Evaluating Delay Factors on Road Construction Projects in Ethiopia Using Relative Importance Index Method

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Abstract

The foundation of the economic and social development of many nations is the transportation infrastructure, particularly road construction. This paper investigates the major causes of road construction project delays in Ethiopia. The research approach was to identify the different types of construction delays, their causes, and effects from different perspectives, in order to determine the impact and the level of importance of the identified delay factors on road construction projects in this study. The data collected from the questionnaire survey was carried out to 154 valid responses and was analyzed with the relative importance index (RII) method to evaluate the impact of construction delays. A relative importance index (RII) method was used to rank the level of importance of the identified delay factors and to determine their individual impact on the overall project delay. The results indicate that cost-overrun and time-overrun factors have the highest delay impact on road construction projects in this study, with RII values of 0.781 and 0.764, respectively. Furthermore, the study found that each delay factor has a different level of impact on the overall project delay and that the most effective method to minimize delays in road construction projects in Ethiopia is the choice of a project manager with sufficient knowledge and experience relevant to project management and the use of appropriate tools and techniques for the project.

Keywords: 1. Construction Delays; 2.Factors; 3.Roads, 4.projects; 5.Ethiopia; 6.RII

1. Introduction

The Ethiopian construction industry has grown at an exponential rate over the past decades, becoming a crucial component of the nation's socioeconomic development. Construction is the second largest economic activity, followed by agriculture. There is currently a lot of research being done to examine the causes of delays and their effects on construction projects, because the construction industry has historically been one of the main sources of income for many developing countries. As a result, delays and their effects on construction projects are a major concern among various industry experts and intellectuals. According to [1]A project is said to be successful if it is finished on time or ahead of schedule, on budget or within specified limits, and with the desired quality and profitability for the owner. As per[2], As a result, there will be many expectations when building begins. Therefore, work should proceed by carefully preparing each and every stage. Any departure from the original intended operations or timetable will cause a delay, which will reduce production and other effects.Construction delays are time overruns that extend past the project delivery date specified in the contract or by the parties in their agreement [3]. Project delays in the road construction sector might result from the extension of the construction period as a result of disruptive occurrences that impede the construction process[4]. Additionally, these delays hurt both the contractors and the people who benefit from the finished projects.Most countries, particularly those that are developing, frequently experience construction delays. There is ample evidence that clients, contractors, and consultants suffer when construction is delayed [3, 5]. Due to the varying environments and construction methods used in each nation, the causes and impacts of

various delays in the road construction business vary. For instance, in Ethiopia, where the government is the only client for road construction projects, a different set of circumstances are likely to affect delays than those that are typical in industrialized nations, where the private sector is mainly responsible for road construction work. The approaches to be used in minimizing these delays, which are common in the road building business, as well as their causes and consequences, become more challenging to generalize as a result.

Therefore, in order to determine the impact and the degree of importance of the identified delay factors in road construction projects in Ethiopia, this study attempts to investigate the main causes of road construction project delays specific to Ethiopia by identifying the various types of construction delays, their causes, and effects from different perspectives. As follows is the order of the paper: Identification and ranking of the causes that cause delays, their considerable influence on Ethiopian road construction projects, and discussions of potential solutions to reduce these effects are all topics that need to be addressed.

The causes and impacts of delays in construction projects for buildings and roads have been the subject of several regional and worldwide papers and research. The effects of delay on building construction projects in Nigeria were discussed by[6], and included cost overrun, time overrun, dispute, arbitration, litigation, and legal abandonment.A study on delays in construction projects in Indian was reported by[7]. They introduced 45 delay factors, which were categorized into six main groups. These resultswere expected to be significant contributions to Indian construction industry in controlling the time overruns in constructioncontracts.

According to[8]investigated factors causing delay in road construction projects in Libya. They introduced 39 delay factors which were grouped into eight categories and 10 effects of delays which were classified into three categories.

Construction project delays were frequent and have substantial effects in many different ways. According to [9], the typical reasons for delays at various stages of construction and how they affect Ethiopian building projects. Data were gathered using a questionnaire with 52 causes and 5 effects of delay from 77 participants chosen through purposive sampling from the various contracting companies.

2. Research Methodology

2.1. Research Method

A questionnaire survey was designed and constructed to collect demographic information from respondents as well as to determine delay factors associated with road construction projects. In figure 1 depicts the process used to identify and assess the hazards of the construction projects under consideration.

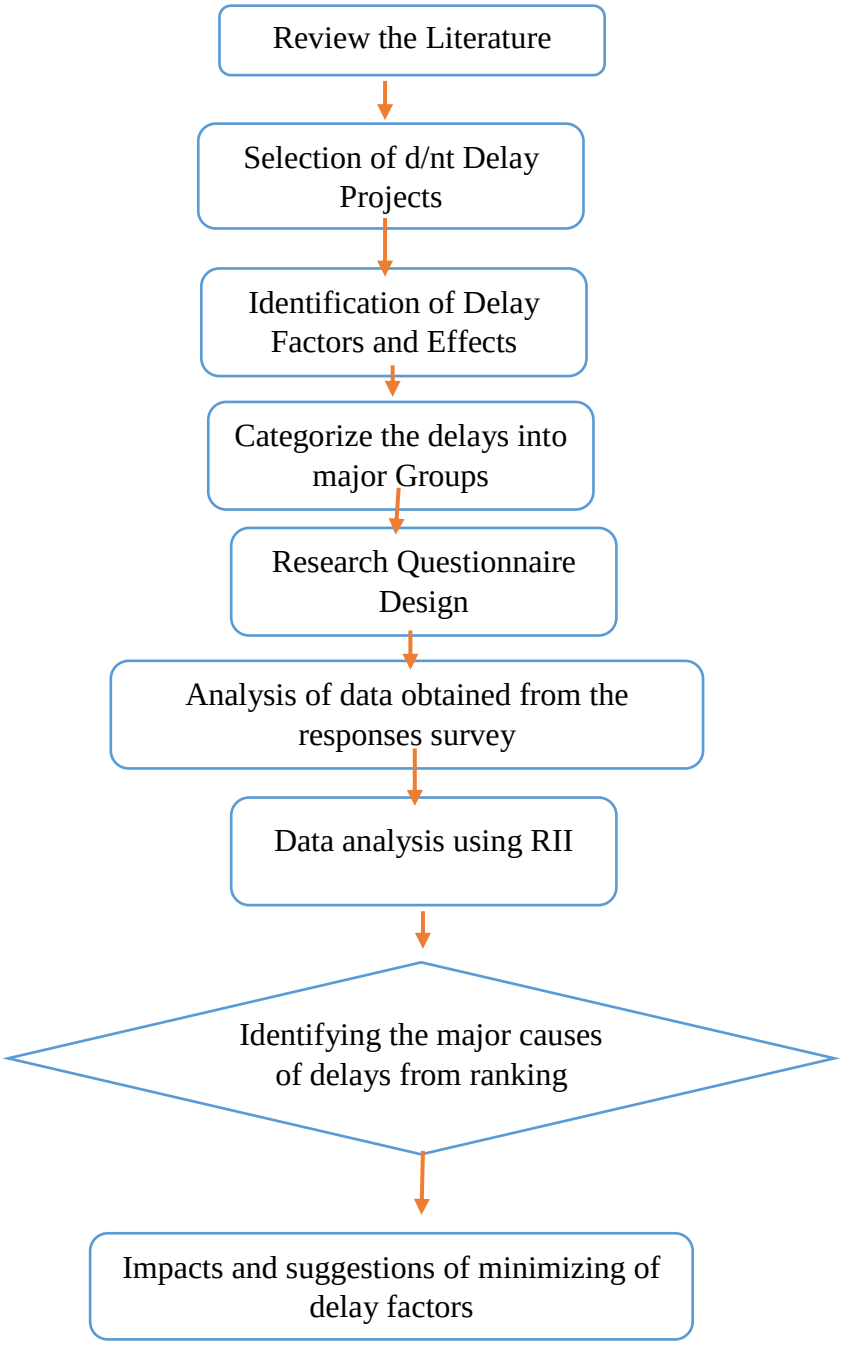

Figure 1: Flow chart of Research methodology

2.2. Preparation of Questionnaire

An essential step for the success of the research is the identification of key study characteristics and the creation of a questionnaire. There has been a substantial amount of research done on the causes and effects of construction delays, and there is a set of delay qualities that have been thoroughly recorded and examined in

the literature. A total of eight broad categories—owner related, contractor related, consultant related, equipment and material related, government related, project related, external related, and utility-service related—and 49 delay attributes—a total of 39 delay factors and 10 delay effects—were identified. Three delayed effects—effects of the government, effects of the site, and effects of the economy—were also identified. Personal interviews with Ethiopian construction specialists were also conducted to reflect the spectrum of the already-available delay attributes in the Ethiopian setting.According to [9], a 5-point Likert scale, the listed causes of delay were classified into 5 zones, with each zone having different causes ranging in impact from very little to very much, with 1-very low impact, 2-low impact, 3-medium impact, 4-high impact and 5-very high impact.

Table 1: Causes of delays in road construction projects[10, 11]

Factors/Effects	***Attributes/Indicators***
Contractor Related	1. Rework due to errors during construction 2. Poor site management and supervision by contractor 3. Improper planning and scheduling of project by contractor 4. Inexperienced man-power employed by contractor 5. Poor qualification of the contractor's technical staff 6. Difficulties in project financing by contractor 7. Shortage of manpower 8. Poor communication between contractor and other project parties
Owner Related	1. Difficulty in Budget availability for the project 2. Delay in decision making by the owner 3. Interference by the owner during construction operations 4. Delay in progress payments by the owner 5. Poor communication between owner and other project parties 6. Change of project scope by the owner during construction
Consultant-related	1. Delay in performing testing and inspection by consultant 2. Delay in approving major changes in the scope of work by consultant 3. Lack of flexibility by consultant 4. Delay in reviewing and approving design documents by consultant 5. Insufficient experience of consultant
Utility-services-related	1. Delays in the conversion and transfer of utility services by the competent authorities [such as power lines, water, etc. 2. Long time for response from utilities agencies 3. Effects of subsurface [underground] conditions 4. Smaller utilities are restrained by funding limitation
Government-regulations-related	1. Complexity and delays in administrative and financial procedures of project 2. Tendering system requirement of selecting the lowest bidder 3. Non-activation of punitive deterrent measures for delays 4. Change in government regulations and rules 5. Delay in obtaining permits from different government offices
Project-related factors	1. Original contract duration is too short 2. Some designs are not suitable for implementation 3. Non-provision of bonus for early completion

	4. Lack of financial liquidity of the project
External factors	1. Delays in construction activities due to weather changes 2. Delays in acquiring land from citizens 3. Economic problems 4. Poor political situation and security, especially after revolution in Ethiopia
Equipment- and material-related	1. Shortage of equipment 2. Re-work because of poor quality materials 3. Change in prices of materials

Table 2: Effects of delays in road construction projects [10, 11]

government-related	1. Time overruns 2. Cost overruns 3. Poor quality
site-related	1. Disruption of traffic movement 2. Obstruction of economical 3. development Delay of other projects related to the main one
financial-related	1. Litigation 2. Arbitration 3. Breach of contract 4. Disputes

2.3. Respondent's profile

Respondents are selected from a wide range of professionals engaged in the Ethiopian construction sector (contractors, clients and engineers). All the respondents identified had experience in relatively large engineering construction projects in the Ethiopian context. The sample consisted of owners, architects, structural engineers, service engineers, project managers, contract administrators, design managers and construction managers. Table 3 shows a brief description of respondents' profile in terms of professional role and experience who participated in the study. A total of 205 questionnaires were distributed by hard copy, out of which 154 valid responses were obtained with a response rate of 75%. Moreover, response rate of 75%, that is acceptable as per[12], as they state that a minimum response rate of 50% can be taken as adequate. Response frequency of these questionnaires in this area of research differs, for instance, [13], 51%, [14], 43%; and in [15]44%. So, in the present study, a response rate of 75% is good enough to make further analysis of collected data and to get more accurate results.Amongst the respondents, the highest proportion (66%) was from the contractors involved in construction activities followed by the clients (21%). Respondents from the roles of architects and design managers were 13%. The average experience of the respondents was about 15 years with 21% over 20 years.

Table 3: Respondents Profile

Nature of work	Experience (years)				Total in each category	% Of role of profession
	<5	5-10	10-20	>20		
Client	6	6	5	15	32	21%
Contractor	28	34	24	16	102	66%
Designer/Architect	8	8	3	1	20	13%
Total	42	48	32	32	154	
% By experience	27%	31%	21%	21%		

2.4. Data Analysis using Relative Importance Index (RII) Method

The survey data was gathered using a 5-point Likert scale with a range of 1 (very low impact) to 5 (very high impact), and the data analysis was done to assess the relative relevance of the various elements that contribute to construction delays. The Relative Importance Index was used to rank the traits according to how important the respondents thought they were (RII). According to [16, 17, 9], used the RII method to determine the relative importance of the various causes of delays for construction projects. The same method is adopted in this study, and Analysis of data consists of the following:

1) Determining the relative importance index (RII)

$$\mathbf{RII} = \frac{\sum \mathbf{W}}{\mathbf{A}*\mathbf{N}} \quad \textbf{(1)}$$

Where,

RII is Relative importance index (0<RII<1).
W is Weighting is given to each other by the respondents (ranging from 1 to 5).
A is highest weight (A= 5 in this study).
N is Total number of respondents (N=770).

2) Calculating the overall relative importance index (ORII)

$$\mathbf{ORII} = \frac{\sum \mathbf{RII}}{\mathbf{N}} \quad \textbf{(2)}$$

Where,

ORII is Overall Relative importance index (0<ORII<1).
RII is Relative importance indexof the causes in each group (ranging from 0 to 1).
N is Total number of factors in each category

3) Ranking of delay factors in each category based on the Relative Importance Index (RII) for step 1and step 2

3. Results and Discussion

The aims of this research are to determine the delay factors and their rankings in road construction projects as shown in table 4, as well as their delay effects in table 5. This section summarizes the study's findings. Specifically, the severity of delayattributes and their effects depend on the severity of each delay factor.

3.1. Factors that cause road construction project delays in Ethiopia

According to the RII value which is calculated from the survey data presented in table 4, the 39 delay factors are listed as follows: economic problems have the highest RII value at 0.899, followed by change of project scope by the owner during construction which has RII value of 0.868, then poor communication between contractor and other project parties which have 0.834 RII value, whereas delays in the conversion and transfer of utility services by the competent authorities [such as power lines, water, etc.] and rework due to errors during construction have 0.832 and 0.822 RII value respectively, and finally, the delays in acquiring land from citizens which has the lowest RII value of 0.505. The results indicate that economic problems have the most significant factors on road construction project delays in Ethiopia, whereas delays in acquiring land from citizens have the least significant factors for both cases occurred in external related factor categories.

Table 4: Construction Delay Factors Analysis Using RII Method

Delay Factor category	Construction Delay ID	Construction Delay Factors	RII	Ranking	ORII	Ranking
Owner Related Factor	OW	Difficulty in Budget availability for the project	0.762	18	0.777	1
	OW2	Delay in decision making by the owner	0.781	11		
	OW3	Interference by the owner during construction operations	0.791	10		
	OW4	Delay in progress payments by the owner	0.778	12		
	OW5	Poor communication between owner and other project parties	0.686	30		
	OW6	Change of project scope by the owner during construction	0.868	2		
Contractor Related Factor	CO1	Rework due to errors during construction	0.822	5	0.755	3
	CO2	Poor site management and supervision by contractor	0.777	13		
	CO3	Improper planning and scheduling of project by contractor	0.760	19		
	CO4	Inexperienced man-power employed by contractor	0.800	8		
	CO5	Poor qualification of the contractor's technical staff	0.578	35		
	CO6	Difficulties in project financing by contractor	0.717	24		
	CO7	Shortage of manpower	0.752	21		
	CO8	Poor communication between contractor and other project parties	0.834	3		
Consultant Related Factors	CN1	Delay in performing testing and inspection by consultant	0.775	14	0.758	2
	CN2	Delay in approving major changes in the scope of work by consultant	0.797	9		

	CN3	Lack of flexibility by consultant	0.771	16		
	CN4	Delay in reviewing and approving design documents by consultant	0.729	23		
	CN5	Insufficient experience of consultant	0.717	25		

Table 4: Continued….

Equipment and Material Related Factors	EM1	Shortage of equipment	0.678	32	0.711	5
	EM2	Re-work because of poor quality materials	0.717	26		
	EM3	Change in prices of materials	0.738	22		
Government Related Factor	GR1	Complexity and delays in administrative and financial procedures of project	0.814	6	0.664	8
	GR2	Complexity and delays in administrative and financial procedures of project	0.687	29		
	GR3	Non-activation of punitive deterrent measures for delays	0.529	38		
	GR4	Change in government regulations and rules	0.596	34		
	GR5	Delay in obtaining permits from different government offices	0.695	27		
Project Related Factor	PR1	Original contract duration is too short	0.764	17	0.691	6
	PR2	Some designs are not suitable for implementation	0.758	20		
	PR3	Non-provision of bonus for early completion	0.562	36		
	PR4	Lack of financial liquidity of the project	0.681	31		
External Related Factor	EX1	Delays in construction activities due to weather changes	0.645	33	0.685	7
	EX2	Delays in acquiring land from citizens	0.505	39		
	EX3	Economic problems	0.899	1		
	EX4	Poor political situation and security, especially after revolution in Ethiopia	0.692	28		
Utility Service-Related Factor	US1	Delays in the conversion and transfer of utility services by the competent authorities [such as power lines, water, etc.	0.832	4	0.743	4
	US2	Long time for response from utilities agencies	0.774	15		
	US3	Effects of subsurface [underground] conditions	0.803	7		
	US4	Smaller utilities are restrained by funding limitation	0.562	37		

Source: own survey (2022)

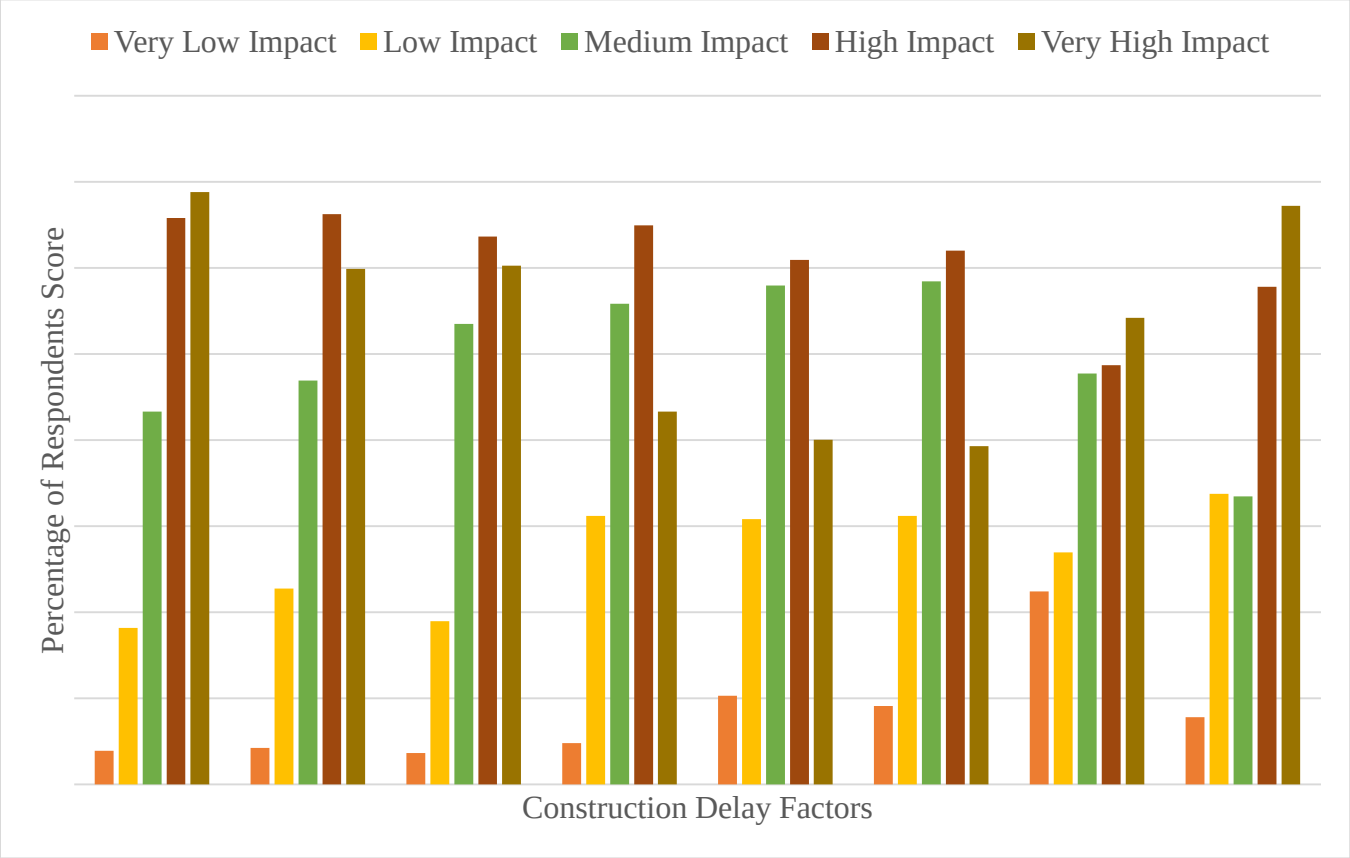

Figure 2: Analysis methods for the construction Delay projects factors

Figure 2 illustrates the most common construction delay factors and it reveals the primary delay factors that affect road construction projects in this study. As the findings show that 33.12% of the respondents, high-impact contractors, prepare a construction delay plan and/or take preventive actions, followed by owners, very high-impact prepare a construction delay schedule, which has a respondent rate of 32.90%, whereas 32.47% of the respondents, the equipment and material high-impact are taken into consideration in the construction phase.

3.2. Effects Of Delays in Road Construction Projects in Ethiopia

The data obtained from the survey study was used to examine the effects of delays in road construction projects in Ethiopia. The effect of delay from the questionnaire survey in table 5, analyzed in general perspective. The rate of relative important index (RII) and ranking the same as explained in case of causes of construction delay. This section shows the analysis results of effect of delay. The influential effects of delay are investigated as arbitration, cost overrun, time overrun, breach of contract, obstruction of economical, development delay of other projects related to the main one, poor quality, litigation, dispute, and disruption of traffic movements equentially.

The relative importance index (RII) was used to rank and categorize these delay factors in order to determine their level of contribution in minimizing delays in road construction projects in Ethiopia as presented in table 4.

Table 5: Construction Delay Effects Analysis Using RII Method

Delay Effects category	Construction Delay ID	Construction Delay Effects	RII	Ranking	ORII	Rank
Government Related	EG1	Time overruns	0.764	3	0.744	1
	EG2	Cost overruns	0.781	2		
	EG3	Poor quality	0.687	6		
Site-Related	ES1	Disruption of traffic movement	0.503	10	0.605	3
	ES2	Obstruction of economical	0.749	5		
	ES3	development Delay of other projects related to the main one	0.562	9		
Financial-Related	EF1	Litigation	0.640	7	0.689	2
	EF2	Arbitration	0.790	1		
	EF3	Breach of contract	0.764	4		
	EF4	Disputes	0.564	8		

Source:own survey (2022)

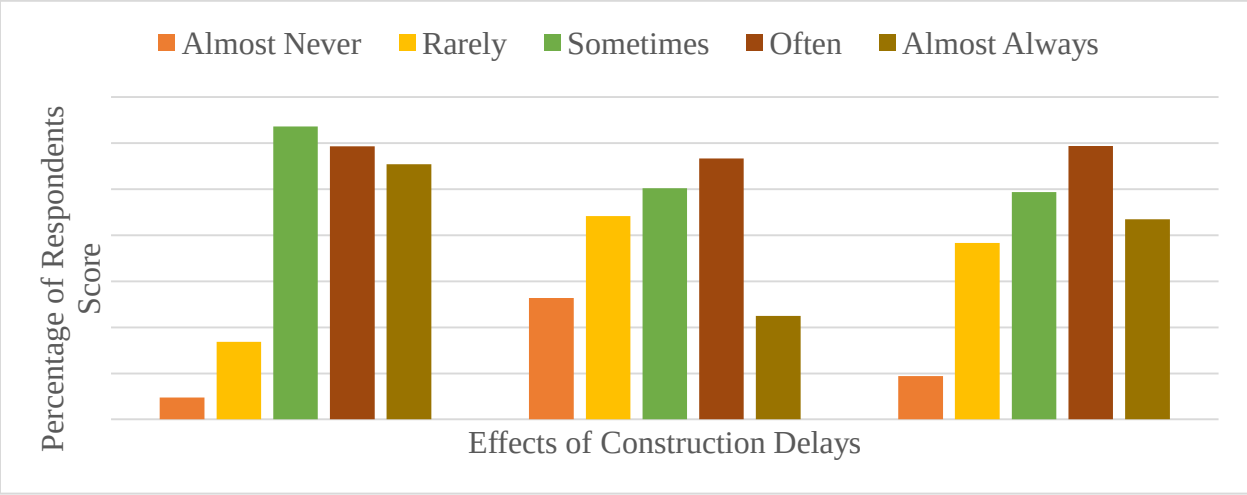

Figure 3: Effects of delays factors in road construction projects in Ethiopia

The main delay impacts that have an impact on road construction projects in this study are shown in Figure 3 and are shown by the most typical construction delay effects. As the results demonstrate, 29.71% of the respondents frequently significant financial effects, prepare a construction delay plan and/or take preventive actions, followed by government effects, which are occasionally significant, prepare a construction delay schedule, which has a response rate of 29.65%, whereas for 28.35% of the respondents, the site effects of frequently significant significance are taken into consideration in the construction phase.

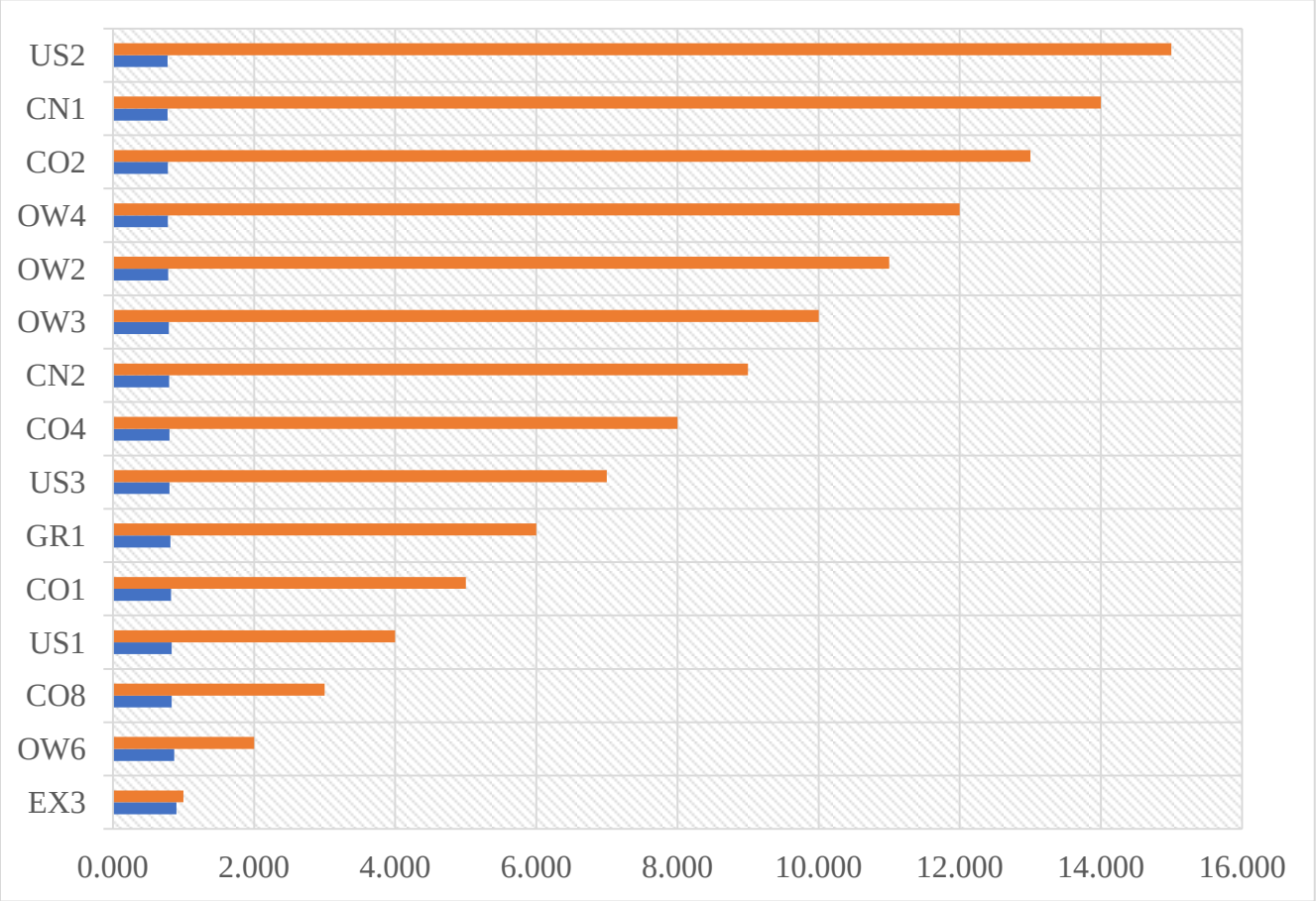

Figure 4: Bar chart Analysis of top harmful fifteen obtained major Delay Factors

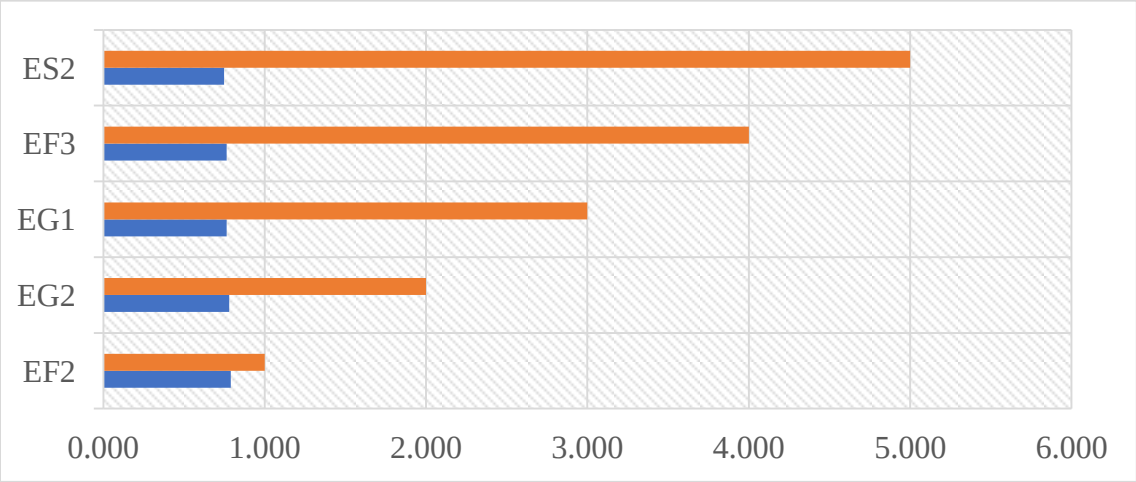

Figure 5: Bar chart Analysis of top harmful five obtained major effects of Delays

The results show that Ethiopian construction projects are impacted by the most significant delays and impacts. In Figure 4 demonstrates the main reasons for construction delays that have the greatest impact on projects in this study. According to the research, the top five delay factor categories among the eight types of delay attributes provided include external related factors; owner-related factors; contractor-related factors; and

utility-service related factors. Figure 5 illustrates the three main causes of delays in road construction: impacts of the government; effects of the environment; and effects of the economy. The findings show that cost overrun and time overrun, factors have the highest construction delay impact on road construction in Ethiopia, with RII values of 0.781 and 0.764, respectively. The results of this research are acceptable as per [18], as they indicate that cost-overrun and time-overrun factors have the highest delay impact on road construction projects in Sudan, with RII values of 0.840 and 0.780 respectively can be taken as adequate.

4. Conclusion

Several studies on the road construction delay factors affecting project performance in construction projects have been published. On the basis of all acknowledged risk and project performance variables, this study evaluates road construction project delay attributes by measuring the joint effect of delay in Ethiopian construction projects. The major aim of this paper was to evaluate the impact of construction delays on road construction project. Questionnaire survey using 5-point Likert-scale was used to collect the responses from the respondents. 154 valid responses collected from the construction professionals were used to analyses the data. Relative importance index(RII) method analysis with their ranking was employed to categorize the 11attributes of construction projects where 8 delay factors and 3 effects of delays. A RII analysis has been determined, ranking of the delay factors that the impact of 39 delay factors on road construction project delay in the Ethiopian construction projects. The results of this research work confirm the significance of construction delay factors impacting project performance. In addition, economic problemsfactor found to be the most dominant delay factor impacting project performance followed by change of project scope by the owner during construction, poor communication between contractor and other project parties. Regardless of endeavor devoted in measuring the impact of delay factors on project performance in Ethiopian construction projects, this study has some limitations.

- Develop the research model representing risk factors on construction delays.
- As current attributes focus on project performance in terms of time, cost, quality, and client satisfaction, within the context of construction projects, other performance variables such as safety and profitability can be taken into account for the future research
- study could be conducted by taking civil engineering (roads, highways, and bridge etc.) infrastructure projects

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