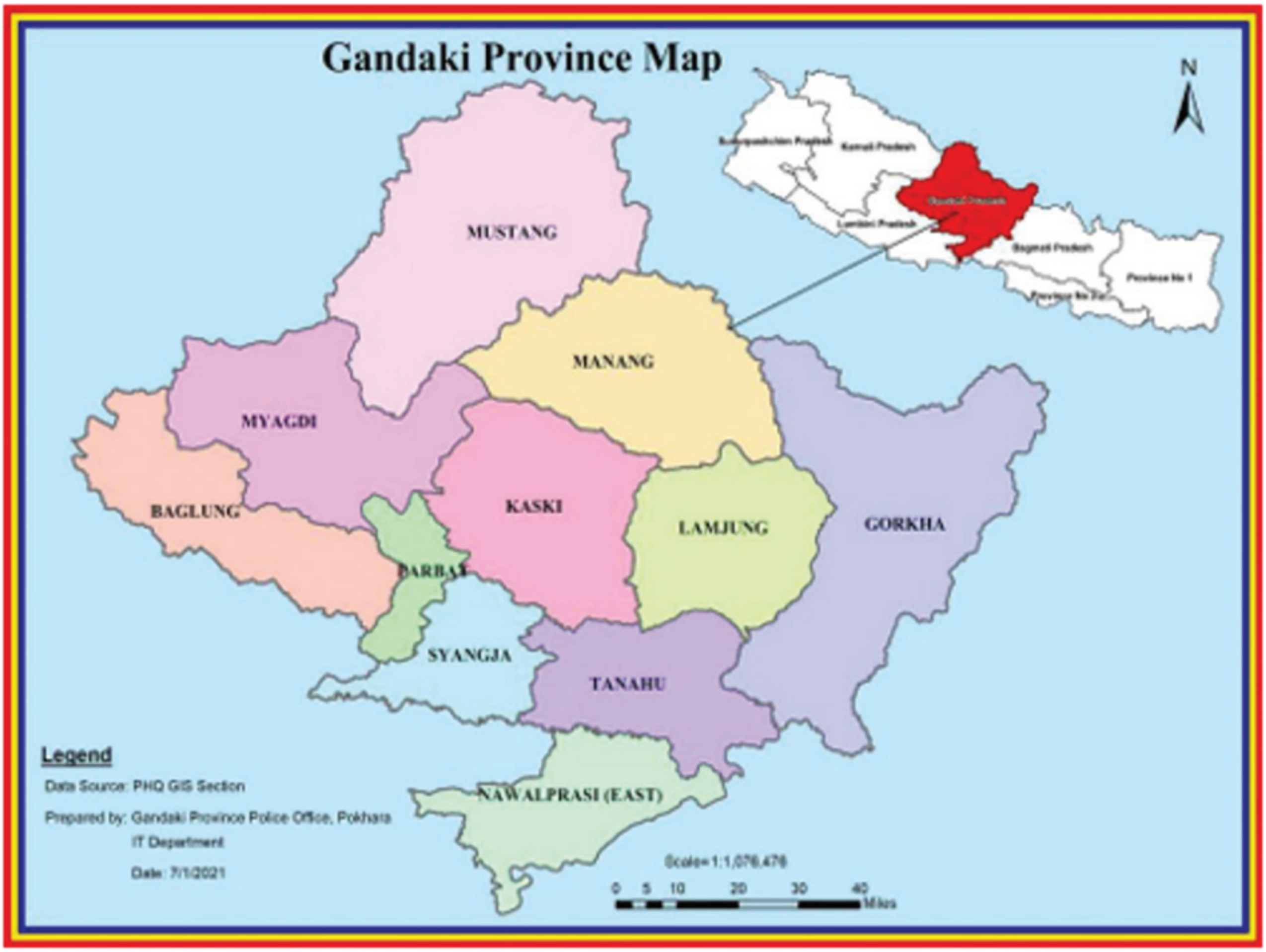

Figure 2: Study area

This study involves gathering a range of data related to construction projects awarded by the Infrastructure Development Office (IDO), Kaski, through the National Competitive Bidding (NCB) process, to identify the causes and impacts of project delays. Primary project-specific data were obtained through questionnaire surveys, which were refined based on interviews and discussions to accurately pinpoint the causes and consequences of delays. Here, the total population for the study is shown in Table 2.

Table 2: Population of clients/consultants and contractors

S.N.	Organization/ Position	Total Population Size
1	Client's/Consultant's (Engineer/Junior Engineer)	23
2	Contractor's Technical Representatives	52
	Total	75

The total population size was found to be small, so, whole population was taken for the questionnaire survey. 26 contractors were involved in the projects taken for study and 2 technical representatives from each contractor were taken as the population for contractors' representatives. Similarly, 23 clients'/consultants' engineers were working in the Infrastructure Development Office, Kaski.

2.3 Primary Data Collection

Quantitative Research focused on numerical data collected through structured questionnaires distributed to stakeholders such as clients/consultants, and contractors. This survey aimed to examine how experts working in the Kaski district's construction project understand the reasons for time overrun. This approach was used to categorize and quantify the responses for producing the ratings for a 5-point Likert scale, with 1= Strongly Disagree, 2= Disagree, 3= Neutral, 4= Agree, and 5= Strongly Agree.

Of the 75 construction professionals surveyed, everyone responded favorably. The responses came from contractor organizations (46), consultants (44), and client organizations (41). Figure 3 shows that participants had considerable experience managing construction projects and had relevant technical knowledge.

a b c d

Figure 3: Demographic information of respondents, (a) Qualification, (b) Working Position, (c) Years of experience in construction, and (d) Total cost of current project involved

2.4 Data analysis

In the present study, Exploratory Factor Analysis (EFA) was performed on the effects to group them into meaningful categories. Principal Axis Factoring (PAF) with Varimax rotation was used to extract factors having eigenvalues greater than one. Subsequently, Confirmatory Factor Analysis (CFA) was carried out using AMOS software to validate the measurement models. This helped identify the most prevalent causes and effects of time overruns.

2.4.1 Relative importance factor

The Relative Importance Index (RII) method was used to determine the relative importance of causes and effects of time overrun for this study. The five-point scale ranged from 1 (Strongly Disagree) to 5 (Strongly Agree) and was transformed to RII for each factor as shown in equation 1:

$$RII = \frac{\sum_{i=1}^{n} W}{A \times N} \quad (1)$$

Where, W is the weight given to each of the factors by the respondents (ranging from 1 to 5), A, is the highest weight (i.e.5 in this case), and N is the total number of respondents.

To identify the most significant causes and effects of time overrun, a comparative table such as Table 3 was used (Gebrehiwet & Luo, 2017).

Table 3: Relative Importance Index Table

S.N.	RII	Ranking
1	0.8.1	High
2	0.6.0.8	Medium
3	0.2.0.6	Low

2.4.2 Exploratory Factor Analysis (EFA)

Exploratory Factor Analysis (EFA) was used as a data-driven dimension reduction technique to divide the 18 observed variables (effects) into various groups. EFA was done using Principal Axis Factoring (PAF) and varimax rotation in SPSS 20. The primary objective of the EFA was to uncover the underlying latent structure of the eighteen effects (Finch, 2020). This approach helps to simplify the dataset by grouping highly correlated effects together and helps to represent their fundamental constructs(groups).

Before grouping the effects of time overrun, the adequacy of the survey data was examined by conducting a Kaiser-Mayer-Olkin (KMO) test and the Bartlett's test of sphericity (Melkamu Asaye et al., 2022). KMO measure of adequacy is an index used to examine the appropriateness of factor analysis. The KMO value lies between 0 and 1 (Melkamu Asaye et al., 2022). The recommended minimum value of KMO for satisfactory factor analysis is greater than 0.7. Bartlett's Test of Sphericity was conducted to test whether correlations among items is present or not. The Bartlett's test of sphericity should be statistically significant ($\rho < 0.05$) (Melkamu Asaye et al., 2022). A factor loading threshold of $\pm$ 0.5 was set to identify significant variable-factor relationships. A Cattell's Scree Plot (Cattell, 1966) and Kaiser criterion (Wang et al., 2025)(eigenvalues > 1) was applied to determine the number of factors to retain. It also ensures that they collectively explained more than 60% of the total variance. The Cattell's Scree Plot is a plot of the extracted eigenvalues associated with each of the factors extracted, against each factor. The graph is used to find the point at which the line levels off (Bentler & Weeks, 1980). The factors were then rotated using varimax rotation to maximize the variance of the squared loading for each factor and to produce clear factor loadings.

2.4.3 Confirmatory Factor Analysis (CFA)

Confirmatory Factor Analysis (CFA) is a multivariate statistical technique that is used to test how well the measured variables represent the number of underlying latent constructs (Bryant et al., 1999). This was done to check the validity and reliability of our measurement variables. In our case, two measurement models were created. In the first measurement model, the seven groups of causes of time overrun are the latent constructs, whereas the top five RII-ranked causes from each group under them are the measured variables. In the second measurement model, the groups of effects of time overrun (which were determined by EFA) are the constructs, and the effects are the measured variables.

In this study, CFA was conducted using IBM AMOS (Analysis of Moment Structures) 23 software to evaluate the measurement model's validity and reliability. The measurement model specifies the relationship between latent variables (groups of causes/effects) and their observed indicators (causes/effects). Each latent variable was represented by multiple observed variables measured through Likert-scale questionnaire responses.

The CFA process involved several key steps:

1. Model Specification

   Based on theoretical foundations and literature review, two hypothesized measurement models were developed. Each construct (group of causes/effects) was linked to its respective observed variables (causes/effects of time overrun). For the first model, the top five RII causes of time overrun were chosen from each group of factors as observed variables and each group as latent variables in order to reduce the complexity of the measurement model. Similarly, for the second model, the groups of effects of time overrun are the constructs, and the effects are the measured variables.

2. Model Evaluation

   The model fit was assessed using several goodness-of-fit indices as shown in table 4. In this research, these included the ratio of chi-square to the degree of freedom (CMIN/DF), which compares the observed covariance matrix with the estimated covariance matrix assuming that the model is true; the root mean square error of approximation (RMSEA), which shows how far the hypothetical model is from a perfect model; the incremental fit index (IFI), which represents the improvement in the fitness of the specified model compared with the baseline model; the Tucker–Lewis index (TLI), which considers model complexity; the comparative fit index (CFI), which indicates the relative improvement in the fitness of the estimated model; standardized root mean square residual(SRMR) that measures the average difference between the observed correlations and the model-predicted correlations (Kar & Jha, 2020). These indices were also used by Edison & Singla (2020) (Edison & Singla, 2020) in their research.

Table 4: Goodness of Fit Measures

Fit Indices	Recommended Values	Source
CMIN/df	1.3	(Edison & Singla, 2020)
CFI	>.9	(Bentler, 1990)
ILI	>.9	(Roderick P. & Bollen, 1989)
TLI	>.9	(Bentler, 1990)
RMSEA	<.08	(Hu & Bentler, 1999)
SRMR	<.08	(Hu & Bentler, 1999)

Validity and Reliability Assessment

The measurement model's convergent validity measurements were verified by using two standards of F. Larcker all indicators' factor loading values should be bigger than 0.7 and p should be less than 0.05; 2) the average variance extracted (AVE) of every latent variable should be greater than 0.5. Factor loading is a statistical measure that measures the correlation between the observed variables and their latent factor (F.Larcker, 1981). Most studies also consider 0.5 or above as the minimum acceptable loading for the factor loading.

Discriminant validity was checked by comparing the square root of AVE for each construct with its correlations with other constructs. According to F. Larcker (1981), if all square roots of AVE are higher than the correlation coefficient between the latent variable itself and the other latent variables in the model, then the model satisfies discriminant validity (F.Larcker, 1981).

The Average Variance Extracted (AVE) (Bagozzi, 1981) was computed using the following Equation (2):

$$AVE = \frac{\sum_{i=1}^{n} \lambda_i^2}{n} \qquad (2)$$

Where, λ= standardized factor loading, i = no. of items

Composite Reliability (CR) was used for the reliability test. It is a measure used in Structural Equation Modeling (SEM) and Confirmatory Factor Analysis (CFA) to evaluate the internal consistency or reliability of a group of indicators measuring a latent construct.

Composite Reliability (Bacon et al., 1995)was measured using the following Equation 3:

$$CR = \frac{\left(\sum_{i=1}^{n} \lambda_i\right)^2}{\left(\sum_{i=1}^{n} \lambda_i\right)^2 + \left(\sum_{i=1}^{n} \epsilon_i\right)} \qquad (3)$$

Where, = Factor loading

= Error variance for item i

$= 1 - \lambda_i^2$

3. Results and Discussion

3.1 Analysis of Time Overrun causes

3.1.1 Relative Importance Index and Analysis

All the causes of time overrun were ranked in order of the most important variables that contribute to the delay of the construction projects. The relative importance index (RII) of all the factors was calculated from the responses of the questionnaires and used to determine the ranking for each delay. The RII was calculated from an overall perspective as well as client/consultant's and contractor's perspectives, and the top 10 RII causes are shown in figs 4, 5, and 6.

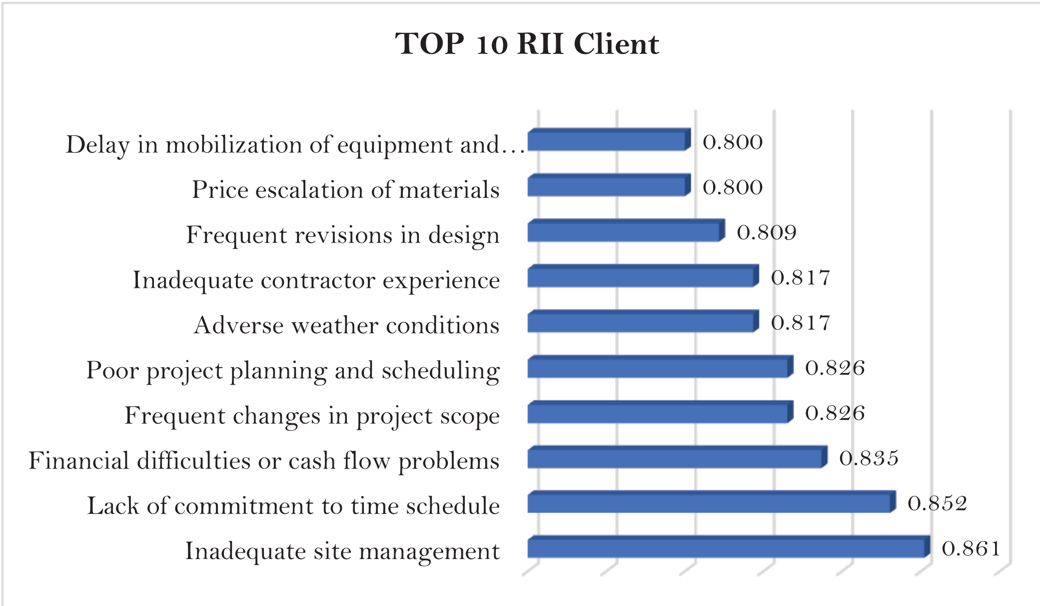

Figure 4: Top Ten Delay Factors Based on Responses of Clients

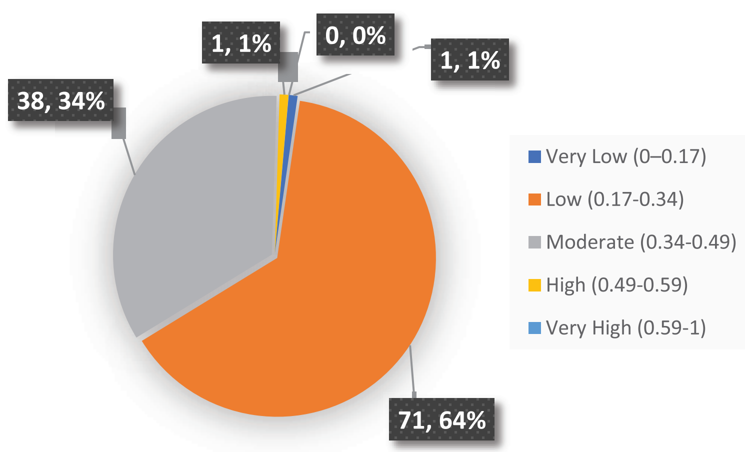

Figure 5: Top Ten Delay Factors Based on Responses of Contractors

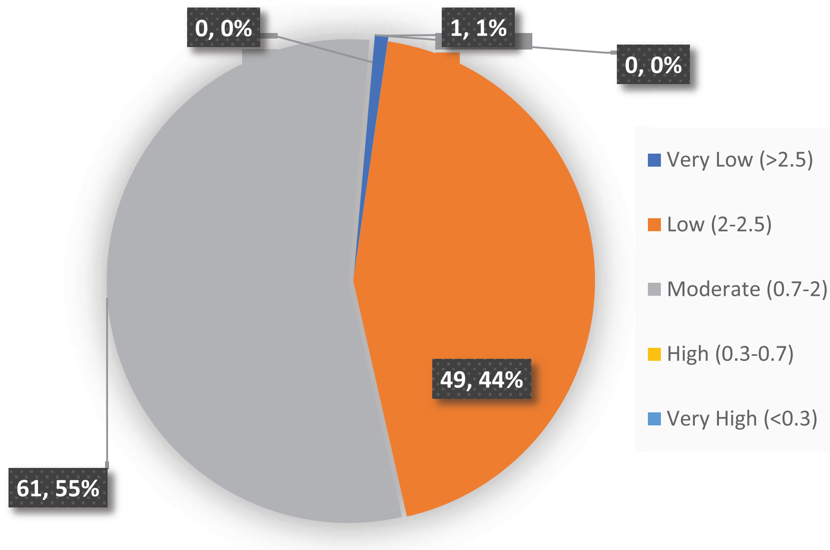

Figure 6: Top Ten Delay factors based on Responses of all respondents

The ranking of the groups of causes of delays was also done in order to find the most significant category causing delay.

3.1.2 Confirmatory Factor Analysis (CFA)

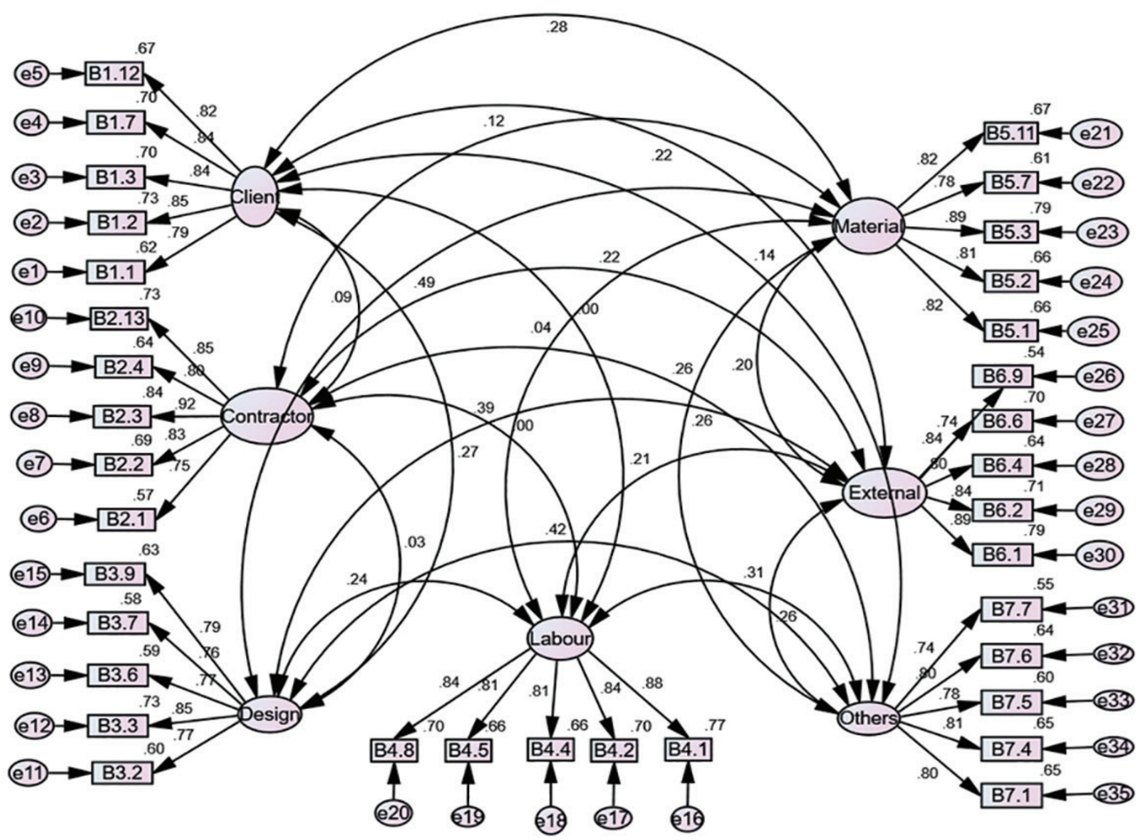

Figure 7: Measurement model for causes of time overrun

A measurement model was developed using the 7 groups of causes as latent variables and the top five ranked RII causes from each group as the indicators. The latent variables and the items used in the measurement model are as shown in table 5:

Table 5: Latent variables and items used in the model

Latent Variable	ID	Item	RII
Client/Consultant	B1.3	Frequent changes in project scope	0.808
	B1.1	Delay in decision-making	0.792
	B1.7	Unrealistic project duration set by owner	0.792
	B1.2	Delay in payment to contractor	0.776
	B1.12	Improper project feasibility study	0.765
Contractor	B2.4	Financial difficulties or cash flow problems	0.800
	B2.13	Lack of commitment to time schedule	0.787
	B2.3	Delay in mobilization of equipment and resources	0.765
	B2.2	Inadequate site management	0.757
	B2.1	Poor project planning and scheduling	0.752
Design	B3.3	Frequent revisions in design	0.789
	B3.6	Incompatibility between design and site conditions	0.776
	B3.2	Errors in structural or architectural design	0.763
	B3.7	Late design approvals from authorities	0.760
	B3.9	Design changes after construction begins	0.752
Labor	B4.1	Shortage of skilled workers	0.755
	B4.5	Poor labor management and supervision	0.739
	B4.2	Low labor productivity	0.699
	B4.8	Lack of labor motivation or incentives	0.672
	B4.4	High worker turnover or absenteeism	0.669
Material	B5.2	Shortage or unavailability of key materials	0.789
	B5.3	Price escalation of materials	0.784
	B5.1	Delay in delivery of construction materials	0.763
	B5.11	Delay in transportation of materials	0.744
	B5.7	Inadequate storage and inventory control	0.680
External	B6.1	Adverse weather conditions	0.800
	B6.4	Bureaucratic delays in government approvals	0.795
	B6.6	Delays due to lockdowns or health-related stoppages	0.731
	B6.2	Political instability or government transitions	0.723
	B6.9	Local community opposition	0.691
Others	B7.1	B7.1 Poor contract management	0.773
	B7.5	B7.5 Legal disputes or litigation	0.728
	B7.6	B7.6 Ineffective communication between stakeholders	0.728
	B7.7	B7.7 Lack of modern project management tools (BIM, PMIS)	0.715
	B7.4	B7.4 Corruption or unethical practices	0.712

Confirmatory Factor Analysis (CFA) was done using AMOS to test the measurement model as shown in figure 7. The model fit measures were used to assess the model's overall goodness of fit. These measures were CMIN/df, CFI, ILI, TLI, SRMR and RMSEA. The desirable value for CMIN/df is between 1.00.3.00. Our obtained value for CMIN/df is 1.239 which is a good fit. The values of comparative fit index (CFI=0.927), incremental fit index (IFI=0.930) and Tucker Lewis index (TLI=0.920) are good fit. Prakash et. al (Prakash & Phadtare, 2018) suggested accepting the model as moderate fit for CFI, IFI and TLI values above 0.80 and good for values above 0.90. The root mean square error of approximation (RMSEA) is another important fit static that describes how far the hypothesized model is from the perfect model. The value of RMSEA for this model is 0.057, which is excellent fit. The value of Standardized Root Mean Square Residual (SRMR=0.065) is also indicating excellent fit. suggested accepting the model as moderate fit for CFI, IFI and TLI values above 0.80 and good for values above 0.90

Table 6: Goodness of fit measures

Fit Indices	Recommended Values	Observed Values
CMIN/df	<3	1.239
CFI	>.9	0.927
ILI	>.9	0.930
TLI	>.9	0.920
RMSEA	<.08	0.05
SRMR	<.08	0.065

Table 7: Latent variables, Items, Factor Loading, AVE, CR of measurement model

Constructs	Items	Factor loading	AVE	CR
	B1.1	0.787		
	B1.2	0.854		
Client	B1.3	0.838	0.684	0.914
	B1.7	0.838		
	B1.12	0.816		
	B2.1	0.755		
	B2.2	0.831		
Contractor	B2.3	0.916	0.693	0.918
	B2.4	0.799		
	B2.13	0.852		
	B3.2	0.773		
	B3.3	0.853		
Design	B3.6	0.768	0.624	0.892
	B3.7	0.759		
	B3.9	0.793		
	B4.1	0.877		
	B4.2	0.837		
Labor	B4.4	0.811	0.698	0.920
	B4.5	0.813		
	B4.8	0.838		
	B5.11	0.818		
	B5.7	0.779		
Material	B5.3	0.888	0.678	0.913
	B5.2	0.813		
	B5.1	0.815		
	B6.9	0.738		
	B6.6	0.836		
External	B6.4	0.8	0.676	0.912
	B6.2	0.842		
	B6.1	0.889		
	B7.7	0.742		
	B7.6	0.801		
Others	B7.5	0.776	0.618	0.890
	B7.4	0.806		
	B7.1	0.803		

Most studies consider 0.5 or above as the minimum acceptable loading for the factor loading. Factor loading above 0.7 is considered good. All the factor loadings are above 0.50 as reported in Table 6. A measurement model was developed using AMOS 23 and maximum likelihood method was used for estimation. The table 7 shows the factor loading, composite reliability (CR) and average variance extracted (AVE) of the measurement model used. The CR values ranged from 0.890 to 0.920, and AVE values ranged from 0.618 to 0.698 which satisfies the condition of Factor loading>0.5 and AVE>0.5 for the convergent validity and Composite Reliability>0.7 for reliability (F.Larcker, 1981).

Discriminant validity was checked by comparing the square root of AVE for each construct with its correlations with other constructs.

Table 8: Result of Discriminant Validity

	Client	**Contractor**	**Design**	**Labor**	**Material**	**External**	**Others**
Client	**0.827**						
Contractor	0.087	**0.832**					
Design	0.267	0.031	**0.790**				
Labor	0	0.004	0.245	**0.836**			
Material	0.423	0.119	0.493	0.041	**0.823**		
External	0.217	0.217	0.392	0.312	0.197	**0.822**	
Others	0.137	0.261	0.262	0.276	0.209	0.259	**0.786**

The above table 8 shows the result of discriminant validity of the model using Fornell and Larcker criterion. The values in bold format are the square root of AVE for each construct and the other values are the correlation coefficient between latent variables. It is seen that all square roots of AVE of latent variables are higher than the correlation coefficient between the latent variables and the other latent variables in the model, hence the model satisfies discriminant validity.

3.2 Effects of Time Overrun

Construction Projects delays have various effects on the construction parties and the environment as well in various ways. From various literature review and discussion, following eighteen effects of the construction delays have been identified and included in the questionnaire.

The RII of the effects of time overrun were also calculated from the responses of respondents as shown in figure 8 show the ranking of effects of construction delays. The effects were ranked according to the client/ consultant's perspectives, contractor's perspectives and overall perspective.

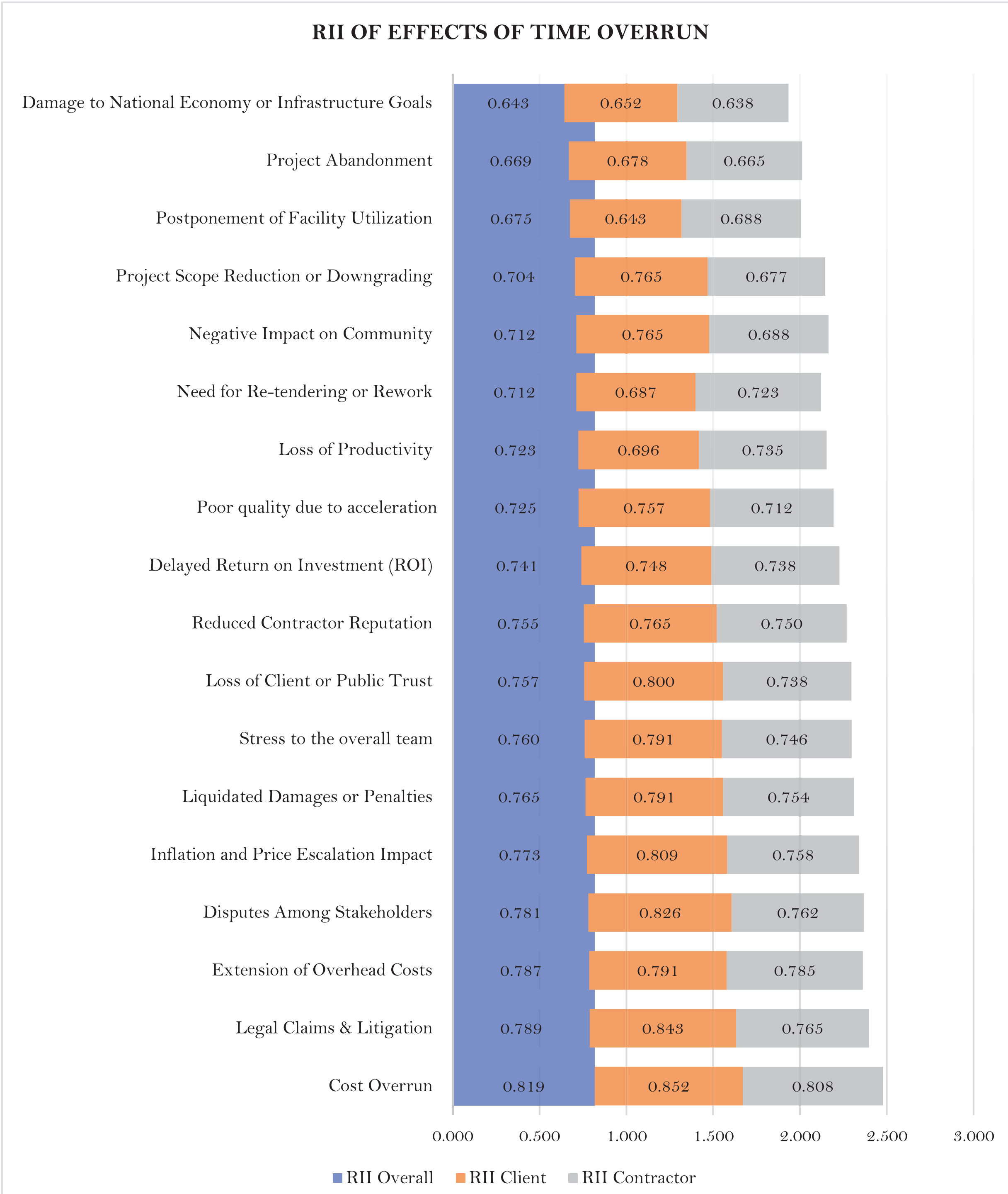

Figure 8: RII of effects of Time Overrun based on respondents of different category

3.2.1 Exploratory Factor Analysis (EFA)

Bartlett's Test of Sphericity was conducted to test the presence of correlations among items which resulted in the Chi-Square value of 781.137, degree of freedom=153 and Significance=0.00, hence, it was concluded that there exists a correlation among items. The following table 9 shows the result of KMO and Bartlett's test.

Table 9: KMO and Bartlett's Table

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		**.869**
Bartlett's Test of Sphericity	Approx. Chi-Square	781.137
	df	153
	Sig.	.000

The scree plot generated from the data Figure 9 shows the point where the apparent break occurred in the graph. This break coincided with the number indicating that 4 factors occurred above the point of inflexion. To confirm the number of factors to retain, the Keiser criterion Table 20 yielded 4 factors with total Eigen values>1.

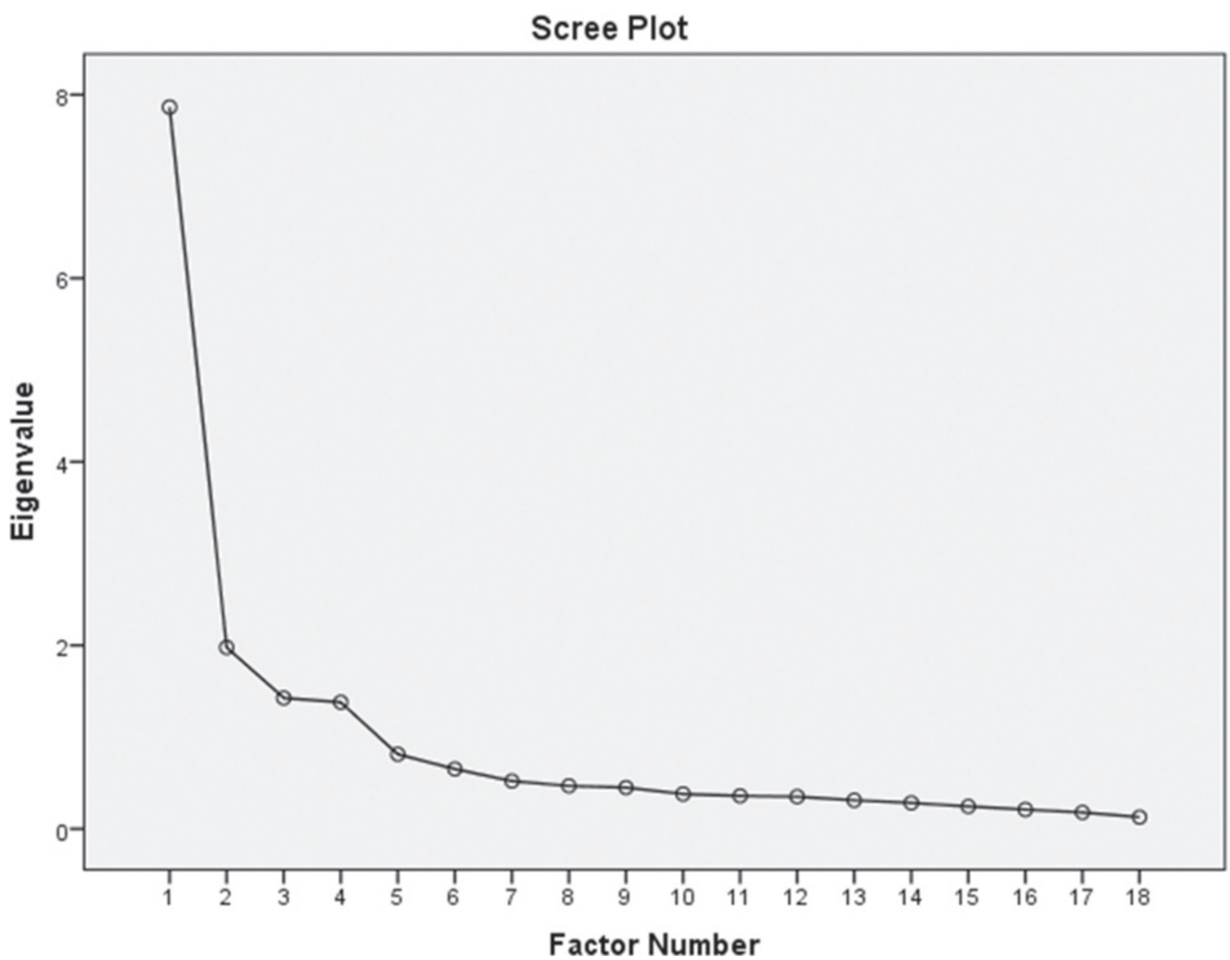

Figure 9: Scree plot

These four factors (groups of effects) were named as 1) Financial; 2) Project Performance; 3) Stakeholder; 4) Legal and Contractual. The first factor, which was labelled financial related effects explained a total variance of 41.63%. The second factor, project performance related explained 8.93% of the total variance. The third factor, stakeholder related effects explained 5.95%. and the fourth factor, legal and contractual explained total variances of 5.58%. The 4 factors accounted for a total variability of 62.09% of the variables representing that the 4 factors sufficiently represent the effects of time overrun.

Table 10: Total Variance Explained

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.865	43.693	43.693	7.493	41.63	41.630	3.959	21.996	21.996
2	1.978	10.986	54.679	1.607	8.930	50.561	2.783	15.459	37.455
3	1.426	7.924	62.603	1.071	5.951	56.511	2.557	14.208	51.664
4	1.380	7.665	70.268	1.005	5.581	62.092	1.877	10.429	62.092
5	.813	4.518	74.786						
6	.652	3.625	78.410						
7	.521	2.893	81.304						
8	.468	2.600	83.904						
9	.450	2.500	86.404						
10	.380	2.110	88.514						
11	.359	1.996	90.510						
12	.350	1.947	92.457						
13	.312	1.733	94.190						
14	.283	1.574	95.764						
15	.245	1.359	97.123						
16	.211	1.171	98.294						
17	.179	.995	99.289						
18	.128	.711	100.00						

The following table 11 shows the effects of time overrun and their 4 factors(groups).

Table 11: Groups of effects of time overrun

Group	ID	Effects
Financial	C1	Cost Overrun
	C5	Extension of Overhead Costs
	C8	Delayed Return on Investment (ROI)
	C11	Project Scope Reduction or Downgrading
	C13	Inflation and Price Escalation Impact
	C15	Damage to National Economy or Infrastructure Goals
	C18	Postponement of Facility Utilization
Project Performance	C4	Project Abandonment
	C10	Loss of Productivity
	C16	Poor quality due to acceleration
	C17	Stress to the overall team
Stakeholder	C2	Disputes Among Stakeholders
	C7	Loss of Client or Public Trust
	C9	Reduced Contractor Reputation
	C14	Negative Impact on Community
Legal and Contractual	C3	Legal Claims & Litigation
	C6	Liquidated Damages or Penalties
	C12	Need for Re-tendering or Rework

3.2.2 Confirmatory Factor Analysis

A measurement model was developed using the four groups of effects of time overrun as latent variables and the eighteen effects as the indicators. Confirmatory Factor Analysis (CFA) was done using AMOS to test the measurement model as shown in figure 10. The model fit measures were used to assess the model's overall goodness of fit. These measures were CMIN/df, CFI, ILI, TLI, SRMR and RMSEA. The desirable value for CMIN/df is between 1.00.3.00. Our obtained value for CMIN/df is 1.053 which is a good fit. The values of comparative fit index (CFI=0.990), incremental fit index (IFI=0.991) and Tucker Lewis index (TLI=0.989) are good fit. Prakash et.al (Prakash & Phadtare, 2018) suggested accepting the model as moderate fit for CFI, IFI and TLI values above 0.80 and good for values above 0.90. The root mean square error of approximation (RMSEA) is another important fit static that describes how far the hypothesized model is from the perfect model. The value of RMSEA for the model is 0.027, which is excellent fit. The value of Standardized Root Mean Square Residual (SRMR=0.0573) is also indicating excellent fit. Therefore, on the basis of combining rules criteria, the measurement is concluded as a good fit.

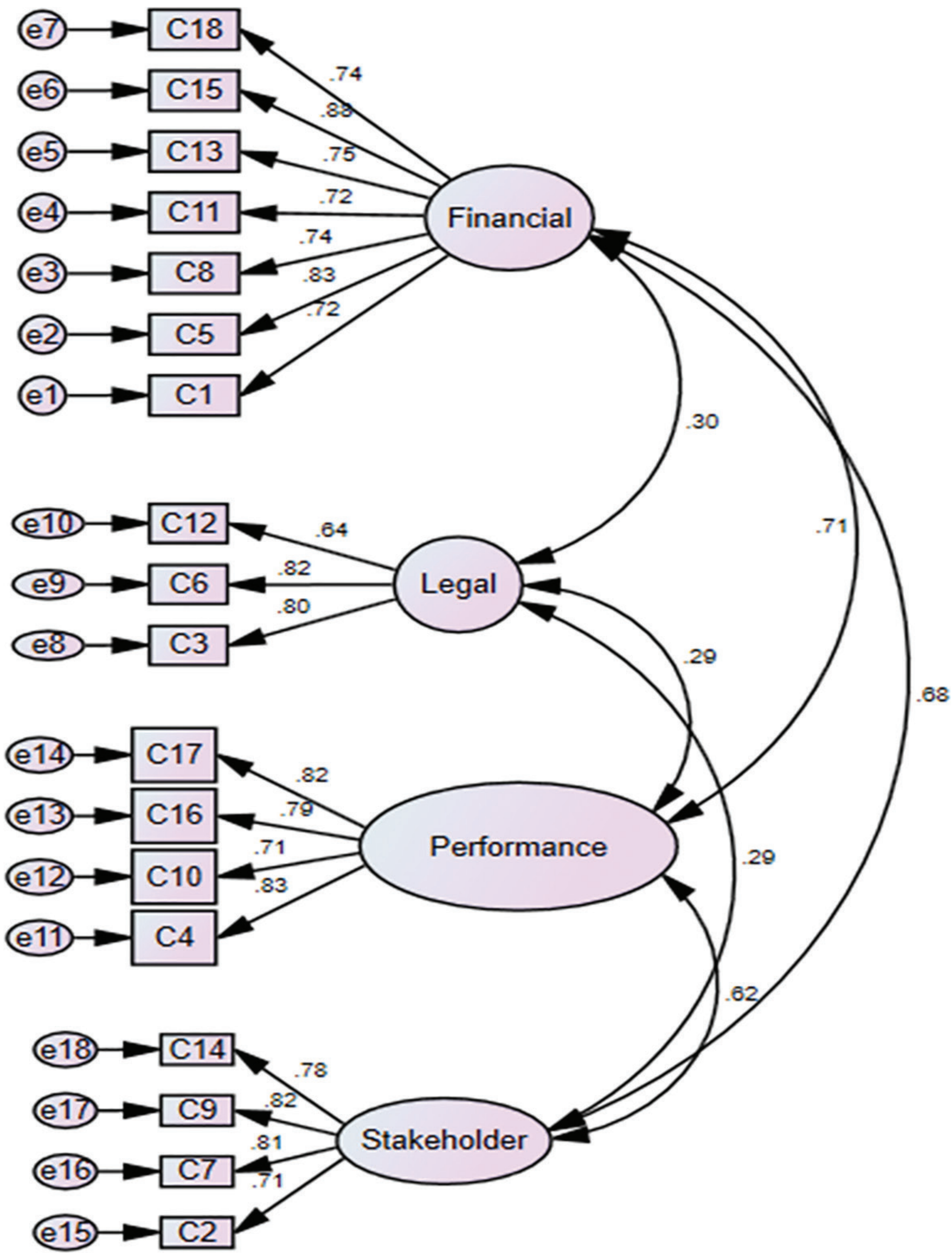

Figure 10: Measurement model for effects of time overrun

Table 12: Goodness of fit measures

Fit Indices	Recommended Values	Observed Values
CMIN/df	<3	1.053
CFI	>.9	0.990
ILI	>.9	0.991
TLI	>.9	0.989
RMSEA	<.08	0.027
SRMR	<.08	0.057

Table 13: Latent variables, Items, Factor Loading, AVE, CR of measurement model

Constructs	Items	Factor Loading	AVE	CR
	C1	0.717		
	C5	0.83		
	C8	0.737		
Financial	C11	0.722	0.592	0.91
	C13	0.753		
	C15	0.878		
	C18	0.736		
	C3	0.73		
Legal	C6	0.746	0.576	0.801
	C12	0.692		
	C4	0.833		
	C10	0.707		
Project Performance	C16	0.789	0.622	0.868
	C17	0.82		
	C2	0.713		
	C7	0.813		
Stakeholder	C9	0.825	0.615	0.864
	C14	0.781		

All the factor loadings are above 0.50 as reported in Table 13. The table shows the factor loading, composite reliability (CR) and average variance extracted (AVE) of the measurement model used. The CR values ranged from 0.801 to 0.910 and AVE values ranged from 0.576 to 0.622 which satisfies the condition of Factor loading>0.5 and AVE>0.5 for the convergent validity and Composite Reliability>0.7 for reliability (F.Larcker, 1981).

Discriminant validity was checked by comparing the square root of AVE for each construct with its correlations with other constructs.

Table 14: Result of Discriminant Validity

	Financial	Legal	Project performance	Stakeholder
Financial	**0.770**			
Legal	0.302	**0.759**		
Project Performance	0.71	0.287	**0.789**	
Stakeholder	0.676	0.289	0.616	**0.784**

The above table 14 shows the result of discriminant validity of the model using Fornell and Larcker criterion. The values in bold format are the square root of AVE for each construct and the other values are the correlation coefficient between latent variables. It is seen that all square roots of AVE of latent variables are higher than the correlation coefficient between the latent variables and the other latent variables in the model, hence the model satisfies discriminant validity.

3.3 Contribution of findings to United Nations Strategic Development Goals

This paper's results support the UN's long-term plans for SDG9 (Industry, Innovation, and Infrastructure) and SDG11 (Sustainable Cities and Communities), as shown in Figure 11.

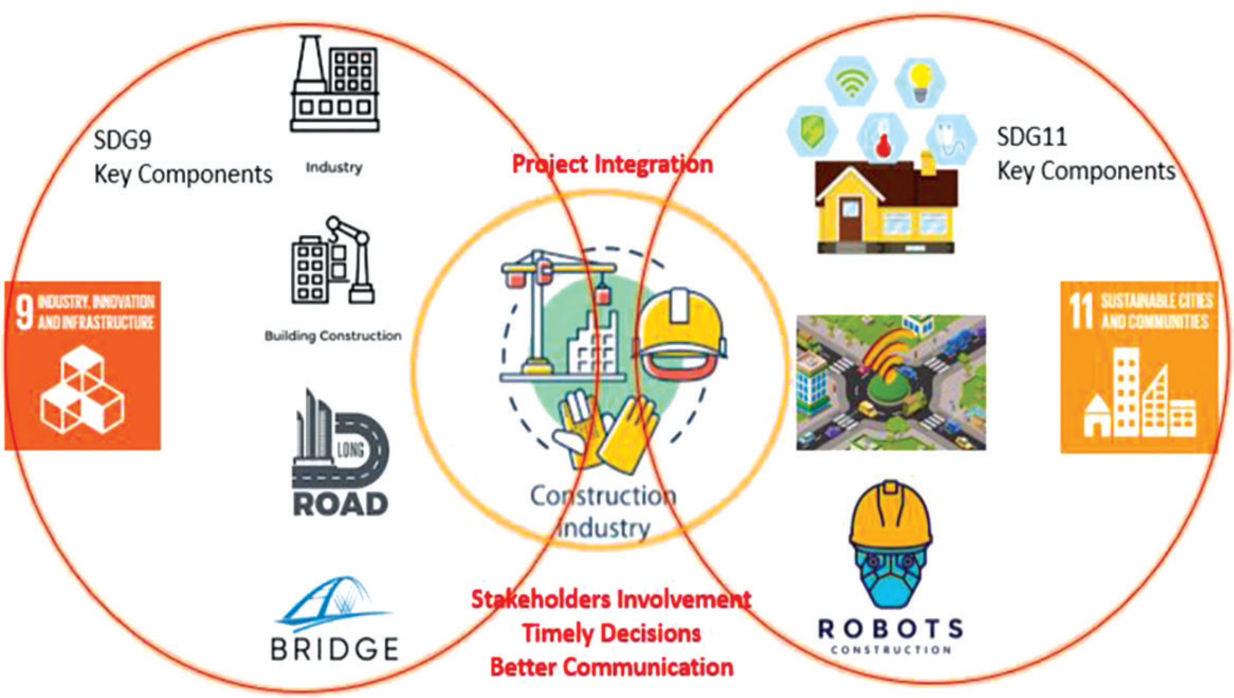

Figure 11: Contribution to UN-SDG's

This study's results relate to industrial innovation and sustainable projects. Several projects in this industry experience delays because of issues identified herein. Given project complexity and design, traditional construction techniques are insufficient in contemporary construction projects. New ways to use materials and equipment are vital to deal with present issues and achieve sustainability in the field (Khahro et al., 2021; Liu et al., 2017) . Industries are shifting, and design needs improvement. Building and infrastructure methods are transforming as well. Machines will be smart, and robots may replace workers in the future. Also, 3D printing, robots, AI, and VR will greatly change things, so learning the main problems toward finishing building projects on time is critical (Khahro & Javed, 2022). This research can guide planners and leaders in making choices and creating guidelines.

4. Conclusions

This research examined schedule delays in building projects in the Kaski District, using project data along with questionnaires. By finding the reasons behind schedule projects, ranking them, and employing statistics for verification, the study gives useful insight into the issues that cause such delays. The results reflect the actual state of building projects managed by the Infrastructure Development Office in Kaski. This work also supplies a solid base that may guide improved planning, choices, and better outcomes in the construction business in Nepal.

Following key conclusions are:

- Project delays were most often attributed to problems in design, or in the interaction between clients and consultants.
- Scope alterations often led to the most project delays, which in turn, caused the biggest cost increases.
- Risk Importance Index analysis enabled focused managerial actions by prioritizing the key causes and effects.
- EFA categorized the impacts of time overruns into four main areas: financial costs, project results, stakeholder relations, and legal or contract matters.
- Confirmatory factor analysis showed that the suggested cause-and- models had acceptable fit, reliability, and validity.
- Labor and contractor issues seem to be the main underlying causes, while project results are the biggest area of impact.
- This research offers a tested tool for diagnosis and planning that can assist involved parties in lessening delays, reducing arguments, and enhancing overall project completion in Kaski District and similar situations.

Recommendation for Future study

This research has the potential to greatly assist construction stakeholders in grasping the various dynamics of project management by drawing insights from the experiences and viewpoints of clients/consultants and contractors, which can lead to significantly more effective strategies in reducing the occurrences of time overrun in construction projects. Conducting this type of research is critical at local levels across the country to identify the root causes of delays and to limit their possible repercussions.

A comprehensive large-scale analysis nationwide examination of the reasons and effects of delays in construction projects is recommended to fully understand the factors contributing to delays and to effectively implement strategies that mitigate their consequences. Also, researchers can develop similar measurement models used in the study and use Structural Equation Modeling (SEM) to test the causal relationships between your cause-and-effect models.

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Author Contribution Atish Gurung conducted the experiments, performed the initial analysis, data analysis

(SPSS Amos) and wrote the original draft. Bishwash Poudel contributed to result validation. Buddi Raj Joshi and Rajendra Aryal conceptualized the study, and Sundar Adhikari supervised the work, and also provided overall guidance, and finalized manuscript.

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Declarations

Ethical Approved: Not required

Competing interests: The authors declare no competing interests

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