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Research Article

Causes and Impacts of Delays in Ethiopian Public Construction Projects (Case on Debre Markos University Construction Projects)

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The construction project is regarded successful when it is given over to the owner within the time, cost, and standards necessary while minimizing delays in public construction projects. Debre Markos University (DMU) is one of the public universities undergoing massive development projects that are experiencing significant delays. This article evaluates the most prevalent delay issues encountered by Ethiopian government-funded construction projects, particularly those using DMU, analyzes their impacts, and suggests a delay management system. The study applied qualitative as well as quantitative techniques to evaluate primary and secondary data. Per the entirety statistics, the top five most important and highly ranked factors are erroneous time estimates, force majeure, lowest bid, procurement policy, and volatile markets, as well as frequent design changes. Nearly every DMU project schedule overruns up to 268.67% of its contract duration. As a result, the institution suffered from poor public relations and a high cost of supervision and contract administration (6.87% of the overall project cost). Conducting a thorough and accurate project feasibility study, awarding bids to experienced contractors, avoiding drawing discrepancies, preparing an accurate initial time and cost estimate, and strict schedule monitoring were discovered to be effective techniques for reducing delays in public construction projects.

1. Introduction

Time and cost overruns are two of the most serious issues confronting the construction sector in developing nations such as Ethiopia. The Ethiopian government is undertaking a variety of development projects, ranging from buildings to several megastructures such as the Great Renaissance Dam. Advanced technologies, new standards, multiparty engagement, and frequent owner-desired adjustments characterize modern construction projects. When combined with the inherent pitfalls and challenges in the physical, monetary, and economic contexts in which most projects are carried out, these circumstances have made completing projects on time and on the allocated funds a difficult task to accomplish, frequently leading to claims for cost compensation and/or time extensions, and it epitomizes additional costs due to late facility occupancy or other factors. Furthermore, it is a loss of revenue, a lack of productivity, and a reliance on current facilities for the client of the project. Construction delays, on the other hand, indicate higher costs, longer work duration, increased labor costs, higher material and equipment costs, and so on to the contractor. This eventually causes a delay in the project's completion [1].

A delay can be described as a time overrun that extends beyond the completion date indicated in a contract or beyond the date specified by the parties for the completion of the project [2]. The delay might happen alongside other delays, and all of them may have an impact on the project's completion schedule [3]. Delays can lead to overruns in time and costs, disputes, court proceedings, poor quality, deliveries, and ultimate abandonment [4]. Construction project delays hurt investors' contractual rights by increasing combative relationships, distrust, litigation,

arbitration, cash-flow issues, and a general sense of fear toward each other [5]. The delay was also defined as an "act event which extends the required time to perform or complete work under *t* contract and manifests itself as additional days of work" [6]. Local and international standards contain declarations about construction delays. A number of the standard documents that outline each party's rights and obligations regarding construction delays are FIDIC, PPA, and the 1960 Ethiopian Civil Code [7–10].

The construction industry is an essential aspect of the economy and has a significant impact on the efficiency and production of other industries; large investment in other sectors is not possible without the necessary infrastructure in place [11]. The construction sector is becoming more dynamic as technology, money, and construction procedures become more uncertain. Construction projects are becoming increasingly complicated and challenging, and the construction project team is confronted with novel obstacles. Clients regard the timely completion of a construction project to be a major indicator of project success [12]. Alemayehu [13] defined delay as an occurrence that increases the time required to complete contract tasks. It frequently manifests as extra days of work or a delayed start of activity [14].

It is critical to analyze whether additional time extensions are necessary for critical activities because the type of delay has an impact on them. There are two types of excusable delays: those that are excusable with compensation and those that are not [2, 4, 10, 15]. A client, end-user, consultant, designer, owner, contractor, or supplier may cause a delay. Seife [16] indicates that the main reasons for time claims in Bahir Dar University projects include client fails to deliver the site to contractors, variations in work orders by the client and consultant, design issues, bad weather conditions, and a significant increase in the volume of work. A general overview of delay-causing factors in Ethiopian public construction projects is shown in Table 1.

In the construction environment, the term "delay" often has a negative connotation for key players specific and the industry overall. According to the Journal of the Ethiopian Association of Civil Engineers [21], it implies claims, price hikes for a client, a reduction in profit/return, cost of both *d* extensions, increasing expenses for operation and upkeep of infrastructure, loss of business opportunities, abandonment of the project and drop-in construction activities, bad reputation, and liability to secure financing for the project or secure it at a higher cost due to the major effects of time overrun discovered in construction projects. Claims, distrust, litigation, cost overruns, cash flow issues, and a negative hostile relationship among stakeholders are instances. Sambasivan and Soon [4] stated that the top six effects of delays reported in a study of the effects of construction delays on the project construction sector were cost run time overrun, disagreement, arbitration, lawsuit, and abandonment. Kemo [19] and Tilahun [12] stated that the following were the six most often seen repercussions of delay: (1) time overrun, (2) overrun of cost, (3) conflicts, (4) arbitration, (5) lawsuit, and (6) outright abandonment.

Aibinu and Jagboro [2] highlighted two approaches to reduce or, if possible, eliminate time overruns: acceleration of site activity and provision for contingencies. Tilahun [12] revealed that minimizing time delays and cost overruns would necessitate: ensuring an adequate and available source of finance until project completion; allocating sufficient time and money for the design phase; selecting a competent consultant and a reliable contractor to carry out the work; performing a preconstruction planning of project tasks and resource needs; hiring an independent supervising engineer to monitor the progress of the work; and ensuring timely completion. Alemayehu [13] recommended improving the construction project's situation by enforcing liquidated damage clauses along with providing rewards for early completion; adopting an innovative approach to contract award procedures that giddiness weight to price and more weight to contractors' capabilities and previous performance; and adopting a novel approach to contracting, such as design-build and construction management (CM) types of contracts. Yifredew [6] stated that essential success element delays are caused by project managers' competency, time management, control system and duties, monitoring and feedback, and ongoing involvement in the project. Aibinu et al. [2, 11, 22] proposed that clear goals and project missions, support from upper management, a capable project manager, a qualified project team, sufficient resources, client/customer participation and consultation, effective communication, responsiveness to clients, proper monitoring, and comments are the factors to be considered in ensuring the successful completion of the project. According to Jagbor [23], the following are some strategies for reducing delays: competent project manager, ensuring an adequate and available source of finance, multidisciplinary/competent project team; availability of resources; commitment to projects, adopting a new approach to contract award procedures by giving less weight to prices and more weight to contractors' capabilities and past performance, adopting new contracting approaches such as design-build (D/B) and construction manager (CM), complete and accurate project feasibility study and site investigation, expedited site clearance, comprehensive contract documentation, frequent progress meetings, project management assistance, utilization of up-to-date technology, and use of experienced subcontractors and suppliers, complete and proper design at the right time, competent consultant/designer personnel, competent and capable client's representative, site management and supervision use of props, proper material procurement; developing human resources in the construction industry through proper training, allocation of sufficient time and money at the design phase, awarding bids to the right/experience consultant and contractor, perform a preconstruction planning of project tasks and resources needs, systematic control mechanism and effective strategic planning.

There are 45 public universities in Ethiopia, with Debre Markos University being the most recent to open its doors in 2008. DMU has built many construction projects for the university's expansion in the last 15 years, including health compass, bure compass, a comprehensive teaching hospital,

Table 1: Factors contributing to Ethiopian public construction project delays.

Researchers	Major causes of delays
[17]	(i) A poor project management strategy, late payments to contractors, delays in sharing information, and delays in funding
[12]	(ii) Inadequate information exchange between government agencies, problems with right-of-way and site disposal, and significant changes to the design
[18]	(iii) Delay in progress payment, severe weather, contractor's incapacity, land acquisition and resettlement, ineffective planning and scheduling, and scope revisions and additional work
[19, 20]	(iv) Delays in providing materials on-site, ineffective site management, incomplete paperwork, delayed site transfer of ownership ineffective site management, and oversight

and main compass expansion programs such as classrooms, laboratories, administration buildings, auditoriums, staff and student launches, hotel and tourism, entrepreneurship training centers, digital libraries, and postgraduate buildings in the main compass to achieve the government's strategic policy in the educational sector. Yet, none of the projects were completed by the deadline. As a result, the majority of the new programs that were meant to be launched in its new faculty are being hosted by the current faculties, creating an overburdening scenario. This vital and practical problem has overwhelmed our minds, producing and damaging delays on Ethiopian public construction projects (case study on DMU construction projects). As a consequence, the focus of this study is on public construction projects at DMU, which will assess for delays and examine the corresponding impacts identified, as well as provide a recommendation based on the findings to improve project performance within university projects and general public construction projects in Ethiopia.

2. Objectives

This investigation intended to assess the primary variables responsible for delays in public construction projects in overland specifically Debre Markos University, and their impact on progress and on-time delivery and also propose approaches and techniques for reducing construction delays to overcome the problems.

2.1. Research Methods. In Ethiopia, public construction projects are rapidly expanding and the largest receiver of government funds under the government's development policy. It accounts for roughly 45% of the yearly government capital budget [24]. This study aims to identify the key reasons for the delay, their effects, and ways for mitigating them in Ethiopian public building projects, such as DMU.

The types of analyses used in this research were primarily descriptive due to their ease of gathering people's opinions on a certain subject. This strategy is focused on gathering data and obtaining completely precise knowledge about the current state of phenomena, as well as concluding facts collected wherever possible [25].

However, before selecting a sample, the sampling unit must be identified. A sample unit can be a geographical unit such as a state, district, hamlet, building unit, or social unit. As a result, the sample unit for this study was Ethiopian public building projects in general, and specifically the DMU project office (DMUPO). Purposive sampling was used in this study to collect the targeted respondents who are considered to have relevant information about the study's aims. Following that, data were gathered through document reviews, questionnaire surveys, and case studies. The questionnaire survey data were organized, coded, categorized, analyzed, and interpreted using the Statistical Package for Social Science (SPSS) version 23 with Cronbach's alpha coefficient for reliability in equation (1) and the Relative Importance Index (RII) to determine the ranking of cause and effects of delay in the following equation:

$$\alpha = 1 - \frac{\sum_{i=1}^{i} \delta_i^2}{\delta_x^2}, \tag{1}$$

where i = the number of items on the scale. σ_i^2 = the variance of item i, and σ_X^2 = the variance of the observed total test scores.

$$\text{Relative Importance Index } (\mathbf{RII}) = \mathbf{\Sigma w} \div \mathbf{H \times N}, 0 \leq \text{RII} \leq 1, \tag{2}$$

where w is the total weight given to each factor by the respondents, which ranges from 1 to 5, and is calculated by adding the various weightings given to a factor by the entire respondent, H is the highest ranking available (in this case, 5), and N is the total number of respondents who answered the question.

2.2. Ethical Considerations. This study adhered to the ethical criteria of research requirements. By keeping the information obtained private, the respondents' privacy and confidentiality were safeguarded. The fraud was avoided by alerting construction companies about the goal of the research and its ramifications for the respondents, and the actual names of the enterprises were replaced with fictitious company names.

3. Results and Discussions

3.1. Desk Study. DMU has had a total of 71 projects since March 30, 2022. Thirty of them have been finished, seven have been terminated, 24 are underway, and ten are in the design and bid stages. The major consulting firm for DMU expansion projects is Alexo Design Share Company (ADSC), a public consulting business, and Birana Consulting PLC, a private consulting firm, is one of the other consultants outside the DMU project office.

Generally, when we see the DMU construction projects, the progress of almost all projects' percentage of execution is far behind their elapsed time, and most of the projects are undergoing work outside of their contract time frame. For this, out of a total of seventy-one DMU projects, including projects on bid and design, there is no single project that ends at its predefined time. Rather, they experienced the termination of seven projects that were too delayed.

3.2. The Severity of DMU's Construction Project Delay. Table 2 shows the magnitude of schedule overruns on selected completed projects, with a total of 88.35% delay on previously completed projects. This means that all projects were finished in more than double the time expected, resulting in a severe loss for the client (DMU). Because the percentage of work completed lags far behind the percentage of elapsed time, we can predict that projects completed within the contract time will also face time overruns unless they compensate for the lag time of the crash program by deploying the necessary resources.

Contractors may lose money, time, and a positive brand image as a result of project delays. They incur additional fees for longer salaries, machinery, and vehicle rent, as well as additional overhead costs associated with project delays. Administrators, office workers, supervisors, and other overhead expenditures such as insurance and equipment leasing accumulate in projects as long as the project is not completed. The entire overhead costs rise when there is a delay. To illustrate the size of the effect, the average contractor's 20% overhead cost is considered, as given in Table 3.

When we look at the construction projects that are currently under construction, as shown in Table 4, nine of them have completed their contract time and can be classified as delayed projects. The reset three consumed more than 60% of their intended time, and their work done percentage is less than 35% in reverse. As a result, unless they compensate for the elapsed time of working under the crash program by deploying the necessary resources, they are likewise vulnerable to schedule delays. As an outcome of this, the DMU construction projects endured and suffered delays.

According to the document analysis, the key causes of delays in Debre Markos University construction projects are lateness in giving orders, low contractor capability, bad contractor project management, and construction materials market volatility.

Nevertheless, the researcher disagrees with the document analysis results. Because all 71 completed, ongoing, and design and bid stage projects are vulnerable to delays, they may be delayed not only due to the contractor's capacity and market fluctuation but also due to improper time estimation, poor supervision, unresolved rights of way, frequent design changes, and poor client and consultant decisions.

Aside from poor quality products and structural failures, additional costs due to market fluctuations, and biding costs for canceled projects, construction project delays affect the client's ability to incur additional costs for consultants. As stated in Table 5, DMU was exposed to a cost of more than eighteen million birrs for consultation fees in the delayed time for only 22 selected projects out of 71 projects held by the university.

We can conclude from this case study that the public client, DMU, is the most affected by the cost overrun effect of delays because its projects are far behind schedule, having a significant impact on its teaching-learning programs and is forced to look for an additional budget to complete those projects that are suffering and require extra time to be completed due to the consultant's fee and accommodations, etc., that are related to the extended project's duration.

4. Questioner Survey

4.1. Characteristics and Profiles of Respondents. The questionnaire was produced and given to three contractual parties, namely, contractors, clients, and consultants who are currently working on DMU construction project sites, as well as in-person contact by visiting all project sites, including the bure and health campus.

According to Table 6, the questionnaire survey response rate for contractors, consultants, and clients was 88%, 83.33%, and 85.71%, respectively. According to Sekaran [20], for most investigations, a response rate of 30% is sufficient. As a result, the response rate was deemed adequate for the study. Furthermore, to obtain reliable information for the study, the respondents' educational background and professional qualifications were restricted to a minimum of a BSc degree in Civil engineering, construction engineering, construction management and technology, or a related profession.

The results of the respondents' interim job experience, as shown in Figure 1, clearly illustrate that the results obtained are valid. This suggests that responders are anticipated to be more knowledgeable about the topic of the questionnaire.

The primary goal of this research was to identify the primary causes and consequences of delays in public construction projects in Ethiopia in general, and notably in DMU. According to Table 7, the majority of respondents (87.4%) agree that time and cost overruns are the most serious issues in DMU development projects. which also supports the document review of the construction project delay magnitude discussed in Tables 4 and 5, which states that there is a total delay of 88.35% on the previously completed and now under construction projects, respectively.

Table 2: The magnitude of delay of Debre Markos University's 10 completed projects.

No	Project name	Contractor name	Consultant name	Original contract amount in millions of dollars	Original contract time in days	Time elapsed delays in days	Total delayed time in days	Total delayed time in %	Remark
1	Health compass staff and student toilet	Aby Ked BC	DMU project office	2.23	150	263	103	68.67	Overrun
2	A main compass security tower	Yh Kale GC		1.52	180	200	20	11.11	Delayed
3	Main compass sewerage line maintenance	Mul Tema GC		1.23	150	180	30	20	Delayed
4	Main compass gym	Age Con		6.00	240	491	251	104.58	Overrun
5	Bure compass water supply	Birth Eye GWC		25.83	240	479	239	99.58	Overrun
6	Main compass moveable security tower	Ayal Madese GC		2.18	100	145	45	45	Delayed
7	Health compass student toilet and shower	Ago Mul GC		3.50	155	251	96	61.93	Overrun
8	Ceiling and floor work	Abe Bel GC		8.60	90	112	22	24.44	Delayed
9	Incliners	Sel Abin Con		1.02	120	195	75	62.50	Overrun
10	Main compass staff launch	Tam Tem Con		50.10	600	1503	903	150.5	Overrun
Total				102.30	2025	3819	1789	88.35	

Source: Debre Markos University Construction Project Office.

Table 3: Summary of cost of contractors' damage in Debre Markos University's construction projects.

No.	Project category	Reason of cost	Total delayed time in a month	Average monthly overhead amount in millions of dollars	Total contract amount in delayed projects in millions of dollars	The magnitude of overhead cost in millions of dollars	% from project contract cost
1	Selected 10 completed projects (Table 2)		59.63	44,780.74	102.20	26,702.75	2.61
2	Selected 12 ongoing projects (Table 4)	Overhead cost (20%)	120.8	44,780.74	1,177.56	54,095.13	0.46

Table 4: The magnitude of delay of Debre Markos University's 12 ongoing projects.

No.	Project name	Contractor name	Consultant name	Original contract amount in millions dollars	Original contract time	Time elapsed delays	Total delayed time in days	Justified time	Total delayed time in %	Work executed in %	Remark
1	Hotel and truism building	Saf Con	ADSC	54.20	540	1360	820	605	151.85	65	Overrun
2	Entrepreneurship building	Saf Con	ADSC	32.49	365	1197	832	647	227.94	68	Overrun
3	Health compass landscape works	Bok Con	ADSC	164.61	570	935	365	240	63.04	28	Delayed
4	Bure compass infrastructures	Mir Con	ADSC	120.41	364	544	180	34	49.45	75	Delayed
5	Bure compass library buildings	Bark Eng	ADSC	40.11	540	573	33		6.11	43	Delayed
6	Water wall to main compass	WWWE	ADSC	24.69	150	553	403		268.67	68	Overrun
7	Main compass administration building	F-Stone con	ADSC	121.52	600	1050	450		75	68.47	Overrun
8	Main campus to Adiss Alemayehu roundabout walkway	Misker G.C	ADSC	12.41	365	800	435	218	119.18	58.5	Overrun
9	Main campus digital library	L-Shayn PLC	ADSC	115.02	990	808	—			35.10	
10	Main campus postgraduate building	KTY Con	ADSC	278.40	730	435				20.2	
11	Main campus ICT building	K-Fitir Con	ADSC	198.27	730	425				22.4	
12	Henhouse construction	M-End BC	ADSC	15.39	365	471	106	—	29.04	67.0	Delayed
Total				1,177.52	6309	9151	3624		57.44		

Source: Debre Markos University Construction Project Office.

Table 5: Cost of client's damage in Debre Markos University's project.

No	Project category	Original contract amount in millions dollar	Original contract time	Elapsed time	Delayed time in the day	Delayed time in the month	Monthly consulting fee in millions of dollars	Total consulting fee in the delayed time	% from project contract cost
1	Selected 10 completed projects (Table 2)	102.20	2025	3819	1789	59.63	100,069.7	5.97	5.84
2	Selected 12 ongoing projects (Table 4)	1,177.18	6309	9151	3624	120.8		12.09	1.03
	Sum	1,279.40	8334	12970	5413	180.43		18.06	6.87

Table 6: Questionnaire response rate.

Representing organizations	Questionnaire distributed	Questionnaire returned	% of return vs distribution
Client (project owner)	7	6	85.71
Consultant (engineer)	18	15	83.33
Contractor	25	22	88.00

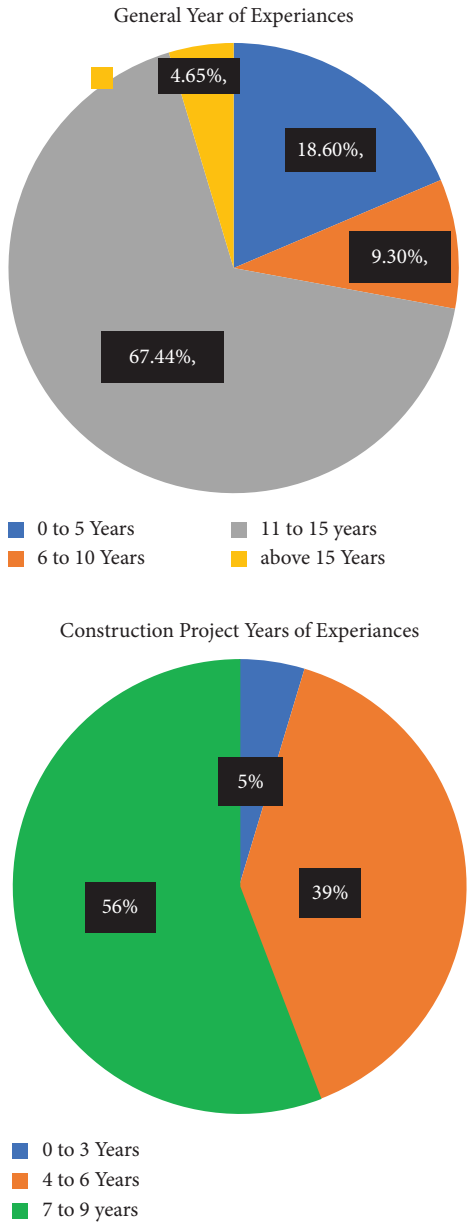

Figure 1: Respondents work experience.

Table 7: Respondents' general opinion on their current project's state.

No	Scenarios	Respondents' responses in %	
		Yes	No
1	Do you think time overrun is a problem for DMU's construction projects?	87.4	12.6
3	Do you think cost overrun is a problem for DMU's construction projects?	81.3	18.7
4	Taking your current project into consideration, is the performance significantly behind schedule?	67.4	32.6
5	Did you conduct a complete and accurate project feasibility study before you start your work?	65.1	34.9

4.2. Reliability Test. Quality is usually one of the most essential topics in research, and as such, it may primarily be determined through testing for reliability and validity. Cronbach's alpha coefficient, with a value ranging from 0 to 1, was used to examine the reliability or consistency of the questionnaire survey. Its worth was calculated using equation (1), and the values for clients, consultants, contractors, and overall responders were 0.825, 0.760, 0.911, and 0.879, respectively. All results exceeded the minimum level of reliability, 0.7 [22]. As a result, it is possible to conclude that the questionnaire survey was credible and consistent.

4.3. Factors Causing Delay of DMU Construction Projects. Construction delays are a commonly acknowledged truth and a prevalent issue in building projects. Delays in construction projects occur due to a variety of circumstances and causes. These causes are categorized into four-factor groups in this study: clients, consultants, contractors, and external associated variables.

According to the questionnaire survey results, Table 8, the most important, highly ranked, and high level of importance consultant-related delay causes are inaccurate time estimates, frequent design changes, delay in performing testing and inspection, failure to give written instructions, late reviewing and approving design documents, preparing an incomplete or undetailed BOQ, and delay in approving a major change in the scope of work. Contractor-related delay factors include: contractor financial capacity, late material delivery, low-balling/low cost, work suspension on the engineer's order, and inadequate coordination and communication with other parties. Client-related delay causes include insufficient staff, slow decision-making, information delays, change orders, and change of mind during construction, while external delay causes include force majeure, lowest bid procurement policy, construction material market instability, poor economic conditions (currency, inflation rate, LC, etc.), and construction material shortage. In addition, respondents suggested evaluating payment delays and the lengthy and bureaucratic payment processes as potential causes of project delays because the lowest bids may be from unqualified contractors. As a result, poor contractor performance will ensue, affecting the project timetable.

The respondents' rankings are depicted in Figure 2. The consultants were responsible for 35% of the top twenty-six potential delay causes with a high priority level, while external variables were responsible for 27%. With a 19% share each, contractors and clients are equally responsible for building project delays in DMU.

4.4. Delay Effect on DMU Construction Projects. The aim to complete a project on schedule, within budget, and to the best quality is shared by all contracting parties, including the owner, contractor, and consultants. Delays typically result in the loss of one or more forms for everyone. Time overruns, cost overruns, wastage and underutilization of resources, tying down of the client's capital due to noncompletion of the project, abandonment of the project, the dispute between parties, reduced profit or total loss, arbitration, and litigation and court cases were the nine effects of delay identified. Respondents were asked to score their agreement on the effect of delay by linking it to the delay it creates in this regard.

Table 9 results demonstrate that discontent by project owners and, as a result, end-users (bad public relations), is ranked first, followed by the high expense of supervision and contract administration for the project's consultant. Loss of users' benefit if it had been completed on time, loss of profit for noncompletion to the contractor, material price escalation costs, pouring money unnecessarily into the project at hand at the expense of other new projects, extended site overhead and general overhead expenses, and liquidated damage expenses. The third through tenth grades were discovered to have the biggest impact on DMU building delays, with a high level of relevance. Every stage of a project's life cycle requires time. When a contract is completed and a deadline is set, the effect of delay affects time and increases the final cost; more money must be paid. Delays will also result in personnel and resource waste and underutilization. These three consequences are intricately linked. According to the correlation between the causes and effects of delay, the phrase "time overrun" refers to late completion or late delivery from the period stipulated or agreed upon by all construction project stakeholders. The primary causes of time overruns are financial issues, late payments for completed and continuing work, change orders, ineffective planning and scheduling, bad site management, material supply delays, and so on.

Cost overruns are the rising costs of labor, labor force, materials, equipment, and so on. The primary sources of cost overruns are modification orders, contract errors, changes in drawings, faulty cost estimation, and so on. Wastage and underutilization of resources related to idle labor, reduced worker and equipment productivity, and so on. Late procurement and material delivery, slow response and approval modification orders, insufficient material supply, changes in drawings, weather conditions, unforeseen site conditions, and other factors are the primary causes of resource underutilization. Disagreements between parties in a building project are referred to as disputes among parties. Slow or late payments for completed or ongoing work, poor communication and coordination, and client meddling are the primary reasons for disagreements. Litigation and court cases refer to legal proceedings in a court to solve problems, which might take a long time. The major causes of litigation and court disputes are late or nonpayment for completed work, increases in material pricing, and so on. Abandonment is halting all work or suspending the project for an extended period. The most common reasons for desertion are regulatory changes, financial and payment issues, natural calamities, and so on.

4.5. Mitigation Measures for Delay of DMU Construction Project. A construction project delay that is not effectively handled or managed will have a detrimental impact on the project, the parties participating in the project, and the construction industry as a whole. Handling delays covers how an extension of time for the delayed project is granted, beginning with notification of the delay, and the degree of

Table 8: Index of importance for the most essential factors in total outcomes.

No	Causes of project delay	RII	Rank	Factors related
1	Inaccurate time estimate	0.9788	1	Consultant
2	Force majeure	0.9884	2	External
3	Lowest bid procurement policy	0.9847	3	External
4	Construction material market instability	0.9753	4	External
5	Frequent design changes	0.9345	5	Consultant
6	Delay in performing testing and inspection	0.9265	6	Consultant
7	Failure to give written instruction	0.92	7	Consultant
8	Late in reviewing and approving design document	0.9121	8	Consultant
9	Financial capacity of the contractors	0.907	9	Contractors
10	Insufficient number of staff	0.9023	10	Client
11	Slow decision making	0.8884	11	Client
12	Information delays	0.8884	12	Client
13	Change order	0.8853	13	Client
14	Poor economic conditions	0.8814	14	External
15	Preparing incomplete/undetailed BOQ	0.8791	15	Consultant
16	Changes of mind during construction	0.8776	16	Client
17	Shortage of construction material	0.8721	17	External
18	Delay in approving a major change in the scope of work	0.8698	18	Consultant
19	Inaccurate cost estimate	0.8698	19	Consultant
20	Poor briefing of the document (specification, BOQ)	0.8605	20	Consultant
21	Late delivery of materials	0.8605	21	Contractors
22	Law-balling/low costing	0.8279	22	Contractors
23	Inadequate preparation of tender and contract documents	0.8233	23	Consultant
24	Poor coordination and communication with other parties	0.821	24	Contractors
25	Suspension of work upon the engineer's instruction	0.803	25	Contractors
26	Late approval of payment	0.8	26	Consultant

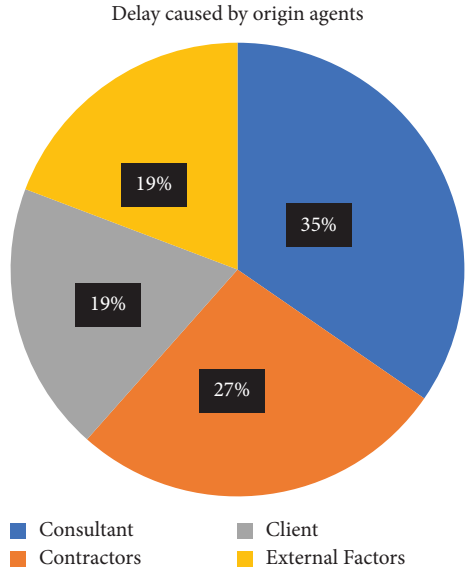

Figure 2: Percentage distribution of delay caused by origin agents.

enforcing liquidated damage clauses put into the contract agreement.

As shown in Table 10, some of the construction delays minimizing mechanisms in public construction projects include conducting feasibility studies before starting projects, selecting appropriate contractors for specific projects, ensuring all design/drawing and contract documents are clear and complete, accurately estimating the time and cost of the project, and ensuring the allocated budget is available before starting the project.

Table 9: Effects of delay on construction projects.

No	Effects of delay on DMU construction projects	RII	Rank	Important level
1	Dissatisfaction by project owners and consequently by end-users	0.9623	1	High
2	The high cost of supervision and contract administration for the consultant	0.9535	2	High
3	Loss of users' benefit that will be obtained	0.8791	3	High
4	Delay in getting service by clients	0.8791	3	High
5	Loss of profit for noncompletion to the contractor	0.8791	3	High
6	Material price escalation costs	0.8512	6	High
7	Pours money unnecessarily into the project at hand at the expense of other new projects	0.8512	6	High
8	Extended site overhead and general overhead expenses	0.8419	8	High
9	Expenses for liquidated damage	0.8140	9	High
10	Economic impact on the country	0.8047	10	High
11	Idling resources	0.7860	11	High medium
12	Dispute	0.7767	12	High medium
13	Environmental impact	0.7721	13	High medium
14	Extended payment/performance bond premiums	0.7628	14	High medium
15	Termination	0.7442	15	High medium
16	Negative social impact	0.6837	16	High medium
17	Create stress on stakeholders	0.6233	17	High medium
18	The contractor will suffer from the budget shortfall of the client	0.5628	18	Medium
19	Negative attitude towards the construction industry by the higher public authority and by society as a whole	0.5442	19	Medium
20	Extended insurance premiums	0.5116	20	Medium
21	Poor quality of work due to hurrying	0.4651	21	Medium
22	Arbitration	0.4233	22	Medium
23	Political impact	0.2465	23	Medium low

Table 10: Mitigation measures for delay of DMU construction projects.

No	Method of resolving/minimizing delay	RII	Rank	Important level
1	Complete and accurate project feasibility study	0.9644	1	High
2	Awarding bids to the right/experienced consultant and contractor	0.9535	2	High
3	Avoid the discrepancy in the drawings	0.8791	3	High
4	Accurate initial time estimate	0.8791	3	High
5	Strong supervision as per a schedule	0.8698	5	High
6	Accurate initial cost estimate	0.8698	5	High
7	Use of appropriate construction method	0.8698	5	High
8	Allocation of sufficient time and money during the design phase	0.8698	5	High
9	Ensuring adequate and available sources of finance	0.8651	9	High
10	Top management support	0.8558	10	High
11	Frequent progress meeting	0.8465	11	High
12	Acceleration of site clearance	0.8465	11	High
13	Performs preconstruction planning of project tasks and resources needs	0.7953	13	High medium
14	The fast decision of site possession or removal of obstructions	0.7860	14	High medium
15	Paying the payment at the right time	0.7488	15	High medium
16	Avoidance of unclear and incomplete contract documents	0.7395	16	High medium
17	Competent client representative	0.6140	17	High medium

5. Conclusion

The following conclusions are derived in parallel with the study's purpose based on literature reviews, questionnaire responses, and case studies. The key causes of the delay from the consultants' duty were found to include an erroneous time estimate, frequent design changes, delays in executing testing and inspection, failure to offer written instructions, and late evaluating and approving design papers. Financial capacity, late delivery of materials, law-balling, stoppage of construction upon the engineer's direction, and inadequate coordination and communication with other parties were discovered to be the key causes of delays on the contractor's side. On the other hand, the client's liability and force majeure was judged to be insufficient staffing, delayed decision-making, information delays, modification orders, and change of mind throughout construction. External sources of delay for DMU construction projects were

discovered to be the lowest bid procurement policy, construction material market instability, weak economic conditions, and construction material shortage.

Dissatisfaction by project owners and, as a result, end-users, high cost of supervision and contract administration for the project's consultant, loss of users' benefit that would have been obtained if it had been completed on time, delay in getting service by clients, loss of profit for noncompletion to the contractor, material price escalation costs, pouring money unnecessarily into the project at hand at the expense of other new projects, extended site overhead and general overhead expenses, and expenses for liquidated damage were found in the sequences of construction projects delayed by DMU.

The outcomes of the case study revealed that not a single project was completed within the time frame specified. Rather, they had six projects terminated because they were too late. The delay for finished and ongoing projects ranges from 11.11% (main compass security tower) to 150.5% (main compass staff launch) and 6.11% (bure compass library buildings) to 268.67% (water wall to main compass), omitting the time required to complete the projects. Furthermore, the university lost 19,679,445.97 in consulting fees during the delay, and the contractors lost nearly 3.07% of the total contract amount during the delay due to project overhead costs.

In general, the study discovered that project schedule delays harmed both the client and the contractors. The degree of harm changes from contract to contract in each project and has a cumulative effect on the client. (i) Significant evaluation results recognized as real repercussions of project delay include client and contractor damage, additional expenditures paid, and loss of good corporate image. (ii) The university lost students who would have received capacity and other benefits from the planned development projects.

6. Recommendation

According to the client, contractor, and consultants, "Change to design during construction" was the most critical element in DMU construction time overruns. They agreed that the most significant factors of time overrun as a result of the design change during construction were a high level of quality requirements, incomplete drawings and project information, contract modification, government obstruction, client-contractor working relationship, late payment, and project location. Based on the study's findings, the authors propose that clients, contractors, and consultants be compelled.

(1) Minimizing design changes, enhancing the quality of design plans, and stressing project completion date meetings; efficiently communicating through paperwork, such as drawings and specifications

(2) The design and documentation should be of high quality, with tight application to the construction project

(3) They must make all required decisions before project execution and avoid making additional decisions after project completion

(4) The recommended remedies for late design review and approval were integration between the client and the consultant, the early beginning of design review, immediate response for design approval, competent and experienced designers, experience exchange, and so on.

Overall, the key causes, impacts, and mitigation strategies of public construction project delays in Ethiopia have followed the same patterns. As a result, this research will assist the government in overcoming it.

Data Availability

All data used to support the finding of the study were included in the article.

Conflicts of Interest

There are no known conflicts of financial interest or personal relationships that could have appeared to affect the work disclosed in this study, according to the authors.

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