

Pandemic Construction Delay and Cost Overrun Analysis in Water Resource Project

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Abstract

This research aims to identify the most critical factors that influence cost and time overruns in water resource projects and assess the risk associated with cost and time overruns. There were fifty (50) time delay factors and fifty-five (55) cost overrun factors included in this study. Identifying the Cause for the project's delay was greatly aided by studying the literature and discussions with various parties. This questionnaire aimed to assess the severity, frequency of occurrence, and significance of the defined courses. The factor was compared and ranked based on the analyses of the Relative Importance Index (RII). Cost overrun-related factors were categorized into six groups i.e. client, contractor, consultant, labour, external, and equipment whereas, time overrun administration, financial, contractor, consultant, and material-related factors. This factor was compared and ranked based on the analyses of the Relative Importance Index (RII). Based on the studies, contractor and external-related factors significantly impacted the frequency and severity of cost overrun compared to other sub-groups. Similarly, we compared the major contributor factor in the project's running time; based on the analysis of the material-related and financial-related problems; there was a significant impact in increasing the project's frequency and severity, respectively. Furthermore, in this research, the percentage of risk of cost and time overrun was also studied in detail. Based on that, external related factors had a high risk for cost overrun compared to the other five categories, and administration-related factors were also exposed time overruns to be raised.

Keywords: Cost overrun • Time overrun • Relative Importance Index (RII)

Introduction

This study covers Delay's risk and cost overrun of water resource construction projects from the Ethiopian perspective. Ethiopia is one of the ancient and non-colonized countries reached in natural resources. Among the natural capacity, water resource is the most and the privileged resource in the country. Ethiopia has over 122 billion meter cube of water resource capacity on both ground and surface [1]. The favourable geographical location and the excellent climate condition made the country get a fair amount of rainfall. However, due to miss management and Lack of water resource structure, people had not been utilized. As research indicates, Ethiopia has 3.7 million hectares of irrigable land; however, 75000 hectares of land were irrigated. The water sector development program main report volume 1(2002), Ethiopia has more than enough hydropower potential of 135 GWh per year. Due to the economic and Delay of project and cost overrun problem, only one percent has been used. From these studies, we will deal with the main Cause of cost and time overrun from Ethiopia's point of view. It implies the impact assessment and analysing the risk of Delay in Water resource projects [2]. The construction industry is one of the activities that are growing the country's growth from time to time it has prevented the Ethiopian economy from being too reliant on the agricultural sector, which accounts for a large portion of its GDP. Construction projects are unique and are an inherent risk due to multi-sector involvement with their interests. The construction industry risks are multiple and can lead to undesirable consequences [3]. construction delay shifts a project schedule beyond the contract date on which the construction involving party agreed to finish. Due to an unwanted increase in estimated cost and highly complex and complicated nature, the project's health would disorder. Delay defines the time consumed over the project contract agreement's specified duration. It can categorize that the time which is taken to complete the project beyond the prescribed contract schedule.so, it can be stated the productive project are the project that is completed per required time for the required purpose

at the right place. In this research, delays in Dam construction projects will be considered as the requested additional time to complete the project beyond the original period of contract or, in other words, it is the amount of difference between the planned construction time for the project and the actual time to complete it [4]. They have identified the primary Cause for both times and cost Delay those are owner during construction, in progress payment, ineffective timing and planning by Contractor, Shortage of labour, Shortage of financial by Contractor, government regulation, traffic control and restriction at the site, the Effect of social and cultural factor and accidental factor [5]. factors for cost overrun for drilling groundwater and identified ten primary reasons for the escalation of cost monthly payment difficulty, poor contract management, material procurement, inflation, contract financial difficulty, escalation of material price, cash flow. In the construction industry, during construction, plan and scheduling deficiencies, bad weather, and deficiency in cost estimated., Delay is a big problem that faces projects not to be completed as planned. Client, Contractor, and Consultant are the main actor that delays the project. Various causes of delays in construction projects are classified under these three main parties. Delay can be categorized into five groups: compensable excusable construction project delay, Non-excusable non-compassable Delay, Non-compassable excusable delay construction delay, and concurrent critical and noncritical Delay. An operation's ability can only be, increased if the contract process is improved. Payment adjustments, financial arrangements, inadequate contract management, material shortages, and unreliable approximation of time and cost were among the sixty major factors reported by the routers as contributing to time and cost overruns. Many studies have explored construction delays, their impact on social, economic, and environmental factors that lead the problem to become complicated. They have often depended on Delay's Cause through time overrun, but they have not sufficiently on cost overrun factors. This study's primary goal is to identify the major contributing factors that cause construction projects to be delayed and assess the likelihood of delays and cost overruns in water resource

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construction projects.

Concept of cost and time overrun

Delay is an activity that creates time needed to complete tasks or activities under a contract to be extended. It is usually expressed as the number of additional days of work required to complete a project in its entirety or part. Described delay as the period spent exceeding the project contract agreement's specified length. It's a way to categorize how long it takes to complete a project after the contract deadline has passed. As a result, it could be claimed that worthwhile projects are done on time and for the right reason right place. Construction delays can be identified as the requested additional time to complete the project after the original contract date or the difference between the planned and actual construction time [6].

Identified as the primary cause for both time and cost overrun were owner during construction, in progress payment, ineffective timing, and planning by contractor, shortage of labour, shortage of financial by contractor, government regulation, traffic control, and restriction at the site, the effect of social and cultural factor and accidental factor. There were ten primary explanations for cost overruns in groundwater drilling, including monthly payment difficulties and lousy contract terms. Management, material procurement, inflation, contract financial difficulty, escalation of material price, cash flow during construction, plan and scheduling deficiencies, lousy weather, and the cost estimate's shortages. The delay was a significant issue in the building industry, with many projects failing to finish on time. The key players in the project's delay were the customer, contractor, and consultant. These three primary players were responsible for a variety of delays in construction projects (Tables 1 and 2).

Table 1. Cause of cost and time overrun.

No.	Factor for cost overrun				
1	Delay in delivering the site to the contractor	Cl	29	Delay in reporting the progress of works done	Cs
2	Frequent change orders during construction	Cl	30	Low productivity of labor	L
3	Late in approving design documents	Cl	31	Shortage of technical staff labor	L
4	Unrealistic contract duration	Cl	32	Weak motivation labor	L
5	Work suspension by clients	Cl	33	The conflict between labor	L
6	Delay in decision making process	Cl	34	Labour nationality	L
7	Owner interference	Cl	35	High cost of labour	L
8	Delay in change orders by the client	Cl	36	Overtime issues labor	L
9	Poor financial control mechanism	Cl	37	Delay in material delivery.	Eq
10	Poor coordination and communication b/t contractor	Co	38	Poor material handling on site.	Eq
11	Financial difficulties by contractors	Co	39	Inappropriate/misuse of material and equip.	Eq
12	Delay in site mobilization	Co	40	Poor procurement programming of material	Eq
13	Often changing sub-contractors	Co	41	Shortage of materials in the market	Eq
14	Mistakes during construction by contractors	Co	42	Low quality of materials	Eq
15	Poor contractors experience	Co	43	Construction equipment shortage	Eq
16	Ineffective planning and scheduling	Co	44	Equipment productivity	Eq
17	Ineffective coordination between contractors and other parties	Co	45	Equipment failure	Eq
18	Lack of sub-contractor skills	Co	46	Equipment choice.	Eq
19	Poor site management by contractors	Cs	47	Corruption	Ex
20	Lack of sufficient experience of consultants	Cs	48	Security	Ex
21	Delay in reviewing the design documents	Cs	49	Warlords influence	Ex
22	Poor inspection plan by consultants	Cs	50	Effect of social and cultural factors external	Ex
23	Project design complexity	Cs	51	Permits from related authorities	Ex
24	Mistakes and discrepancies in design documents	Cs	52	Land acquisition	Ex
25	Poor coordination/communication between consultant and parties	Cs	53	Natural disasters	Ex
26	Slowness in giving instruction	Cs	54	Utilities issues	Ex
27	Inadequate quality assurance and quality control plans	Cs	55	Foreign labour permits	Ex
28	Conflicts amongst consultant with other parties				

Table 2. Frequency and severity of cost and time overrun.

No.	Cause of time overrun	Category			Cs
1	Effect of hot/cold weather on the construction and the materials	Co	26	Unstable cost and delay in preparing special materials	M
2	Lack of sufficient contact between consultant and other groups	Co	27	Bureaucracy in bidding method	Ad
3	Mistakes and reworks wanted for them during construction	Co	28	Not enough information before design	Ad
4	Domination of construction industry by foreign firms and aids	Co	29	Changes in the laws provided by the government	Ad
5	Sudden order change by owner during construction	Co	30	Disagreement between consultant and design team	Ad
6	Wrong consideration about the owners requirements	Co	31	High number of public holidays (time)	Ad
7	Insufficient scheduling of project by Contractor	Co	32	Poor contract management	Ad
8	Delay in decision making	Co	33	Poor supervision on the site	Ad
9	Shortage of equipment	Co	34	Traffic facilities	Ad
10	Low level of qualification and technical staff	Co	35	Shortage of technical and qualified personnel	Ad
11	Poor communication and coordination with other parties	Co	36	Low-speed decision making process	Ad
12	Sub-contractor delay work	Co	37	Delay in delivering the site to Contractor	Ad
13	Delay in delivering the imported materials	Co	38	Not having enough experience by consultant	Ad
14	Effect of subsurface condition	Co	39	Ground problems	Ad
15	Third party final inspection and certification delay by a third party	Co	40	Delay in site mobilization	Ad
16	Delay in producing and completing the design documents	Cs	41	Late preparation of the materials	Ad
17	Low level of experience in design team	Cs	42	High cost of maintenance of machinery	fi
18	Delay in accepting and performing the changes in scope of project	Cs	43	Inflation	fi
19	High cost of the qualified personnel	Cs	44	Low level of efficiency from the equipment	fi
20	Contrast and poor communication between Contractor and consultant	Cs	45	Economical condition of the government	fi
21	Lack of variety of materials in market	M	46	Monthly payment difficulties	fi
22	Problems in sub-contractors schedule for finishing the project	M	47	Inconstancy of the price of materials	fi
23	Lack of variety of materials in market	M	48	Financial difficulties	fi
24	Rigidity of consultant (not able to be flexible)	M	49	Mode of financing and payment for completed work	fi
25	Unexpected geological condition natural disaster	M	50	Taxes on the construction utility and equipment	fi

Methodology

There were fifty (50) time delay factors in this research, and fifty-five (55) cost overrun factors are considered. Literature review and discussion with some parties were played grate role in identifying the Cause for the Delay of the project. The questionnaire was created to assess the severity, frequency of occurrence, and significance of the courses listed. There are quantitative and qualitative methods that can be used to understand better how people perceive construction. The quantifiable response will be assessed or analyzed through the quantitative approach, as its name indicates. Qualitative data is another type of data type, as its name indicates it offers more emphasis to the qualitative response. Primary data and secondary data are the two types of information gathered. Primary data is knowledge gathered by researchers in order to manage firsthand information. The questionnaires were sent out by email and hand-delivered to respondents after they had completed them. Structure questionnaires were prepared and distributed to a selected sample to determine the serious causes of Gibbie, GERD, and Rib water supply construction project delays [7]. Several experts, including structural engineers, geologists, hydraulic engineers, electromechanical engineers, and regular laborers, took part in the questionnaire filling. Secondary data was another form of data used in this research. It was a type of data used in a literature review to gather information like cost overruns and delays in the development of a water resource project. It was used to understand better the various theories that relate to the research issue. Literature review content includes books, journals, magazines, the internet, and other research sources. The questionnaires were written with the research objective in mind, focusing on the causes of construction delays and cost overruns in water resources projects. It determines the Cause of the construction project, the effect of delays and overruns on the project, and the importance of those impacts on the project. The questioners majorly consist of

- Respondent background this is the mechanism of gathering the necessary information of the respondent.
- Cause of delay helps collect the data on various Cause of delay happened in the project.

Important index technique

This approach is used to determine the frequency and the severity of the Causes of project execution. Frequent occurrences can often be characterized, often and rarely, whereas severity includes very high, medium, and low (on 4 to 1 point). Assaf and Al-Hejji put formula used to rank cause of delay and cost overrun.

$$Fi_{co} = \sum X_{i0} (fco / N) * 100 / 4 \quad (1)$$

$$Fi_{to} = \sum X_{c0} (fco / N) * 100 / 4 \quad (2)$$

Where x_{i0} and x_{c0} is the constant expressing weighting given to each response and (ranges from 1 for rarely up to 4 for always), f_{co} and f_{to} is the frequency of response for cost and time overrun, and N total number of responses. In the same manner for a given four points, the hardness or Severity of occurrence can be categorized as very high, high, moderate, and low (on a 4 to 1 point scale).

$$Fi_{co} = \sum X_{c0} (fco / N) * 100 / 4 \quad (3)$$

$$Si_{to} = \sum X_{i0} (fto / N) * 100 / 4 \quad (4)$$

Where Si_{co} and Si_{to} severity index, x is the constant expressing weighting given to each response and (ranges from 1 for low up to 4 for high), f_{co} and f_{to} is the frequency of response for cost and time overrun, and N total number of responses.

Calculation of these values, the importance index of each course can be known as a function of both severity and frequency index.

Risk assessment

Risk can be viewed in a variety of ways by various academics. Most people, however, consider the risk to be only adverse, but it is characterized as the likelihood of loss or benefit multiplied by the magnitude of the loss or gain. If the chances of occurrence are 100%, we call it certain, and if the probabilities of occurrence are 0%, we call it uncertain. One of the factors that influence the construction industry's performance and execution is the level of risk. Risk management is an integral aspect of the decision-making process in projects.

$$(R) \text{risk} = \text{severity index (SI)} * \text{frequency index (fi)}$$

$$R_{c0} = \sum fx_{c0} (fco / N) * 100 / 4 * \sum SX_{c0} (f_{c0} / N) * 100 / 6$$

$$R_{t0} = \sum fx_{t0} (fto / N) * 100 / 4 * \sum SX_{t0} (f_{t0} / N) * 100 / 6$$

Where R_{c0} and R_{t0} the risk for both cost and time overrun.

Results and Discussion

Respondent profile

The contractor, consultant, customer, employer, and daily labor, the main contributor in responding to the questionnaires. Twenty-five were questionnaires paper distributed to the contractor, and 21 or (84%) responded. Similarly, twenty (20) were allocated to the consultant, and seventeen (17) responded, Fifteen (15) to clients, and 13 responded finally, ten (10) daily labor nine answered. The percentage of validity for contractor, consultant, client, employer, and daily labor is 84, 85, 80, 80, 90, and 78.82, respectively.

Frequency and severity analysis of cost overrun

Contractor related factor (RII=0.66): The Contractor is one of the most prominent factors in the construction project's execution. However, due to internal and external factors, the contractor may fail to meet the project's objectives [8]. The cost overrun dilemma was the critical challenge that put the contractor under difficulty. The concept of cost overrun can be defined in terms of frequency and Severity (Figures 1 and 2). Frequency is the rate at which project cost and time overrun occurs over a certain period or in a specified sample, where the Severity indicates the hardness of overrun on the construction projects. Table 3 describes the rank of the frequency and severity of the cost overrun problem by the contractor. The financial difficulties by the contractor (RII=0.73), poor contractor experience (RII=0.68), a mistake during construction by the contractor (RII=0.656), Lack of sub-contractor skill (RII=0.656), ineffective planning, and scheduling, Delay in site mobilization, often changing subcontractors, poor communication between and other parties, and ineffective coordination between the Contractor and other parties were the main reason for the delay of the Gibe III hydropower project GERD hydropower project and rib irrigation project. On the other hand, the severity of cost overruns due to the contractor could also affect the GERD, Rib, and Gibe III. Those severities of delay include, Lack of subcontractor skill (RII=0.73), poor coordination and communication between contractor and other parties (RII=0.68), financial difficulties by contractors (RII=0.68), and poor contractor experience was the primary factor for cost overrun problem.

Consultant factor (RII=0.611): Consultants play a crucial role in fostering and carrying out the construction industry's responsibilities. On the other hand, if consultants do not commit from start to finish, it will negatively affect the project's progress. In Table 4, the frequency of poor coordination/communication between consultant and parties (RII=0.7), slowness in giving instruction (RII=0.69), mistakes and discrepancies in design documents (RII=0.63), Lack of consultants' sufficient experience significantly impacted the frequency of delay water resource project (RII=0.61).

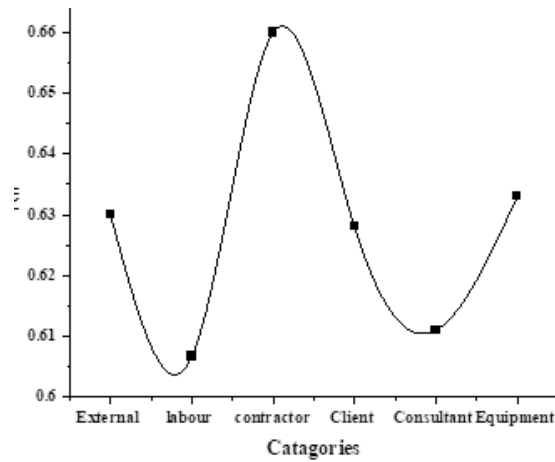


Figure 1. Average frequency of cost overrun. Note (—■—) Average frequency cost overrun

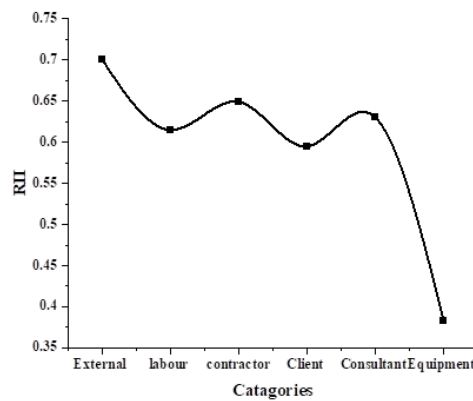


Figure 2. Average of severity of cost overrun. Note: (—■—) Average severity of cost overrun.

Table 3. Frequency and severity of contractor related factor.

No.	Contractor related	f rRII	Rank	sevRII	Rank
1	Poor coordination and communication b/t contractor	0.681	2	0.68	2
2	Financial difficulties by contractors	0.734	1	0.57	5
3	Delay in site mobilization	0.619	5	0.73	1
4	Often changing sub-contractors	0.572	6	0.63	4
5	Mistakes during construction by contractors	0.656	3	0.57	5
6	Poor contractors experience	0.681	2	0.65	3
7	Ineffective planning and scheduling	0.628	4	0.68	2
8	Lack of sub-contractor skills	0.656	3	0.73	1

Table 4. Frequency and severity of consultant related factor.

No.	Consultant related factor	Fre RII	Rank	Sev RII	Rank
1	Poor site management by contractor	0.58	6	0.63	5
2	Lack of sufficient experience of Consultant	0.61		0.56	8
3	Delay in reviewing the design documents	0.60	5	0.65	4

4	Poor inspection plan by consultants			0.59	6
5	Project design complexity	0.57	7	0.57	7
6	Mistakes and discrepancies in design documents	0.63	3	0.65	4
7	Poor coordination between consultant and parties	0.70	1	0.76	1
8	Slowness in giving instruction	0.69	2	0.63	5
9	Inadequate quality assurance	0.58	6	0.57	7
10	Conflicts amongst consultant with other parties	0.58	6	0.66	3
11	Delay in reporting the progress of works done	0.57	7	0.68	2

Poor coordination or communication between consultant and parties (RII=0.76), delay in reporting the progress of work done (RII=0.68), and conflicts amongst consultant with other parties (RII=0.66) were the top three major severed factor.

Equipment factor (RII= 0.674): Equipment or material-related issues were other factors that greatly accelerated the rate of cost overruns. Table 5 shows that poor procurement programming of material (RII=0.73), Shortage of materials in the market(RII=0.73), equipment failure(RII=0.73), equipment productivity(RII=0.71), low quality of materials (RII=0.70),construction equipment shortage(RII=0.68), inappropriate/ misuse of material and equipment(RII=0.63), delay in material delivery, poor material handling on-site and equipment choice is the top ten equipment factor which affects the cost overrun of a water resource project. Equipment can also be described as in terms of material, which means the facilitating of construction material was the big issue in developing countries. Even though material accumulation was sufficient, there was a shortage of transportation and road access such kinds of problems highly worst or severe in the construction project. Based on analyses in the case of our research area, equipment failure(RII=0.44), shortage of materials in the market(RII =0.44), poor procurement programming of material(RII=0.42), poor procurement programming of material, equipment productivity, low quality of materials, construction equipment shortage, inappropriate/misuse of material and equipment, delay in material delivery, poor material handling on-site and equipment choice are the top ten equipment factors that severed cost overrun of a water resource project.

External related factor: Corruption (RII=0.76), security (RII=0.68), social and cultural (RII=0.68), permit from relative austerity (RII=0.68), utility issue, natural disaster; war load influence, foreign labor permit, and land acquisition the were top ten cost overrun delays factor. Table 6 shows the severity of external related factor occurred due to natural disaster (RII=0.82), corruption (RII=0.81), land acquisition (RII=0.72), the effect of social and cultural factors external (RII=0.706), permit from relative austerity, utility issue, war load influence, and foreign labor permit, have been exposing the construction project not to complete on time per its required budget [9].

Labor related factor: Low productivity of labor (RII=0.68), shortage of technical staff labor, weak motivation labor (RII=0.6), the conflict between work (RII=0.57), and high cost of delivery (RII=0.53) was the primary indicator that delay of a water resource project. The severity of the labor-related problem was the most important in developing the selected water resource structure's progress [10]. Weak motivation Labour, High cost of labor, Low Productivity of labor, Low productivity of labor, Shortage of technical staff labor, and weak labor motivation were the most severe problem in exposing the project for unwanted cost overrun (Table 7).

Client related factor: The client was an essential participant in any construction project. In this case, construction customer is the entity that initiates construction or infrastructure projects at its own cost. The construction client also interprets and translates the needs, desires, and wishes of an organization to set specifications and conditions for construction and construction projects. Clients use a facility to carry out the business or service; thus, the facility is a tool or a technology for serving a function, giving the consumer a secondary interest in buildings. Besides, when it comes to credentials, institutional environments, discretionary powers, the gap between clients and users (Ryd). The client could also affect the project by delaying and running the project. In the case of our selected project, the frequency of problem due to the client include low financial control mechanism (RII=0.82), Delay in change orders by the client (RII=0.72), owner interference (RII=0.68), delay in the decision-making process (RII=0.65) and work suspension by clients (RII=0.62) was the top factor delaying construction. In another way, severity index for a client, the low financial control mechanism (RII=0.73), late in approving design document (RII=0.68), frequent change orders during construction (RII=0.65) was the top three major factor which highly severe the construction project of gibe, GERD hydro project and rib irrigation project (Table 8).

In general, the average frequency of Contractor (RII=0.66) was the top factor, followed by external (RII=0.634), equipment-related factor (RII=0.633), Client (RII=0.629), Consultant (0.611) and labour (RII=0.607).

Time overrun analysis

Contractor related delay factor: The construction project was delayed due to a contractor-related factor, and it took longer than expected to complete. The frequency of contractor-related time delay factors includes the effect of hot/cold weather on the construction and materials, lack of sufficient contract between consultant and other groups, sudden order change by the owner during construction, the effect of subsurface condition. In another direction, the severity delay factor by a contractor on the respected water resource project was sudden order change by the owner during construction, the effect of hot or cold weather on the structure and materials, and poor scheduling of project by contractor categorized under highly severed factor for the delay of the project (Figures 3 and 4).

Consultant related delay factor: Consultant was the primary factor that affects project completion time. Consultant delay factor can be described in terms of frequency and severity rate or percentage. The frequency of consultant delay factor in time overrun analysis mainly includes high cost of qualified personnel, delay in accepting and performing the project's change in scope, and delay in producing and completing the design document [11]. The severity of consultant delay factor on those selected water resource

Table 5. The frequency and severity of cost overrun related to equipment.

No	Equipment related	RII	Rank	RII	Rank
1	Delay in material delivery	0.58	6	0.32	6
2	Poor material handling on-site	0.58	6	0.41	3
3	Inappropriate/misuse of material and equip	0.63	5	0.44	1
4	Poor procurement programming of material	0.73	1	0.34	5
5	Shortage of materials in the market	0.73	1	0.44	1
6	Low quality of materials	0.70	3	0.35	4
7	Construction equipment shortage	0.68	4	0.35	4
8	Equipment productivity	0.42	8	0.42	2
9	Equipment failure	0.71	2	0.41	3
10	Equipment choice	0.57	7	0.35	4

Table 6. Frequency and severity external related (RII=0.7).

No	External related	fre RII	Rank	Sev RII	Rank
1	Corruption	0.76	1	0.81	2
2	Security	0.68	2	0.68	6
3	War loads influence	0.68	2	0.70	5
4	Effect of social and cultural factors external	0.68	2	0.706	4
5	Permits from related authorities	0.65	4	0.68	6
6	Land acquisition	0.5	7	0.72	3
7	Natural disasters	0.57	5	0.82	1
8	Utilities issues	0.66	3	0.66	7
9	Foreign labour permits	0.53	6	0.53	8

Table 7. The frequency and severity of cost overrun by a labor-related factor.

No	Labor-related Cause of Delay	freq RII	Rank	sevRII	Rank
1	Low productivity of laborv	0.68	1	0.63	2
2	Shortage of technical staff labour	0.63	2	0.57	5
3	Weak motivation labour	0.63	2	0.66	1
4	The conflict between labor	0.6	3	0.59	3
5	Labour nationality	0.57	4	0.58	4
6	High cost of labour	0.53	5	0.66	1

Table 8. The Frequency and Severity of the client-related factor.

No	Client related factor	Fr RII	Rank	Sev RII	Rank
1	Delay in delivering the site to the contractor	0.63	4	0.57	4
2	Frequent change orders during construction	0.53	8	0.65	3
3	Late in approving design documents	0.57	5	0.68	2
4	Unrealistic contract duration	0.50	6	0.56	6
5	Work suspension by clients	0.57	5	0.53	7

6	Delay in decision making process	0.62	4	0.57	4
7	Owner interference	0.68	3	0.50	8
8	Delay in change orders by client	0.71	2	0.569	5
9	Poor financial control mechanism	0.82	1	0.73	1

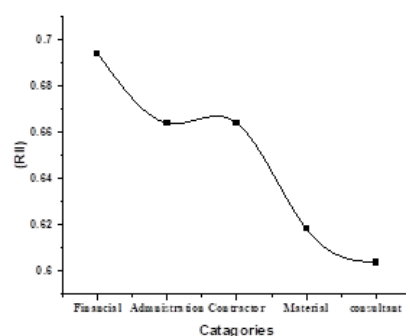


Figure 3. The average Severity of time overrun categories. Note: (—■—) Average severity of time overrun

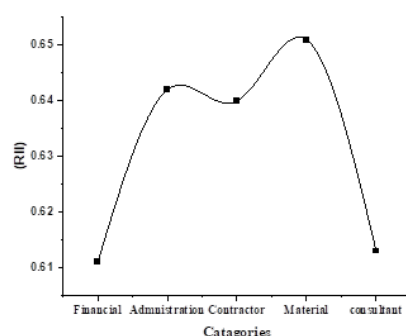


Figure 4. The average frequency of time overrun categories. Note: (—■—) Average frequency of time overrun

project included the high cost of the qualified personnel contrast and poor or communication between contractor and consultant or owner, low level of experience in design, and delay in accepting and performing the change in scope of the project were severe the project no to complete on time.

Cause of time delay by material: Lack of variety of material in the market, unstable cost and delay in preparing special material, the rigidity of consultant (not flexible), unexpected geological condition, or a natural disaster, a high-frequency rate lags over prescheduled time. The Severity of unstable cost and delaying preparing unique material, the rigidity of consultant or Lack of flexibility, and Lack of variety of material in the market was the high severity factor delaying the water resource construction beyond the prefixed time.

Cause of time delay by administration: The construction project's administration sector was a major sector in planning, construction, operation, and maintenance. However, this sector may lead the project not to complete on time and increase the completion time over schedule time due to different reasons. That problem may describe in terms of frequency and severity rate of a factor on delaying project. The frequency of poor supervision on-site, traffic facility, Shortage of technical and qualified personal. The severity includes changes in the government's law, ground problem, not having experience by a consultant, not enough information collected, and survey done before design.

Cause of time delay by the financial sector: The financial sector

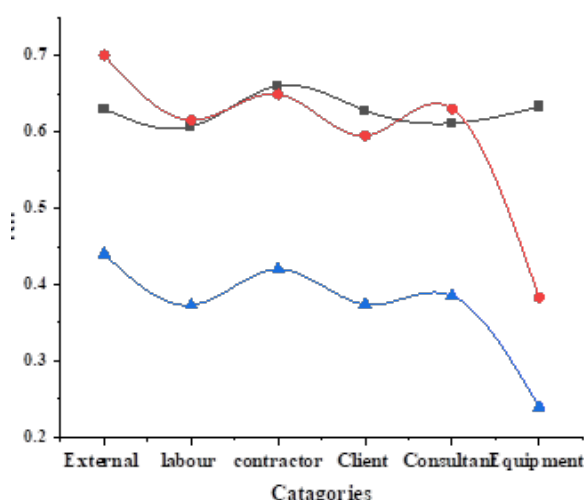
is also another most crucial sector in advancing the development of construction projects. In Ethiopia's financial sector, even the problematic primary industry due to known and unknown reasons. In our selected construction water resource project, high-cost maintenance and machinery, monthly payment difficulty, government's economic condition, and highly frequented financial sector factor delay the project. The Severity of the financing mode and payment for the completed project, monthly payment difficulty, and financial problem were the main reason for the project's lagging. In general, from Table 9, we observe that the average frequency of time overrun that due to the material (RII=0.65), administration (RII=0.642), a contractor (0.64), consultant (0.613), and financial (0.611) were the primary playmaker in delaying those selected project. However, the main factor that exposed the project to a highly severed rate was the financial factor (RII=0.694). The economic factor problem is currently a big issue for developing countries. Since it is related to foreign exchange or currency. The contractor (RII=0.664), administration (RII=0.664), material (RII=0.65), and consultant (RII=0.604) also lead the project for delay frequently.

Risk of cost overrun

External related factor (Risk=43.578%): Based on analysis, the problem mainly result from corruption (Risk=61.7%), permit from related Authority (Risk=49%) and security (Risk=46.2%). Whereas, labor-related factor (Risk=40.613%), was mainly due to labor nationality (Risk=51%), the weak motivation of labor (Risk=44.9%),

Table 9. Average frequency and severity of time overruns categories.

No	The factor for increment severity of time delay	Avf RII	Rank	AVs.RII	Rank
1	Cause of time delay by material	0.650	1	0.650	3
2	Cause of time delay by administration	0.642	2	0.664	2
3	Cause of time delay by contractor	0.640	3	0.664	2
4	Cause of time delay by consultant	0.613	4	0.604	4
5	Cause of time delay by financial	0.611	5	0.694	1

**Figure 5.** The average risk of cost overrun. **Note:** (■) Average frequency cost overrun; (●) Average severity of cost overrun; (▲) Av.risk of Cost overrun.

and low productivity of labor (Risk=44.6%) (Figure 5).

Contractor-related factor (Risk=40.6127%): The Contractor was one participant in progressing the selected water resource project's construction. The contractor-related problem may result in the project too late and fail. The contractor-related problem had a considerable risk on the construction project. In the case, our selected project, the risk of cost overrun delay is Lack of subcontractor skill (RII=48.2%), ineffective planning and scheduling (RII=45.4%), poor contractor experience (RII=44.7%) are the top three major factor which highly risks on the completion of the project.

Client related factor (Risk=37.87%): The client-related group risk factor was the most critical factor that causes the cost overrun to be raised. The main risk of cost overrun by the client was poor financial mechanism (RII=59.9%), Delay in a change of order by the client (RII=40.9%), late in approving design document (RII=40.9%) were the major risk on the completion of our selected project.

Consultant related factor (Risk=37.875%): The consultant was one of the stakeholders in facilitating the construction of the water resource project. On the other hand, the consultant's problem also leads the project not to complete on time. It makes the project to be under pressure. the risk of a consultant was the product of the frequency of cost overrun delay by Consultant and the Severity of cost overrun Delay by Contractor. Based on that, the risk of consultant on our selected water resource construction project is poor coordination or communication between consultant and parties (RII=50.1%), slowness in giving (RII=43.4%), mistake and

discrepancies in design document (RII=41.4%).

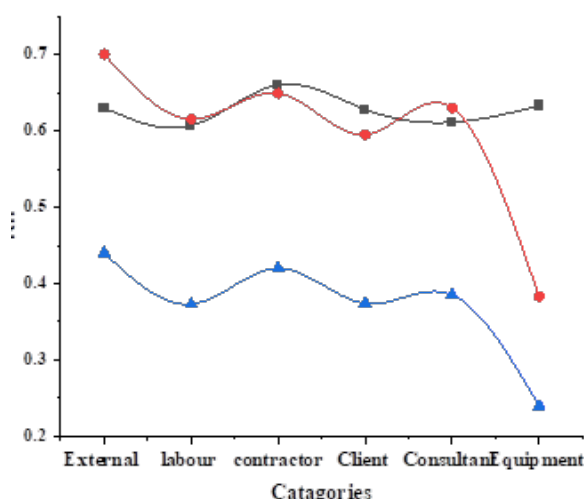
Equipment related factor (Risk=25.64): Shortage of material in the market (Risk=32.6), equipment productivity (Risk =29.2%) and construction equipment shortage (Risk=29%) were mainly the major risk factor that would result for the increment of risk of the water resource project (Table 10).

Risk of time overrun on the construction of water resource project

The risk of time overrun in our selected research area was categorized under broad five groups: administration, financial, Contractor, and material were the influential groups that show risk (Figure 6). Administration gaps play a big hand in resulting a negative role in delaying those selected projects not to complete on time, and its trouble (Risk=0.426) became very high while comparing to others. The second significant contributor in enhancing and developing the risk of our research area was the financial problem (Risk=0.424). Financial problem was one of the major concerns since Ethiopia is a developing country, and there were shortage exchange and another related issue. The third case which leads the project to risk was Contractor (Risk=0.424) related problem. The material-related problem (Risk=0.42) was the fourth in its risk. (Risk =0.37) The last but not least factor in exposing the construction project to not complete per its preschedule was a consultant-related problem (Table 11).

Table 10. Average of risk factor cost overrun.

No.	Risk factor	RII	Rank
1	External related factor	0.44	1
2	labour related factor	0.41	2
3	Contractor related factor	0.40	3
4	Client related factor	0.37	4
5	Consultant related factor	0.37	4
6	Equipment related factor	0.25	5

**Figure 6.** Frequency, severity, and risk of time overrun. **Note:** (■) Average frequency cost overrun; (●) Average severity of cost overrun; (▲) Av.risk of Cost overrun.**Table 11.** Average of risk of time overruns categories.

No.	The factor for increment risk of time delay	AV.RII	Rank
1	Cause of time delay by material	0.42	3
2	Cause of time delay by administration	0.426	1
3	Cause of time delay by contractor	0.424	2
4	Cause of time delay by consultant	0.37	4
5	Cause of time delay by financial	0.424	2

Conclusion

Managing time and cost overrun in construction projects has been considered an essential process to achieve projects objective within the prescribed time for required purposes. This research's main objective is to determine the major contributing factor that delays the construction project and analyses the risk of delay and cost overrun of water resource construction project. To analyze studies, we obtained information through a questionnaire survey conducted in Ethiopia. Basically, the Cause of cost and time overrun was obtained from literature review and 105 key factors for both time and cost overrun. According to our analyses, the major reason for the rising frequency of cost overrun was the contractor-related factor. An external factor was the severity factor for cost overrun of the construction of Grand Ethiopian renacance dam, Gibe III, and Rib irrigation project. The second objective of this research is determining time overrun of the selected water resource project. Based on that, the frequency of time overrun or delay was occurred by material related factor and the severity of the time overrun is maximum due to financial related problem. This selected research's final objective was determining the factor that exposes for the increment of risk for both cost and time overrun. Accordingly, the external related factor for cost overrun and administration related factor was for time overrun.

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