Identifying Factors Influencing Time and Cost Overruns in Public Construction Projects in Bhutan.

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Abstract: Construction industries worldwide are impacted by time and cost overruns, resulting in significant financial loss and failure to complete projects on time. Clients, contractors, and consultants can plan properly for public construction projects if they have a better understanding of cost and time overruns.

The Construction Development Board (now Bhutan Construction and Transport Authority) is the lead agency regulating and overseeing the government construction projects in Bhutan. However, in recent four years, from July 2017 to June 2021, about 50% of the total 2111 government construction projects experienced time and cost overruns, and the total financial loss was Nu. 2,578.86 million.

Therefore, study was designed to examine the factors causing delays and cost escalations in the construction project implemented by government during the financial year July 2017 to June 2021. Thus, this study explores identifying factors influencing time and cost overruns to avoid time delays and financial losses.

The primary data was collected through the questionnaire survey from engineers of 20 Dzongkhags and 4 Thromdes. The secondary data was collected from the CDB's annual reports, the Construction Association of Bhutan (CAB), and the National Statistics Bureau (NSB). The data was analyzed using the descriptive statistics method, and the relative importance index (RII) was calculated to rank the factors identified from literature reviews.

The research results show that financial issue was the critical factor causing delays and cost escalation in the government construction project in Bhutan. Followed by the issue of delays and cost overruns due to shortage of local construction materials, inadequate experience of the contractor, poor site planning, shortage of skilled workers, unrealistic schedule, design change, contractual issues, and project manager competence.

Keywords: Time overrun, cost overrun, construction, government, public, project success.

Introduction

The construction industry is an important industry that contributes to Bhutan's economic growth (Andrić et al., 2019). In 2017, the total contribution by the construction industry to the Gross Domestic Product (GDP) was significant, accounting for nearly 16.28 % (NSB, 2017). Considering the significant contribution of the industry to the GDP, it was found that delays and cost escalation in construction projects implemented by public agencies were a big issue in Bhutan (Yangzom et al.,2021).

Time overrun is one of the most prevalent, costly, and risky issues that arises in construction projects, resulting in additional expenditures and losses. Thus, delay is costly for both the owner and the contractor. Furthermore, project delays and cost overruns are common features in public construction projects in Bhutan which emphasizes the importance of understanding the factors influencing the time and cost overrun.

As per the CDB annual report (2022), out of 799 works completed in the Financial Year 2021-2022, 457 works ran into time overrun and 531 works ran into cost overrun causing total cost overrun amounting to Nu. 1181.972.

This study aims to figure out what variables has influenced time and cost overruns in the construction of public projects implemented between July 2017 and June 2021. This period was selected to cover 5 years' time duration to capture the pandemic as well as no pandemic situation in this study. Also, data was more readily available for this time period.

Data and Method

The research project was based on a structured questionnaire survey and interview. Based on literature reviews, common factors influencing time and cost overruns in construction projects were identified. Total of 20 common factors for time and cost overruns were identified from the literature review that were relevant to Bhutan's construction industry, as shown in Table 1. The identified common factors were then presented to all the selected respondents online using a Google survey form, and also via emails.

The factors were rated under five categories of Likert scales such as *very large extent, large extent, some extent, little extent and not at all.* The respondents rated the factors causing delays and cost escalation in construction project implemented by the government agencies. For reliability and consistency of data collected, focal engineers in each Dzongkhag and Thromde administration,

who have or are working as site engineers, or project managers were requested to respond to the survey questionnaire.

The survey questionnaire was divided in three sections. The first section focused on the demography of respondents which included their professional background, type of agency, work experience and working district. This was intended to get adequate coverage of the data collection in the country. The second and third section focused on the factors causing time and cost overruns in public construction projects in the country.

Through a survey, the data was analyzed using descriptive statistics with the support of Microsoft Excel, and the qualitative data from the interview was analyzed using thematic analysis.

Table 1.

Identified Factors Influencing Time and Cost Overruns based on Literature Review.

Factor No.	Factors.	Author references.
Factors influencing time overruns.		
Factor_1	Change in design and scope of project.	Al-Kharashi & Skitmore (2009); Aziz (2013); Doloi et al. (2012)
Factor_2	Long administration or approving procedures.	Idrees & Shafiq (2021)
Factor_3	Inaccurate/unrealistic project schedule.	Assaf & Al-Hejji (2006); Doloi et al. (2012)
Factor_4	Poor site planning and management.	Assaf & Al-Hejji (2006); Doloi et al.(2012); Rahman et al.(2013)
Factor_5	Lack of competent project manager.	Aziz (2013)
Factor_6	Contractual administration issues/conflict.	Moazzami et al.(2011)
Factor_7	Shortage of local construction materials.	Cheng (2014)
Factor_8	Inadequate contractor experience.	Doloi et al.(2012); Hamzah et al. (2011)
Factor_9	Payment delays from agency.	Marzouk & El-Rasas (2014)
Factor_10	Lack of coordination between procuring agencies and contractor.	Doloi et al. (2012); Iyer & Jha (2005)
Factor_11	Financial issue (cash flow problem) of contractor.	Doloi et al. (2012); Hamzah et al. (2011) ; Mahamid (2011)
Factor_12	Additional works without time extension.	Doloi et al. (2012); Le-Hoai et al. (2008)
Factors influencing cost overruns.		
Factor_13	Unrealistic estimation during the initial project planning.	Assaf & Al-Hejji (2006); Doloi et al. (2012); Moazzami et al. (2011)
Factor_14	Additional works.	Doloi et al. (2012); Le-Hoai et al.(2008)

Factor_15	Lowest bidder.	Wanjari & Dobariya (2016)
Factor_16	Construction materials cost escalation.	Kaming et al. (1997); Kavuma et al. (2019)
Factor_17	Shortage of skilled and experienced technical person in project management.	Mahamid (2011); Shehu et al.(2014)
Factor_18	Poor project planning and management .	Assaf & Al-Hejji(2006); Mahamid (2011) Doloi et al.(2012); Rahman et al.(2013)
Factor_19	Inaccurate and unrealistic project scheduling.	Assaf & Al-Hejji(2006); Doloi et al.(2012)
Factor_20	Insufficient cash flows of contractors.	Doloi et al. (2012); Hamzah et al. (2011) ; Mahamid (2011)

Data Collection and Analysis

In this research project, the primary data was collected through a questionnaire survey from 70 engineers out of 90 questionnaires distributed through emails to 20 Dzongkhags engineering cells including the 4 Thromdes (municipality). The 20 factors were checked for reliability and the Cronbach Alpha value was found to be 0.87, which falls in the good category, indicated reliability of data as shown in Table 2. The Cronbach Alpha reliability test was conducted to check the internal consistency reliability of the data collected, using the scale range from 0 to 1(Table 3).

$$\alpha = \left(\frac{K}{K-1}\right)\left(\frac{S_y^2 - \Sigma S_i^2}{S_y^2}\right)$$

Table 2.

Cronbach Alpha Value for the 20 Factors.

Variable	Decription	Values	Internal Consistency
K	No. of items	20.00	Good
$\sum S_i^2$	sum of the item variance	17.76	
S_y^2	variance of total score	104.85	
	α	0.87	

Table 3.

Cronbach Alpha Scale.

Cronbach's alpha	Internal Consistency
0.90 and above	Excellent
0.8 - 0.89	Good
0.70-0.79	Acceptable
0.60-0.69	Questionable
0.50-0.59	Poor
below 0.50	Unacceptable

In order to find the ranking of the factors influencing time and cost overruns in this study, the relative importance index (RII) was used to rank the factors on the scale of 0 to 1. RII has been used in many studies to rank the factors using the formula shown below (Aziz, 2013; Chan & Kumaraswamy, 1997; Kazaz et al., 2008). The factors were ranked as shown in the Table 4.

Relative Important Index (RII) = $\frac{5n_5+4n_4+3n_3+2n_2+1n_1}{A*N}$

n_5= Number of respondents for very large extent.

n_4= Number of respondents for large extent.

n_3= Number of respondents for some extent.

n_2= Number of respondents for little extent.

n_1= Number of respondents for not at all.

A (highest weight) = 5.

N (total number of respondents) = 70.

Table 4.

Response Score, Relative Importance Index and Factor Ranks.

Group	Factor No	Factors	Respondents score in Likert scale						
			1 Not at all	**2** Little extent	**3** Some extent	**4** Large extent	**5** Very Large extent	**RII**	**Rank**
Factors influencing	1	Change in design and scope of project.	0	3	28	22	17	0.751	8
	2	Long administration or approving procedures.	1	5	22	25	17	0.749	9
	3	Inaccurate/unrealistic project scheduling.	2	1	25	23	19	0.760	7

	4	Poor site planning and management.	0	2	20	27	21	0.791	4
	5	Lack of competent project manager.	1	4	31	16	18	0.731	10
	6	Contractual administration issues/conflict.	1	3	28	19	19	0.749	9
	7	Shortage of local construction materials.	0	1	16	23	30	0.834	2
	8	Inadequate contractor experience.	0	1	14	30	25	0.826	3
	9	Payment delays from agency.	3	21	29	10	7	0.591	16
	10	Lack of coordination between procuring agencies and contractor.	5	12	24	22	7	0.640	15
	11	Financial issue (cash flow problem) of contractor.	0	3	12	22	33	0.843	1
	12	Additional works without time extension.	3	8	30	20	9	0.669	14
Factors influencing cost overruns.	13	Unrealistic estimation during the initial project planning.	1	12	21	25	11	0.694	13
	14	Additional works.	2	9	20	26	13	0.711	12
	15	Lowest bidder.	3	6	24	23	14	0.711	12
	16	Construction materials cost escalation.	1	2	28	29	10	0.729	11
	17	Shortage of skilled and experienced technical person in project management.	2	3	17	30	18	0.769	5
	18	Poor project planning and management.	0	5	20	29	16	0.760	7

	19	Inaccurate and unrealistic project scheduling.	1	6	23	26	14	0.731	10
	20	Insufficient cash flows of contractors.	1	6	16	29	18	0.763	6

In the demography section of the questionnaire survey is represented in Figure 1. It shows the percentage of respondents from 20 Dzongkhags and 4 Thromdes. The data coverage was good, covering all Dzongkhags and Thromdes in Bhutan with the government agency constituting about 84%, followed by government-owned corporations with 12%, as shown in Figure 2.

Figure 1.

Number of Respondents From 20 Districts and 4 Thromdes.

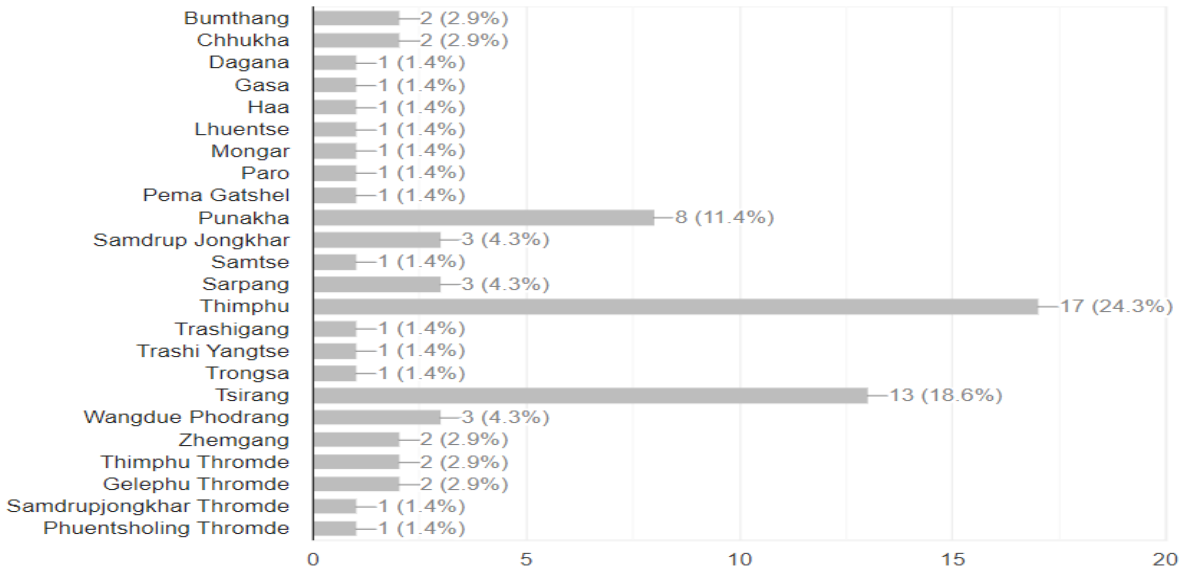


Figure 2.

Percentage of Respondents from Different Agencies.

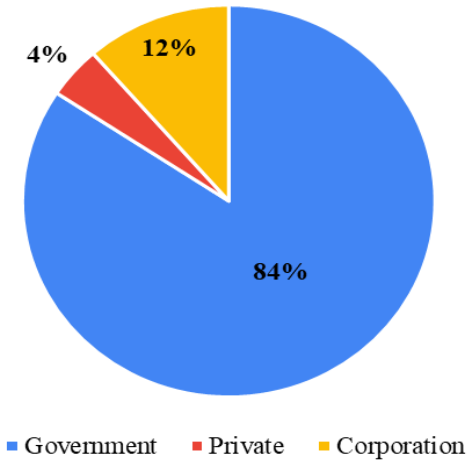
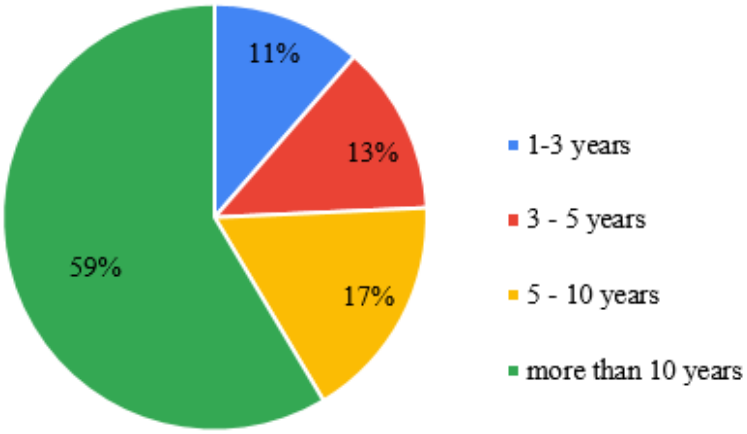


Figure 3.

No. of Respondents with Work Experience.



Most of the respondents have good working experiences; 59% have work experiences more than 10 years in construction followed by 17% having 5-10 years' experience as shown in Figure 3 above.

Discussion of Results

Based on the RII value, top 10 common factors causing time overrun and cost overrun in the construction project implemented by the public agencies in Bhutan are ranked accordingly as shown in Figure 4.

Figure 4.

Top Ten Factors Influencing Time and Cost Overruns in Public Construction in Bhutan

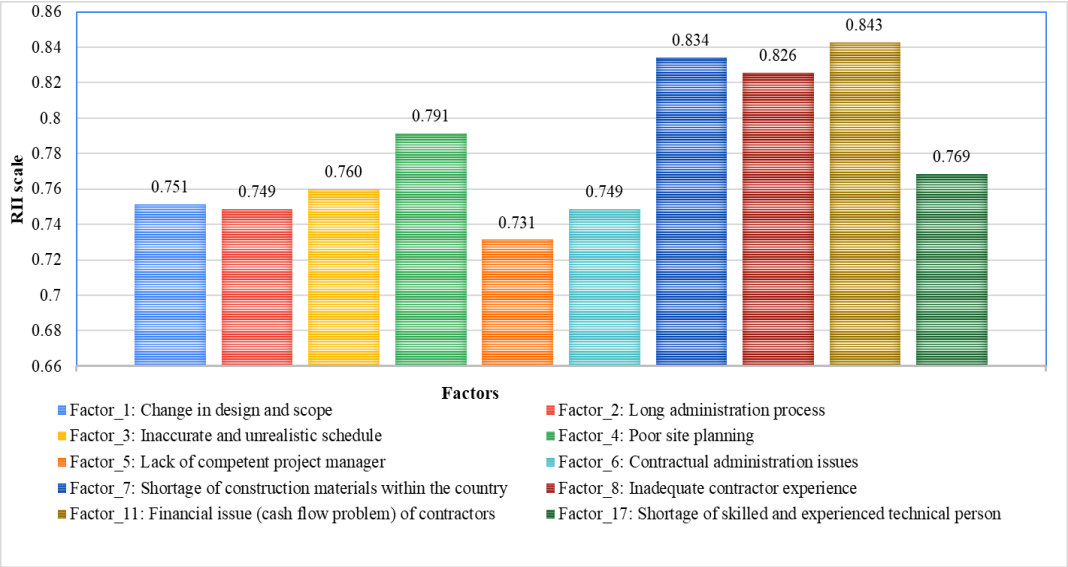
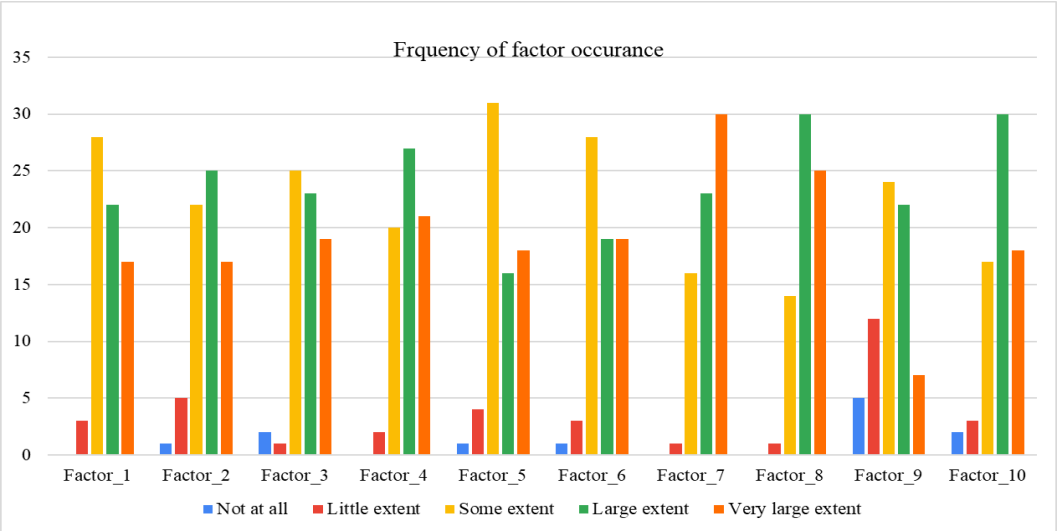


Figure 5.

Top 10 Factors Frequency of Occurrence based on Likert Scale.



According to the frequency of occurrence of factors, it was observed that 'some extent' and 'large extent' occurred the most, followed by 'very large extent' as shown in Figure 5. To explain more on each top ten factors, each factor is discussed below:

Factor Influencing Time and Cost Overruns.

1. Financial issues (cash flow problem) of contractors (Factor_11).

Financial capability is the driving force behind any project (S Ahmed et al., 2018), which also came true for Bhutanese projects as per this study. The contractor's financial stability, which plays an important role in construction projects, as per Procurement Rules and Regulations 2019, a mobilization advance of 10% of the contract price is eligible (Ministry of Finance, 2019). If the contractor is not financially stable, the 10% mobilization advance may not be sufficient to acquire required materials at the beginning of the project, which leads to delays in the project from the beginning itself.

2. Shortage of construction materials within the country (Factor_7).

The second-ranked factor causing time and cost overrun is the shortage of construction materials in the country. This issue was faced severely during the COVID-19 pandemic when the borders were closed, and import materials were restricted. When there are no sufficient local construction materials within the country, it hampers the project in purchasing materials from neighboring countries, taking time and high cost. For example, one of the major Bhutanese construction components is brick imported from India. When borders are closed, it takes time to import bricks, leading to project completion delays.

3. Inadequate contractor experience (Factor_8).

The experience of the contractor in the project, plays an important role in completing the project on time. It was also found to be a major factor causing time overrun in projects in developing countries (Odeh & Battaineh, 2002).

In Bhutan, there is lack of screening mechanism to check the initial contractor experience during the registration. Furthermore, the contractor's classification, such as large, medium and small, is classified based on the human resource and equipment requirement (CDB, 2020). Therefore, the experience factor requirements of contractors are not captured in any guidelines or regulations in Bhutan, which led to time cost overruns when a new inexperienced contractor undertakes the project.

4. Poor site planning and management (Factor_4).

Poor site planning and management was found to be one of the top 5 factors leading to time and cost overruns in Bhutan. When project sites are poorly managed, it reveals that the contractors are unable to implement the project properly due to inadequate coordination. This issue can arise if the concerned agency (client) does not monitor the project from the beginning and when the contractor does not know the coordination mechanism of the project.

5. Shortage of skilled and experienced technical person (Factor_17).

This factor was one of Bhutan's concerns and led to cost overruns in projects. The shortage of skilled labor for the specialized project was one of the concerns since there is still a lack of skilled labor in the Bhutanese market. This was at its worst when the import of labor was restricted during the pandemic. Many public construction projects were delayed due to a shortage of labor in the country.

6. Inaccurate and unrealistic project schedule (Factor_3).

The unrealistic project schedule caused a major delay in the completion of the project in Bhutan. Many of the public construction projects implemented in Bhutan were delayed because of this factor, since many projects were planned within a short span of the term without proper planning. When a designer or planner does not get enough time to prepare a realistic schedule, it leads to an inaccurate schedule. With the number of contractors in the market, many contractors do not care about the schedule at the beginning of the bidding, where the amount is taken into consideration. There is no room to question the designer or planner on the project duration.

7. Change in design and project scope (Factor_1).

The design and project scope change is ranked seventh with RII (0.751). It was found that design change and project scope change during the project implementation was one of biggest challenges faced in the public construction projects in Bhutan. This causes project delay and extra budget. Many of the projects implemented faced this problem mainly because of poor project planning and no detailed feasibility study conducted, where design was not done as per the site condition leading to changes in the design and scope of the project during the implementation.

8. Long administration process (Factor_2).

It was found that the long administration process in the project caused the delays. When there are many administrative processes to fulfil, time is lost and it causes the delays. For example, when a problem arises from the remote site, with poor communication network. To get the approval or order from the headquarters, it needs to organize meetings and getting all members on board, which takes time, causing delays in the project.

9. Contractual and administration issues or conflict (Factor_6).

This factor is not known sometimes during the bidding and awarding process of the project. Once the project is awarded to a contractor and if the contractor has contractual issues or conflicts in a different project, it can cause the cancellation of the award leading to retender, causing loss of time. Many contractual issues happen when the contractor is not able to complete the work or when the contractor runs away. This factor was found to be common in Bhutan, where contractors' several works were incomplete, causing delays and costing extra budget.

10.Lack of competent project manager (Factor_5).

The final factor in the top ten causing project delays in Bhutan was found to be the competence of the project manager. Many of the projects completed with time and cost overruns faced this issue of getting a competent project manager. It was learnt that getting a competent project manager was not an issue, but the concern was with the salary package demand and facilities requirement. It was also found that many of the projects do not have a project manager at the site; rather, the site engineer supervises the whole project.

Conclusion.

Public construction project completed on schedule and within the allocated budget is an important indicator for evaluating project success. Project time and cost overrun issues were a big concern in the public construction projects in many developing countries, including Bhutan.

The study concluded that financial issues was the top-ranking factor in the public construction in Bhutan. Followed by the issue of delays due to a shortage of local construction materials, where many of the construction materials were imported and caused further delays when the import was restricted. Other factors include inadequate experience of the contractor, poor site planning, shortage of skilled workers, unrealistic schedule, design change, contractual issues, and project manager competence. These factors were identified as most common influencing factor causing the delay and cost escalations in construction projects implemented by the public agencies in Bhutan. This study recommends immediate and long-term attention from the procuring agencies to avert the issue of cost and time overrun in uplifting the socio-economic development of Bhutan.

Recommendations.

The financial issues can be resolved if concerned agencies can increase the mobilization advance from 10% to 20%, which will help in the initial setup of the project. To solve the shortage of local construction materials, it should begin with the designer and planner during the project planning stage itself to change construction material from the traditional to modern, example; changing the brick wall to the light prefab materials.

To enhance the contractor experience in the construction project, the concerned agencies should train the aspiring contractors and screen them with the selection criteria of experience. Making the expectations from the contractors clear is an important step to be undertaken by client in averting poor planning and management issues. To minimize the shortage of skilled and experienced technical people in the project, concerned agencies should conduct the skilling training for the construction professional and make it available in the market.

Many projects face unrealistic and inaccurate project schedules, and to solve this issue detailed feasibility study should be conducted, and enough time should be given for the planning of the project. Also, there should be a mechanism where the contractor can propose a tentative schedule for the project during the bidding.

The solution to the long administration process, the concerned agency should build an online system to solve the site issues within 24hours. Strict monitoring should be carried out from the beginning of the project to minimize contractual issues or conflicts in the project.

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