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Do Sustainability Initiatives Cause Delays and Cost Overruns in Construction?

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Abstract

The purpose of this research paper is to analyze the major causes of construction project delays and cost overruns in terms of sustainability activities which are not extensively covered in the literature and thus appear to be novel. This research identifies eight major factors that contribute to construction project delays in Pune, India, through a survey of the key stakeholders: clients, contractors and consultants. Sustainability initiatives, land scarcity and rising land prices, increase in infrastructure development, project delays and cost overruns, material cost, challenges in recruiting skilled labor, Goods and Services Tax (GST) on real estate sector, regulatory norms, Non-resident Indian (NRI) investments in Pune real estate market are all included. The study evaluated data normality, reliability, and important factors affecting construction costs in Pune, India using Cronbach's Alpha, the Shapiro-Wilk test, the Relative Importance Index (RII), and Spearman Rank Correlation. The RII shows that land scarcity and rising land prices, increased infrastructure development, project delays and cost overruns are evidently the foremost issues requiring corrective action. The sustainability initiatives appears only as the third ranked factor. However, the Spearman's rho, which measures the strength of association between two variables, identified a correlation between sustainability initiatives with ‘project delays and cost overruns’ and challenges in recruiting skilled labor. Further, using regression analysis, the study also assessed how strong this relationship is and found out that sustainability measures have a positive correlation with project delays and cost overruns. Therefore, this study reveals that sustainability initiatives delay project completion and lead to cost overruns, in real estate sector projects.

Keywords: Sustainability initiatives; Sustainable construction, project delays; causes of delays; cost overruns; time overrun; India

Introduction

The construction sector occupies a pivotal position in the infrastructural and economic advancement of a given economy. The construction industry serves nearly all economic sectors, thereby rendering it an indispensable element of socioeconomic progression. Furthermore, construction engenders a substantial number of employment opportunities and facilitates reciprocal linkages among various industries. Previous studies (Turin, 1973; Wells, 1986) indicate that there exists "a positive correlation between the proportion of construction in gross domestic product (GDP) and the per capita income level." Scholars specializing in the construction domain, including Turin (1978), Wells (1986), Bon (1992), Hillebrandt (2000), Tan (2002), Myers (2008), and Jackman (2010), have underscored the critical importance of the real estate and construction sectors for the economic development and growth. Consequently, fostering construction and infrastructure development initiatives is essential for the sustained prosperity of the economy.

The construction sector exerts influence over various economic sub-sectors, encompassing manufacturing, mining, transportation infrastructure such as roads and highways, maritime ports, railway systems, airports, electrical utilities, irrigation systems, telecommunications, healthcare facilities, educational institutions, urban developments, and the real estate market (which includes water supply, sewage, and drainage systems in both metropolitan and rural contexts). Consequently, it emerges as an essential determinant in the socioeconomic advancement of a nation. The establishment of a construction facility or service, characterized by high financial investment, temporal urgency, and specific performance criteria—which are informed by quality standards, project completion deadlines, budgetary constraints, and various limitations—constitutes a multitude of factors integral to the construction process.

The construction industry represents a burgeoning sector within the Indian economy. The realization of projects aimed at establishing new productive capacities has stagnated at an approximate annual expenditure of Rs.6.5 trillion (CMIE). During the quarter ending in March 2023, initiatives valued at Rs.7.3 trillion were projected for completion. However, out of this Rs.7.3 trillion, only projects amounting to Rs.1.27 trillion were successfully finalized.

While project sustainability is increasingly in the spotlight as organizations look to shrink their ecological footprint but remain viable in the long run. "Sustainable construction seeks to mitigate the detrimental effects on the environment resulting from construction activities while also giving due consideration to the economic and social dimensions of the project" (Francis, A., and Thomas, A. 2020). However, it can be problematic for project management since it may affect the financial situation or schedule. Meaning, as the integration of sustainable materials and technologies is it will cost more expensive since it requires knowledge specialization and additional labor. Moreover, sustainability must also take time in building sustainable practices, thus prolonging schedule project.

In light of the unresolved construction project delays over the past decade, enterprises are actively seeking more cost-effective and temporally efficient methodologies to optimize their project development processes, as the existing management paradigms and conventional project management practices have proven inadequate (Aziz & Hafez, 2013; Koskela, Bølviken, & Rooke, 2013; Koskela, 2000; Norzima, Sorooshian, & Chow, 2011; Rahman, Wang, & Lim, 2012).

The core reasons behind delays and financial irregularities in construction ventures have prompted notable academic interest due to the all-encompassing nature of this concern across the globe. Nonetheless, the extant literature has predominantly neglected the dimension of sustainability initiatives. This research focuses on nine most prevalent contributors to delays in construction projects, as delineated by principal stakeholders from client, contractor, and consulting entities within the designated domain of inquiry.

Literature Review

In accordance with the Asian Development Bank (2023), price escalation denotes the rise in prices that may be factored into a contractual agreement. When such escalations surpass the expected thresholds, they can detrimentally affect a contractor's liquidity, potentially leading to delays in construction and a deterioration in the quality of the output. The challenges associated with cost overrun arise from a multitude of factors, thus rendering it imperative to explore the dominant causes of cost overruns within the construction industry. Various empirical inquiries have established that budgetary excesses present major difficulties across different nations and sectors.

Challenges in construction cost management

A Nigerian study (Fagbenle et al., 2018) concluded that the challenges in construction cost management ranged from poor leadership and inadequate management, inefficient resource allocation, wastage of materials on sites, cumbersome payment process, theft of materials to variations during construction activities. Simushi and Wium (2020) explains that simply managing the project environment is not sufficient in containing schedule and budget excesses; organizational and external factors must also be factored into contentions.

Challenges and factors contributing to cost overruns in construction projects

A plethora of empirical investigations has demonstrated that diverse sectors globally frequently experience cost overruns within their projects, which can be ascribed to an array of factors. Flyvbjerg et al. (2002) theorized that these overruns arise from deliberate underestimation, deceptive practices, and an inherent optimism bias. Flyvbjerg and his colleagues received much attention for their controversial claims, Siemiatycki continued; however, their academic work has drawn criticism for its respective correlation of estimates made at different levels of project advancement and for use of second-hand sources. In contrast, alternative scholars like Love et

al. (2016) and Love and Ahiaga-Dagbui (2018) argue that intrinsic project challenges such as scope changes, variable ground conditions, and low levels of project management are critical factors contributing to cost overruns. Furthermore, Zhang et al. (2023) discovered that fluctuations in material and construction costs significantly impact expenses related to private residential construction. This is important because, although these costs can vary greatly, they often lead to higher overall spending. However, the extent of this influence may depend on various factors, including market trends and economic conditions.

Cost overruns in mega-projects across multiple sectors have been an area of inquiry for over forty years. These construction endeavors often present complex engineering, technological, or logistical challenges that may not have been fully anticipated during the initial planning phases. Moreover, mega-projects typically require substantial allocations of resources, time and labor; they frequently involve extensive infrastructure, construction, or developmental activities. Consequently, cost overruns significantly influence profitability within these project categories. The frequency, scale, factors and potential solutions for cost overruns in mega-projects have been examined in a variety of academic papers, books and evaluations throughout the decades (Tihanski, 1976; Merewitz, 1973; Hall, 1982; Baerenbold R., 2023; Gehring and Narula, 1986; Pickrell, 1992; Nijkamp and Ubbels, 1999). Recent studies on mega-projects, however, have focused on urban rail projects, which present numerous risks that can negatively impact the strategic objectives of project owners (Nguyen et al., 2024). This research rigorously identified thirty risk-associated variables, categorized into seven principal domains, and ascertained that these elements exert a significant influence on both project timelines and expenditures.

One of the most important factors in determining a project's success is cost control. The industry's capacity to control cost rises often determines its economic impact. This aspect is a primary priority throughout the whole project life cycle. One of a project's most important features is efficient cost management, and a project is considered successful when its objectives are met within the budget that was set aside for it (Memon, A. H. et al., 2010). According to research on road construction projects in Zambia (Kaliba C. et al., 2009), unfavorable weather, flooding, and payment delays make strict cost control through efficient project management necessary. Furthermore, a Malaysian study (Azis et al., 2012) shows that techniques including thorough cost estimation, tender budgeting, and cash flow forecasting are helpful for cost control. In South-West Nigeria the major problems affecting construction project costs are poor leadership, ineffective management, inefficient resource allocation, material wasting, complicated payment procedures, theft, and project deviations (Fagbenle et al, 2018).

Key factors affecting cost performance in construction projects in India

Success factors and failure factors were the basis for identifying the issues affecting the cost performance of construction projects in India which was identified through a review of numerous literature texts by Iyer and Jha (2005). The poll detected various success criteria, including project managers' process leadership, executive backing, efficient coordination, and project managers' subject matter experience. By contrast, issues related to conflicts among project participants and lack of experience and specific characteristics for the project and teamwork negatively impacted project cost performance. According to the study, the strongest factor affecting project success is well-functioning coordination among project parties.

Other variables that had the potential to impact project costs included vagaries in socioeconomic and meteorological conditions, inertia in using decision tools and intense competition within the tendering process. According to Hatamleh et al. (2018), the cost estimating phase, is one major aspect that influences the accuracy of cost. They added that problems related to equipment expenses, level of the project's interference, the precision of as-built cost data, constraints of the construction site, material accessibility, and the board for tender for previously undertaken buildings of a similar type may be reduced by such measures as well-detailed and clear drawings and specifications and the experience with charging for the ready-made and on-call projects. Osamudiamen, B., et al. all cited material prices on the upward trend, design change, inconsistencies in contract documentation and delay of resources available. (2022) as one of the relevant issues impacting project performance.

Cost estimates at the beginning of any project are vital in deciding on whether it can be implemented. Such estimates are used in the evaluation to monitor the project's progress and determine if it is worth to carry on with or if it is even advisable to terminate. Nowadays a construction company, as well as a construction consultant or supplier, is expected to make such forecasts of construction costs and time frames, that make sense in terms of investment and future financing.

According to the study by Doloi, project planning and control processes have a very big effect on project cost performance. Cost performance is significant for the parties to a contract - the industry does recognize this. But if construction costs come in well above amounts planned, project rationale may be lost. Things that affect how much a project initially costs are experience of client, knowledge of client, funding of project, quality of drawings, payment discipline, technology, assumptions made, detailed information, documentation of material, filing of data and design ability to construct a building (Bhattad & Jain, 2013).

Factors contributing to construction cost overruns

In a study conducted in Egypt, E. M. Asal (2014) has been able to identify other significant factors affecting the variance in construction cost that include the availability and quality of project planning and organization within the firms, relevant experience of the estimating team, existing administrative and financial plans, estimation method applied, required workforce and equipment, project site, proper payment cycle, accuracy of bid documents submitted by clients, the skill and professional attributes of the project manager and expected effect of time overruns and general economic fluctuations.

As noted in a study conducted in Gaza, several of the critical factors are the availability and quality of raw materials and equipment required for the project, the anticipated availability of resources over the entire period of the project, the leadership capacity of the manager, increase in the price of materials, skilled and experienced labor force, and shortages of materials (Shaban S. S. A., 2018). Additionally, according to a 2012 Malaysian investigation, the primary reasons for cost overruns are differences in material prices, cash flow issues and other financial difficulties faced by contractors, owner delays in progress payments (Abdul-Rahmanet al. 2009), and numerous design changes. Financial challenges often culminate in cost overruns, which not only delay projects but also strain relationships between stakeholders (Sadat & Thomas, 2024).

Several important factors that contribute to cost overruns were identified in a 2012 study carried out in Turkey. These factors included "inadequate planning, inaccurate project cost estimations, elevated costs of essential resources (financial, human, material, and machinery), a shortage of skilled labor, rising prices of construction materials, and high land costs." "Delayed decision-making, ineffective schedule management, increases in material and machinery costs, subpar contract management, design-related issues or delays, rework due to errors, challenges in land acquisition, inaccurate estimations or estimation methods, and prolonged intervals between design and bidding/tendering" are also important contributors to cost overruns, according to the 2014 study by Subramani, Sruthi, and Kavitha.

The authors Adam, Josephson, and Lindahl in 2015 carried out a research which sought to unearth the root causes for excessive cost and schedule overruns in large public construction projects and also attempt to evaluate the impact of these on sustainability of these projects. In what seems to improve cost performance by reducing overruns, Khabisi, Aigbavboa, and Thwala (2016) advocated for the need to flag probable factors that may be responsible for construction cost overruns at the initiation stage of the project. Moreover, the study by Adam, Josephson and Lindahl in 2017 also elaborated that management factors are also fundamental factors which have been the main causes of delays and excessive cost in most projects. Therefore, it is possible that the exposure to and managing of critical features in order of their severity would enable contractors, project managers and customers to bring down cost over runs and increase the value addition of the construction industry to the economy of the country (Durdyev et al. 2017).

Predominant causes of delays and cost-overruns

Various studies have been done on the causes of delays and cost overruns in different types of construction and real estate projects across the globe. Most of these studies have focused on the factors causing delays based on their relative importance index and have employed survey-based methods for data collection. Most of the studies focused on delay individual, which were then classified according to researchers' intuitions or field expertise rather than statistical analysis. Alternatively, the authors used a '5-point Likert scale' to collect each participant's opinions and impressions of growing costs in order to collect detailed data about the causes of cost rises in real estate projects. Price changes during the executive order period (Covid-19) were mostly caused by a fall in housing supply, whereas price changes after the order were impacted by both the decrease in supply and an increase in demand for housing (Zhang et al., 2023).

According to Car et al. (2020), the predominant causes of cost overruns are additional works, change orders, and unforeseen construction activities driven by unexpected circumstances. Plebankiewicz and Wieczorek (2020) proposed the "cost overrun risk prediction model" for general contractors that split specific work stages into subcontractor sections with a previously defined range of tasks. Research by Kepher, Rambo and Nyonje (2021) in Nairobi and Kisumu found that oversight of subcontractors has a great impact on cost overruns in real estate development projects.

Steininger, Groth and Weber (2021) highlight multiple reasons that can lead to costing coordinate overruns for large infrastructure projects such as scope changes, geological context, a high-risk appetite, long execution durations, cost inflating conflicts of interest or low engagement with citizens. During the Great Recession, when earnings and rents lagged behind in regions with strong supply constraints, prices grew faster (Garriga, C. et al. 2023). In addition, Krolage, C. (2023) found that rather than improving housing affordability for households, the subsidy program dictated higher home prices and predominantly benefited real estate sellers.

Green project management strategies and financial viability

Within realistic financial constraints, green project management strategies can produce a sustainable construction project that adds significant value (Robichaud, L. B., and Anantatmula, V. S. 2011). Despite indications of significant progress, there are still challenges and barriers to green development, chief among them being the increased cost of going green. Despite conflicting research on the incremental costs of sustainable building (some studies claim a 0–10% green premium over comparable conventional projects) (Robichaud, & Anantatmula, 2011), a survey of building industry professionals conducted by McGraw-Hill Construction (2006) found that the most commonly mentioned barrier to sustainable development is the perception of higher costs. In the end, sustainable practices must also be financially viable for green ventures to be successful. The distinctions between cost and profitability must be made clear. Cost is a phrase used to describe how well the project team produces the outcome while talking about construction projects. On the other hand, the facility's profitability shows how well the business case for the project was prepared and how well the cost-benefit analysis of the project deliverables was completed before the building was put into service.

Although most of the public focus on green building is on its environmental benefits, research shows that a developer's decision to go green is still primarily motivated by its potential to generate revenue. According to a 2006 McGraw-Hill Construction research, 54% of participants said that the main justification for green design was energy savings. It showed that 24% of respondents said their main reason for working in the green building sector was the environmental advantages of green buildings.

The majority of respondents cited higher initial costs as the largest obstacle to green development. The 2004 Davis Langdon study found that the costs of conventional and sustainable initiatives varies significantly. Although green building may be more expensive initially than typical projects, it is generally accepted that these expenditures can be compensated for over time by operational and maintenance savings. Green buildings are expected to result in operational cost savings of 8–9%, a 7.5% increase in overall building value, and a 3.5% increase in occupancy rates (U.S. Green Building Council 2006a,b). However, the benefits of operational savings

may not be as great for a speculative developer who has no long-term interest in operating or leasing a facility. For this reason, it is essential that project managers develop plans for cost management early on in a project.

Impact of delays on sustainability in industrial activities

Delays and cost overruns negatively impact the sustainability of these industrial activities by delaying the population's access to clean and efficient energy sources, new technologies, processes, and infrastructure (Álvarez-Pozo, A. H., et al 2024). Clients have to account for the extra time required when determining the comprehensive project timeline for green construction efforts. According to research, green building initiatives have an impact on the project's overall timeline (Hwang, B. G., and Leong, L. P., 2013; Hwang, B. G., Zhu, L., and Ming, J. T. T. 2017; Sajjad, M., and Pan, Z. 2019). Studies by Abdul-Rahman et al. (2006), Al-Momani (2000), Assaf and Al-Hejji (2006), and others have shown that financial concerns, environmental conditions, managerial services, labor and other resources, and construction laws and regulations are some of the broader contributing factors to project delays.

It goes without saying that the increased implementation time, resource requirements, and sourcing complications associated with sustainability programs can result in project completion delays and cost overruns. All parties involved may be impacted by cost overruns that result from these delays, particularly in mid-rise projects. NRI investments in Pune real estate, regulatory standards, the impact of GST on the real estate industry, the role of land scarcity and rising land prices, the rise in infrastructure development, project delays and cost overruns, sustainability initiatives and measures, material costs, and the difficulties in hiring skilled labor are all covered in the following sections.

Research Method

Data Collection and Sampling Design

Factors influencing cost of construction

The study tried to identify and analyze the key factors affecting the cost of construction in Pune, India. Factors influencing the cost of construction in Pune were identified through an interview of experts in construction sector of Pune. The study aimed to identify and analyze key factors affecting the cost of construction in Pune, India, through interviews with construction sector experts.

Primary data was collected with the help of a pre-tested questionnaire developed after an exhaustive literature review. The data was collected based on a 5-point Likert scale. Cronbach's Alpha method was used to test the data reliability.

Why Likert scale

The widely used psychometric scale is the Likert scale, which was initially introduced by Rensis Likert in 1932. It is the only tool available for the quantitative transformation of qualitative data (Joshi, A., et al. 2015). The Likert method has the following benefits (Li, Q. 2013). A Likert scale is a quick and adjustable tool that can directly apply numerical measurement results to statistical inference. The Likert scaling studies demonstrate robust measurement reliability, allowing numerical results to be directly applied to statistical inference.

Respondents of the study

Respondents for this study are contractors, engineers, and housing developers, amongst others. A total of 80 responses were received. Of 80 responses received, around 95% of respondents were from the construction sector, the other 5% were from another sector. From total 80 responses 76 respondent were people working in Pune construction industry. Majority of the respondents were contractors. A detailed break-up of type of organization is given in the following table (Table 1).

Table 1: Break-up of Type of Organization

Type of Company	Frequency	Percentage	Cumulative Percent
Client	20	25	25
Consultant	23	28.75	53.75
Contractor	37	46.25	100.00
Total	80	100	

Sum of responses

Data has been collected from 80 respondents. The following table (Table 2) presents the sum of responses received from the data collection.

Table 2: Sum of Responses Received

Likert Scale Options	Land scarcity and rising land prices	Increase in infrastructure development	Project delays and cost overruns	Sustainability initiatives/ measures	Material cost	Challenges in recruiting skilled labor	GST on real estate sector	Regulatory norms	NRI investments in Pune real estate
Least Affecting Factor	02	-	-	01	03	02	06	04	07
Slightly Affecting Factor	04	05	02	10	08	05	08	12	12
Moderately Affecting Factor	10	21	21	18	22	30	16	32	30
Very much Affecting Factor	32	24	33	30	28	29	33	21	25
Extremely Affecting Factor	32	30	24	21	19	14	17	11	6
Total Responses	80	80	80	80	80	80	80	80	80

Data Analysis

Reliability of the data collected

Cronbach's Alpha method (Cronbach, 1951) was used to ascertain reliability of the data collected for the study. The equation for Cronbach's Alpha method is as follows:

$$\text{Cronbach's alpha; } \alpha = \frac{K}{K-1}\left[1 - \frac{\Sigma V_i^2}{V_x^2}\right] \quad \text{Eq (1)}$$

where
K = the number of items;
Vi = the variance of scores on each item; and
Vx, = the variance of the observed total test scores.

Data normality test

Shapiro-Wilk test was used first to test the data normality (Ferretti et al., 2017; Hsu et al., 2000). The equation for Shapiro-Wilk test (W) is as follows:

$$\text{Shapiro} - \text{Wilk test; } W = \frac{(\sum_{i=1}^{n} aix_{(i)})^2}{\sum_{i=1}^{n}(x_i - \bar{x})2} \quad \text{Eq (2)}$$

where:
x_i = the ordered random sample values
a_i = constants generated from the covariances, variances and means of the sample (size n) from a normally distributed sample.

The null hypothesis of the Shapiro-Wilk test is that 'the data were normally distributed'. The Shapiro-Wilk test was conducted using the common alpha value, which tests normality at 0.05. If the test's p-value is lower than the chosen alpha value, the null hypothesis should be rejected, indicating that the data is not normally distributed.

The study's Shapiro-Wilk test results were all less than 0.05, indicating that the data was not normally distributed (Table 3). This is an expected result since data collected from samples that are not very large are usually not normally distributed (Hwang et al., 2017; Shan et al., 2017). The selection of statistical tests for data analysis was influenced by the non-normal distribution of the data.

Table 3: Tests of Normality

	Shapiro-Wilk		
	Statistic	df	Sig.
Infra	.838	80	.000
NRI	.902	80	.000
Material Cost	.888	80	.000
GST	.867	80	.000
Regulatory Norms	.907	80	.000
Project Delay	.844	80	.000
Skilled Lab	.882	80	.000
Sustainability Initiatives	.877	80	.000
Land Price	.800	80	.000

Ranking and computation of relative importance index (RII)

The Relative Importance Index (RII) was chosen as a suitable analytical method in an effort to achieve the research study's goal (Doloi et al., 2012). Using a five-point Likert scale, the RII was utilized to assess the relative significance of the different elements and their impact on Pune's construction costs. The relevance of the cause or Extremely Affecting Factor (EAF) of building cost increases with RII value, and vice versa. The calculation was carried out using RII formula in Eq. (2) (Doloi et al., 2012):

Relative importance index; $\text{RII} = \frac{\Sigma W}{A\ x\ N}$ Eq (3)

where,

W = the rating given to each factor by the respondents.
In this case, "5" denotes Extremely Affecting Factor (EAF), "4" Very Much Affecting Factor (VAF), "3" Moderately Affecting Factor (MAF), "2" Slightly Affecting Factor (SAF), and "1" Least Affecting Factor (LAF) for factors that induce delay.

A = the highest weight of the scale (i.e., '5' in this case)
N = the total number of samples (80 for this study).

Correlation

Spearman's Rank Correlation Coefficient

Spearman's rank correlation coefficient is employed to measure the correlation among the groups of responses (Tikote et al., 2017; Pearson, K., 1896; Fisher, R.A., 1915; Zar, J.H. 1972).

$$r_s = 1 - \frac{6\sum d^2}{(n^3 - \text{n})} \quad \text{Eq (4)}$$

Where,

r_s = Spearman rank correlation coefficient (r_s value ranging from 1 showing the robust direct relationship, and –1 showing strong inverse correlation);

d = difference in causes ranking of the identified conditions;
n = number of variables.

The regression model

The regression method used to establish the relationship between profit and cost is linear regression. This linear regression model is used to provide a dependent description of the variable in the straight-line equation that is defined as follows:

$$Y = a + bX \quad \text{Eq (5)}$$

Where,
a = the y- intersect of the line
b = its slope
Y = the dependent variable
X = the in dependent variable

The coefficient of determination is given below:

$$r^2 = \frac{\sum_{i=1}^{n}(\hat{y}\text{i} - y)^2}{\sum_{i=1}^{n}(y\text{i} - y)^2} \quad \text{Eq (6)}$$

Where,
n = the number of observations
$\hat{y}$i = the estimated value of the dependent variable for the i^{th} observation, as computed with the regression equation
yi = the observed value of the dependent variable for the i^{th} observation
y = the mean of all n observations of the dependent variable r 2 is the fraction of the overall variance that is explained. The closer the regression model's estimated values $\hat{y}$i lie to the observed value.

The factors influencing cost used in the study are:

1. Sustainability initiatives
2. Land scarcity and rising land prices
3. Increase in infrastructure development
4. Non-resident Indian (NRI) investments in Pune real estate
5. Project delays and cost overruns
6. Material cost
7. Challenges in recruiting skilled labor
8. Goods and Services Tax (GST) on Real Estate sector
9. Regulatory norms

Results and Data Analysis

The data used was gathered from clients, consultants, and building construction contractors. The reliability of the data gathered for the study was determined using the Cronbach's Alpha technique. First, the normality of the data was tested using the Shapiro-Wilk test. The main determinants affecting construction costs in Pune, India, have been identified using the Relative Importance Index (RII). The correlation between the parameters has been ascertained using the Spearman Rank Correlation. According to the Spearman rank correlation coefficient, "project delays and cost overruns" are associated with (i) sustainability measures and (ii) difficulties finding qualified workers. Regression analysis has been used to examine the relationship between these variables. The results indicates a positive relationship between project delays and cost overruns and sustainability initiatives.

1. Cronbach's alpha data reliability test

Prior to assessing the questionnaire survey results, the internal consistency of respondents' responses was assessed using the Likert scale and Cronbach's Alpha data reliability. According to the goal of the study, nine elements that have a major influence on construction costs were subjected to a reliability test. Additionally, the Cronbach coefficient is used to evaluate the cost's internal consistency. With a "N" of 9, the Cronbach's Alpha was 0.550 and 0.547 based on standardized items. According to the study by Gliem and Gliem (2003), Cronbach's alpha is sufficient if it is $0.7>\alpha >= 0.5$. Fair is 0.4 to 0.59, good is 0.60 to 0.74, and exceptional is 0.75 or higher, according to Cicchetti (1994). The number of items in a scale determines α. Since the number of items are less than 10, with a Cronbach's alpha of 0.550, the collected data for all the nine factors of cost are correlated, valid and reliable for the study. The internal consistency of the cost is assessed using the Cronbach coefficient obtained.

2. Analysis of the factors that influence construction

Based on the factors' relative significance index (RII) values, the mean, standard deviation, co-efficient of variances, ranking by category, and an overall ranking for each category were determined.

RII Ranking

RII has defined the relative importance of the elements and their implications upon the construction cost in Pune, which is shown below in the ranking of causes of cost overrun under investigation. Land scarcity and rising land prices, increased infrastructure development, project delays, and cost overruns are evidently the foremost issues requiring corrective action. This is only an endogenous component of project delays and cost overruns that would be independent due to two exogenous factors. Thus, it appears that the builder is the only agent who could reduce project delays and cost overruns.

Table 4: Ranking of Cost Overrun Factors

Factors	RII	Mean	Rank
Land scarcity and rising land prices	0.828	4.139	1
Increase in infrastructure development	0.798	3.988	2
Project delays and cost overruns	0.798	3.988	2
Sustainability initiatives	0.749	3.747	3
Material cost	0.730	3.650	4
Challenges in recruiting skilled labor	0.722	3.608	5
GST on real estate sector	0.714	3.570	6
Regulatory norms	0.658	3.288	7
NRI investments in Pune real estate	0.628	3.138	8

3. Correlation of the Major Causes of Delay

Table 5 illustrates the relationship between the identified factors.

Table 5: Correlation

		Land scarcity and rising land prices	Increase in infrastructure development	NRI investments in Pune real estate	Project delays and cost overruns	Sustain-ability initiatives	Material cost	Challenges in recruiting skilled labor	GST on Real Estate sector	Regulatory norms
Spearman's rho	Land scarcity and rising land prices	1.00	0.20	-0.12	0.15	-0.02	0.11	0.19	-0.20	0.01
		.	0.08	0.31	0.18	0.89	0.32	0.09	0.08	0.95
	Increase in infrastructure development	0.20	1.00	0.09	0.03	.22*	-0.07	0.08	0.05	0.01
		0.08	.	0.42	0.81	0.05	0.52	0.47	0.69	0.93
	NRI investments in Pune real estate	-0.12	0.09	1.00	0.08	-0.08	.27*	0.08	.36**	0.21
		0.31	0.42	.	0.50	0.47	0.02	0.48	0.00	0.06
	Project delays and cost overruns	0.15	0.03	0.08	1.00	.42**	-0.01	0.20	0.17	0.16
		0.18	0.81	0.50	.	0.00	0.95	0.07	0.13	0.17
	Sustainability initiatives	-0.02	.22*	-0.08	.42**	1.00	-0.03	.41**	0.19	0.09
		0.89	0.05	0.47	0.00	.	0.77	0.00	0.09	0.46
	Material cost	0.11	-0.07	.27*	-0.01	-0.03	1.00	0.12	0.10	0.11
		0.32	0.52	0.02	0.95	0.77	.	0.30	0.36	0.34
	Challenges in recruiting skilled labor	0.19	0.08	0.08	0.20	.41**	0.12	1.00	0.00	0.19
		0.09	0.47	0.48	0.07	0.00	0.30	.	0.98	0.09
	GST on Real Estate sector	-0.20	0.05	.36**	0.17	0.19	0.10	0.00	1.00	.43**
		0.08	0.69	0.00	0.13	0.09	0.36	0.98	.	0.00
		0.01	0.01	0.21	0.16	0.09	0.11	0.19	.43**	1.00

	Regulatory norms	0.95	0.93	0.06	0.17	0.46	0.34	0.09	0.00	.

According to the Spearman rank correlation coefficient, "project delays and cost overruns" are correlated with (i) sustainability initiatives and (ii) difficulties finding skilled employees. Additionally, non-resident Indians (NRIs) invest in Pune real estate, which is subject to GST and other regulations. Regulatory standards, which are governed by the government, are the common element here. Thus, the association between project delays and cost overruns and (i) sustainability measures and (ii) difficulties in hiring competent workers seem to be the more important variables. By building a linear regression model, the study likewise attempted to determine the association between these characteristics.

Project Delays and Cost Overruns, Sustainability Initiatives, and Challenges in Recruiting Skilled Labor

Results of Regression Analysis

With sustainability initiatives and difficulties finding qualified workers as independent variables and project delays and cost overruns as the dependent variable, a regression model is created to examine the link between these factors.

The findings show that only sustainability measures have a positive correlation with project delays and cost overruns, while difficulties finding qualified workers are not statistically significant. At 0.016, the corrected R^2 value is 0.229 significant. The regression analysis coefficients are displayed in Table 6.

Table 6: Coefficients [a]

Model		Beta	Sig.
1	(Constant)		0.003*
	SUS_INITIATIVE	0.474	0.000*
	SK_LABOR	-0.059	0.638
	INFRA	-0.141	0.21
	NRI	0.157	0.217
	MATCOST	-0.053	0.649
	GST	-0.055	0.691
	REGULATORY	0.102	0.415
	LAND PRICE	0.2	0.081

a. Dependent Variable: DELAY
* Significant at 1%.

Discussion

Since construction project delays and cost overruns are still common worldwide, scholarly research has focused heavily on the root causes of these problems. Nevertheless, sustainability initiatives have not yet been covered in these studies. According to key stakeholders from client, contractor, and consultancy firms in the research region, the nine most common reasons for construction project delays are the main focus of this study.

Nine factors that affect project delay were identified, and the most influential ones were determined, through a review of the literature and additional interviews with subject-matter experts. Sustainability initiatives, material costs, land scarcity and rising land prices, increased infrastructure development, project delays and cost

overruns, difficulties hiring skilled labor, GST on the real estate sector, regulatory standards, and NRI investments in Pune real estate were among the factors considered during the selection process.

Data for the study was gathered from building construction contractors, consultants, and clients, and data reliability was evaluated using the Cronbach's Alpha method. Data distribution normality was determined using the Shapiro-Wilk test. RII has been employed to explain the most important factors affecting the cost of construction in Pune, India. In addition, the investigation was concerned to measure the degree of association among the constituents with the aid of Spearman rank correlation which revealed that 'project delay and budget overrun' are associated with (i) the provision of sustainability measures and (ii) constraint of finding competent staff. In order to enhance, evaluate and establish the strength of association between these variables, a regression analysis has been applied.

The RII shows that land scarcity and rising land prices, increased infrastructure development, project delays and cost overruns are evidently the foremost issues requiring corrective action. The sustainability initiatives appears only as the third ranked factor. However, the Spearman's rho, which measures the strength of association between two variables, identified a correlation between sustainability initiatives with 'project delays and cost overruns' and challenges in recruiting skilled labor. Further, using regression analysis, the study also assessed how strong this relationship is and found out that sustainability measures have a positive correlation with project delays and cost overruns.

Findings of the study showed that sustainability activities and 'cost overruns and project delays' had a positive relationship. According to the study findings, delay studies on green building projects, which reveal that green sustainability initiatives influence overall schedules (Hwang, B. G., & Leong, L. P., 2013; Sajjad and Pan, 2019). Another study conducted by Hwang and Ming (2017) showed the most six important factors affecting the productivity of green building construction projects: workers' experience, technology, design improvements, workers' skill level, and work planning and sequencing. In this study, challenges of skilled labor recruitment were one of the factors considered, as it is hugely associated with environmental sustainability. However, it did not show much significance.

It can be inferred that the findings emphasize the need for policymakers to create laws that favor sustainability strategies and encourage feasible solutions for minimizing these impacts on construction project delays in order to effectively implement these Sustainable Development Goals (SDGs) concerning construction. They advocate for sustainable practices that will ultimately balance immediate benefits for the environment and the construction industry. By dealing with these development issues, the building industry could make an enormous contribution to the global sustainability agenda and bring forth a sustainable future.

Sustainable building techniques are enacted through competent legislative frameworks, which are popularly regarded in Indonesia. Proper legislation solves the predicament of construction and enlists the active involvement of the community in the environment-friendly activities Agustina & Eddy, 2024). Research to date shows the extent of dependency on policy tools to speed up the establishment of Green Buildings. The rationale emphasized is the transfer of focus from cost towards policy support that pays dividend on environmental gain and economic growth Ekung et al., 2024). Such improvement in policy support is the first need of the hour to integrate SDGs and promote sustainable construction. By providing measurable indicators for the early identification of delays in work performance and enabling early adjustment action to meet project timelines, sustainability assessment frameworks improve project management Ramprasad et al., 2023).

Conclusion

The purpose of this research paper is to analyze the major causes of construction project delays and cost overruns in terms of sustainability activities which are not extensively covered in the literature and thus appear to be novel. This research identifies eight major factors that contribute to construction project delays in Pune, India, through a survey of the key stakeholders: clients, contractors and consultants. Sustainability initiatives, land scarcity and rising land prices, increase in infrastructure development, project delays and cost overruns, material cost,

challenges in recruiting skilled labor, Goods and Services Tax (GST) on real estate sector, regulatory norms, Non-resident Indian (NRI) investments in Pune real estate market are all included.

Using Cronbach's Alpha for data reliability, Shapiro-Wilk for normality, RII and Spearman rank correlation, the study establishes the extent of relevance of these variable association. The study finds a strong relationship between project delays and cost over runs with sustainability measures (Gaza, et al., 2023) and challenges in the recruitment of workforce. The study of RII has ranked land availability and the increase in cost of land further explaining the delays and cost increase in the project. However prior correlation and regression analysis contradict this (refer Tables 5 and 6). It is shown in the results of the current paper, that the Spearman rank correlation coefficient failures to undertake the two, "Delay in completion of projects and high cost over achievement" are due to (i) The effect of the sustainability initiatives and (ii) the challenge to recruit skilled labor. An emphasis with tools of regression was directed towards establishing the association between the variables. The results of regression analysis established a positive relation between project delays and adoption of sustainability practices. It clearly states that sustainability initiatives are affecting and delaying the completion of projects and causing and cost overruns too.

The results of the study revealed a positive relationship between project delays, cost overruns, and sustainability initiatives. The results of this study are consistent with findings of earlier researches carried out on green building projects where it was established that, sustainability practices do have impacts on the time, cost and productivity of the projects. For instance, delay studies on green building projects, which reveal that green sustainability initiatives influence overall schedules (Hwang, B. G., & Leong, L. P., 2013; Sajjad and Pan, 2019). Another study of Hwang and Ming (2017) indicated that workers' experience, technology, design changes, workers' skill level, and planning and sequencing of work were the top five most critical factors affecting the productivity of green building construction projects. Challenges in recruiting skilled labor was one of the factors for this study also because it is very much associated with environmental sustainability because sustainable construction requires manpower with specialized skills in those areas. But challenges in recruitment of skilled labor was not showing much significance in the current study.

The study's results offer valuable insights to both academicians and practitioners in construction concerning how effective it is to use sustainability measures to reduce the number of delays and instances of cost overrun. By understanding the reasons, the stakeholders can reduce the occurrence of delays and cost overruns, devise proactive measures to improve project performance, and focus on further research on the area. To achieve sustainable construction goals, the building sector needs to incorporate the Sustainable Development Goals 11 (sustainable cities and communities), 12 (responsible consumption and production) and 13 (climate action) taking climate action and making cities resilient. It can also be added that due to the extensive training a construction professional undergoes concerning green construction practices, the potential concerns will be less likely to arise and thus reduce project delays and cost escalation, consequently training such professionals in these practices will reduce the delays as well. Besides, the results also provide useful information for both theorists and practitioners in the field, emphasizing the importance of integrating sustainability with the goals of completing the project in time with minimum compromise. While the study contributes to the body of knowledge on construction delays, its findings are limited by the sample size, suggesting the need for further research in this domain.

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