PJET, Vol. 2, No. 2, July 2024: 82-99
Poly Journal of Engineering and Technology
journal homepage : https://journals.bdu.edu.et/index.php/PJET/index
ORIGINAL ARTICLE

# Causes and Effects of Delay in Ethiopia's Public Construction Projects

Getahun Borja Mekonnen[1], Bereket Haile Woldegiorgis[2, *], Zerihun Wondimu Lemessa[2], Alehegn Melesse Semegn[2]

[1]Ethiopian Construction and Supervision Works Corporation, Addis Ababa, Ethiopia

[2]Faculty of Mechanical and Industrial Engineering, Bahir Dar Institute of Technology, Bahir Dar University, Bahir Dar, Ethiopia

**ABSTRACT**

*The construction industry plays a great role in the development of any country by transforming the aspirations and needs of its people into reality by implementing various physical structures. However, there are differences in its contribution depending on how well the projects are managed. One of the challenges in construction projects is delay and associated problems with project delays. Therefore, this study aimed to investigate the most significant causes and associated effects of delays in public construction projects in Ethiopia, as well as to provide overviews for potential future action. The study is limited to the causes and impacts of delays in public construction works only at randomly selected construction projects. As a result, purposive, snowball sampling techniques were applied. Structural Equation Modeling was applied to examine the relationship between 48 variables (41 factors and 7 effects), previously identified as contributing to public construction delay in the Ethiopian construction industry and their consequences. The results show that the most important element of the contractor-related factor, shortage of materials on site, is estimated to be 3.405 according to the path analysis with IBM SPPS Amos 23. On the other hand, with a value of 3.132, external-related issues, environmental factors, had the least impact on construction-related delays. Moreover, this study identified seven consequences of delays on public construction projects in Ethiopia, ranging from the most significant to the least significant: (1) time overrun, (2) cost overrun, (3) disagreement between the parties involved, (4) arbitration, (5) litigation and court case, (6) complete project abandonment, and (7) resource waste and underutilization.*

*Keywords: Delay, Public Construction Project, Structural Equation Modeling, Effect of Delay*



*DOI: https://doi.org/10.20372/pjet.v2i2.1695*

***Corresponding Author:*** Bereket Haile Woldegiorgis
Faculty of Mechanical and Industrial Engineering, Bahir Dar Institute of Technology, Bahir Dar University, Bahir Dar, Ethiopia
*Email berekethi12@gmail.com*

## 1. Introduction

The construction industry is very large and complex, requiring significant capital investments (Bril et al., 2017). This industry is commonly acknowledged as successful when projects are completed on schedule, within the agreed budget, at the highest quality, and in the safest manner, in accordance with specifications and to the satisfaction of stakeholders (Mohsen Alawag et al., 2023). Functionality, profitability for contractors, absence of claims and court proceedings, and "fitness for purpose" for occupants have also been used as measures of project success (Alfakhri et al., 2018). For public or private construction firms, upgrading project performance can be considered one of their main objectives. This can be achieved by reducing costs, finishing projects on schedule, and increasing quality (Amare et al., 2017). Public construction projects in Ethiopia are part of the country's development initiatives, consuming a considerable amount of the country's scarce financial resources. For instance, research shows that public construction projects consume an average annual rate of nearly 60% of the government's capital budget (MoFED, 2014; Yohannes & Mohammed, 2023). Delays in the completion of construction projects are one of the biggest problems facing the industry and can lead to costly disputes and adverse relationships among project participants. The term "delay" in construction contracts has no precise technical meaning. According to their research findings, several researchers have proposed varying definitions of building delay. For example, Patrick et al. (2021) described delay as a prevalent risk in project construction that is most severe one. According to Assaf & Al-Hejji (2006), a construction delay is the time overrun either beyond the contract date or beyond the date that the parties agreed upon for delivery of a project. In summary, a construction delay is a decline in production (or disturbance) that results in loss and/or expense for contractors and/or subcontractors (Burr, 2016). Construction delays can be minimized only when their causes are identified (Kullaya et al., 2022; Mbala et al., 2019). Delays are classified as non-excusable, excusable with compensable delays, excusable without compensable delays, and concurrent. Non-excusable delays are those that the contractor causes or bears the risk of. Excusable but not compensable delays are those induced by unforeseeable causes that are beyond the contractor's reasonable control and are not related to the contractor's fault or carelessness (P.J.Keane & A.F.Caletka, 2015). Excusable with compensable delays are delays, suspensions, or interruptions to all or part of the work that are excused because they are the result of the owner's action or inaction leading to owner's breach of an implied or expressed obligation in the contract. When both the owner and the contractor are at fault for the delay, it is said to be concurrent. Delay or extension of time: the contractor is responsible for damages if the actual completion date of the works is later than the agreed completion date, unless the delay was brought on by a circumstance for which an extension of time is possible and the contractor complied with the notice and other contractual requirements (Shabbar et al., 2016). In Ethiopia, most construction projects subject to delays especially in some government-run projects (Hailemarkos, 2020). Project success is typically determined by the ability to achieve the goals and objectives outlined in the project schedule while staying within budget constraints, maintaining quality standards, and completing the project on time. If occurs, delays can be lead to huge losses to states and individuals, loss of investments, and failure of the companies. If the delay is not identified and the corrective project management decision is not taken in time, a project may incur extra cost and extension of project time. As a result, it gives rise to dissatisfaction to all the parties involved and nowadays it's becoming a major obstruction for their development for developing countries like Ethiopia (Koshe & Jha, 2016). With the stated situation in the Ethiopian public sector

construction project, quantification of the relationships among different causes of delay in Ethiopian public construction projects is certainly an important topic for investigation. The originality of this paper is situated in quantifying the interdependencies between different factors and their respective impacts on construction delays. The study recognizes that the project outcome is influenced by the collective effect of these factors and emphasizes the importance of understanding their relative significance. Given this background, the primary objective of this research is to investigating the cause and effect of delay in Ethiopia's public sector construction projects by using Structural Equation Modeling (SEM). The research objectives are translated into the following research questions:

- What are the reasons that drive delay and its consequence in public construction projects?
- What are the associated impacts of delays in public construction projects?
- What are the approaches to manage and reduce delays in public construction projects?

To answer the stated research questions, survey questionnaires, observation (site visits), Focused Group Discussion (FGD) through a teleconferencing and videos conferencing were used. A non-probabilistic snowball sampling techniques were used to identify potential respondents from clients, contractors, and consultants through referral networks to respond to questionnaires accurately (Fellows & Liu, 2015).

## 2. LITERATURE REVIEW

The achievement of construction projects primarily relies on meeting the objectives outlined in the project specifications which greatly contributes to their success (Bajjou & Chafi, 2018). If a project exceeds the anticipated duration, it may lead to the termination of the contract in order to prevent additional expenses, reduced productivity, and legal claims from third parties (Memon et al., 2023). Consequently, the project will experience significant delays resulting in unrecoverable cost overruns and creating avoidable financial hardships (Yohannes & Mohammed, 2023). Therefore, it is crucial to prioritize timely completion of projects. The initial step towards achieving this goal is to identify the challenges and factors contributing to delays enabling the implementation of necessary measures to address them. Kullaya et al., (2022) analyzed the main causes of delays in the completion of road construction projects and identified six significant causes of delays emerged, and these were inadequate access to finance and delayed payments for completed work, financial problems or difficulties, unwillingness or inability to sustain operations over long periods of non-payment, an unrealistic program of works (Works Schedule), inadequate site management, and political interference.

In order to help project planners and implementers detect potential conflicts and take preventative action to mitigate their negative effects, such as delays, Kumar et al. (2006) investigated relevant conflicting elements in construction projects. These elements, with importance weighting, were: differing site conditions (24.1%), public interruptions (22.5%), differences in change order evaluations (21%), design errors (17.1%), excessive contract quantities variation (8.2) and double meanings of specifications (7.1 percent). According to their survey, the people most at fault for disagreements in building projects are the owner (35.6%) and the consultant (34.18%).

Koshe & Jha (2016) investigated the causes of construction delays in the Ethiopian construction industry and identified 88 key factors contributing to these delays. Their findings show that the main critical factors causing construction delays in Ethiopia are: (1) difficulties in financing projects by a contractor; (2) escalation of material prices; (3) ineffective project planning; (4) scheduling or resource management; (5) delays in progress payments for completed work; (6) lack of skilled professionals in the field of construction management within the organization; and (7) fluctuating labor availability from season to season (seasonal labor availability). According to Shabbar et al. (2016), provisional completion dates are provided for contracts, and construction timetables are typically not realistic. The underperformance of the construction industry further evidences that schedules were not effectively managed and monitored for project progress. These improbable schedules increased the number of demands for extensions of time. A realistic evaluation of extensions of time and the identification of the most essential or harmful delays require conducting delay analysis while taking into account the impact of concurrent delays. In evaluating extension of time claims, delay analysis techniques are not frequently applied, which leads to overly optimistic judgments. Payment to contractors had the largest contribution to the delay events that resulted in extension of time requests. Assaf & Al-hejji (2006) conducted a time performance study of various construction projects in Saudi Arabia's Eastern Province to identify the reasons for delays and their significance as perceived by each project stakeholder (owner, consultant, and contractor). It was determined that time overruns occur in 70% of projects. With the help of 23 contractors, 19 consultants, and 15 owners, a survey was undertaken. During the research, they discovered 73 reasons for delays and classified them into 9 types. Change orders were cited as the main reason for delays by all three parties. According to the overall findings, factors related to labor, contractors, project owners, and consultants ranked the highest. In their investigation for identifying main causes for schedule delay in construction projects in Bangladesh, Mizanur et al. (2014) explored the top five factors of construction delay according to their level of importance: (1) the rapid increase in the price of construction materials; (2) the political situation (revolutions/public strikes); (3) shortages of skilled workers; (4) poor site management and supervision by contractors; and (5) incompetent or immature subcontractors. Bajjou & Chafi (2018) conducted an empirical study on schedule delays to determine the critical causes affecting project delays in the Moroccan construction industry. They administered a questionnaire survey with public and private contractors and consultants to assess the relative importance of the causes of construction delays in Morocco. Their study revealed that the top ten delay causes are: (1) delays in progress payments; (2) lack of training for employees; (3) lack of a waste management strategy; (4) unrealistic contract durations imposed by clients; (5) rework due to construction errors; (6) excessive subcontracting; (7) delays in obtaining permits from governmental agencies; (8) ineffective planning and scheduling; (9) lack of collective planning; and (10) an unskilled workforce. In the research that was conducted by Amare et al. (2017) to assess the causes of excessive delays in the completion of road projects during the construction phase due to failures by the Employer, Consultant, and Contractor in Addis Ababa City Road Authority projects, the results showed that the contractors bore the highest percentage of responsibility for the delays, at about 40%. The employer followed, with a responsibility percentage of 26.15%, and the consultant ranked third at 23.08%. Additionally, 10.77% of the respondents indicated that the shared responsibility among the three parties contributed to project delays during the implementation phase.

Delays are costly and often lead to disputes and claims. Many projects suffer from extensive delays that far exceed initial cost estimates and timelines. In addition, extensive delays create a fertile ground for costly disputes and claims. Many studies find that blame is often directed at the contractor; however, numerous types of delays are caused by other parties and stakeholders. In their study on the effects of construction delays on project delivery, Aibinu and Jagboro (2002) identified cost overruns and time overruns (elongation of project duration) as the two most frequent effects of delays in the Nigerian construction industry. Sambasivan et al. (2017) conducted a study with a twofold purpose: first, to develop theoretical underpinnings using Transaction Cost Economics, and second, to perform the analysis using an advanced tool such as structural equation modeling (SEM). The key findings of their investigation were as follows: cost overruns can be explained by consultant-related and material-related factors; disputes arise from cost overruns; arbitration is influenced by consultant-related, cost overrun, and dispute factors; litigation is driven by client-related, dispute, and arbitration factors; and abandonment is associated with consultant-related, external-related, dispute, arbitration, and litigation factors. From the selected literature review, it is apparent that in most studies, priority has been given to identifying the critical causes based on the perceptions of different parties in construction. However, the quantification of the dependencies of one factor on another and their relative impacts on construction delays, particularly regarding how these factors collectively influence project outcomes, has not been extensively addressed in many studies. Hence, it is important to identify the precise relationships between various key delay factors and their interactions concerning overall project delays. Research is still needed to identify the relationships between the relative importances of delay factors when these factors are present in groups and to develop a framework for explaining the quantitative impacts on delays.

## 3. RESEARCH METHODOLOGY

### 3.1 Research Design

Mixed research approaches were adopted to examine the current situation of construction delays and their effects in the study area. Employing these approaches helped neutralize or cancel the biases associated with using any single approach. This design was preferred because it enabled the researchers to collect sufficient information necessary for generalization and to summarize the essential features of the data gathered from the study area. The qualitative data collection approach was intended to obtain facts and figures from incomplete or delayed public infrastructure projects, not solely to gather the views of the respondents. Thus, both qualitative and quantitative data were used in this study.

Qualitative data includes project challenges, comments and opinions from project stakeholders (e.g., clients, architects, and contractors) regarding the online completion of the project. Quantitative data includes timeline metrics, performance metrics, resource usage, and budget figures. The research was aimed to address the unclosed issue (Fellows & Liu, 2015) as per the aim to differentiate major factors to the delay of public construction projects in Ethiopia, to solve the problem and descriptive research was aimed to reveal the existing issue using the responses of a stakeholders.

Nevertheless, the particular approach adopted for any piece of research influences the methodology to be used to carry out the research. According to Damoah, (2015), a research technique for a given problem is not like the solution to a problem in algebra; there is no one best recipe which implies that there are several research approaches. And also the researchers of this study tried to construe the research technique as the mechanism of approaching to the anticipated result for the problem towards the objective of the study conducted by utilizing any tool that shows good output for decision making. So, this study adopted a mixed research design which is used to describe the attitude, or opinions of participants to analyze the perception of respondents found in the public construction projects in Ethiopia. Utilizing this type of research needed more validating rather than using single technique due that incorporating both qualitative and quantitative approaches. As a result, purposive, snowball samples were applied by contacting professionals and requesting them to complete the survey and help to recruit other professionals in their companies or in other stakeholders found anywhere in the public construction projects in Ethiopia.

## 3.2 Data Collection and Analysis

Both primary and secondary data were included in this study. Primary data is sourced through a questionnaire, observation, and semi-structured interviews. Through these interviews, relevant facts, as well as opinions, were obtained. In our study, we have prepared the questionnaire by taking the literature into consideration to suit the specific objectives and research context of our investigation (Ismail et al., 2018). These questionnaires distributed to construction stakeholders (Client, Contractors, Consultants, and other participants) to get primary data. The questionnaire includes three parts: The first part contained general demography of respondents, type and projects status of the respondents work in, and project location. Part two of the questionnaire focused on the causes of delay to respective stakeholders in public construction projects in Ethiopia. The third section of the questionnaire concentrated on the effects of delay as per involved participants in Ethiopian public construction projects. The data collected from the questionnaires were analyzed from the perspective of the developers. Every cause of delay based on stakeholders, and external factors, were computed for the overall analysis. The analysis was done by using IBM SPSS statics v23–Amos through engineering tools structural equation modeling (SEM). SEM is a multivariate method for statistically assessing several interdependent relationships between the latent or independent variables (Doloi et al., 2012). SEM is widely used across many disciplines, although it was not very common in construction management research fields. It was preferred to test the interdependence and/or correlation of one factor with another. To address the objectives of the study, survey questionnaires, observation (site visits), Focused Group Discussion (FGD) through a teleconferencing and videos conferencing were used. The questionnaires were prepared in the English language since it was distributed to the professional found in the stakeholders involved in public construction projects in Ethiopia. As there were more than one engineer or project managers found in stakeholders and difficulty to get in touch with all public construction found in Ethiopia, true random sampling was not feasible. As a result, purposive, snowball samples were applied A non-probabilistic snowball sampling techniques were used to identify potential respondents from clients, contractors, and consultants through referral networks to respond to questionnaires accurately (Fellows & Liu, 2015).

The population of the research consists of different groups involved in the public construction sector in Ethiopia and the sample size was determined using statistical formula (equation 1) considering the population and confidence level to estimate the number of questionnaires to be distributed to respondents considering the response rate. The sample size is determined by the following formula (Hogg et al., 2013).

$$n = \frac{m}{1+\frac{m-1}{N}} \quad (1)$$

Where n, m, and N represent the sample size of the limited, unlimited, and available population respectively.

$$m = \frac{z^2 * p * (1-p)}{\varepsilon^2} \quad (2)$$

Where z=the statistical value for the confidence level used i.e. 2.575, 1.96 and 1.645 for 99%, 95% and 90% confidence level, respectively.

P=the value of the population proportion that is determined, take a conservative value of 0.5

Ɛ = the sampling error limit = 5%

So, let's assume that 95% level of confidence for the available population (N=161), then the sample size (n) for this study determined as follows:

From the calculation the lowest acceptable number of responses must be 114 at a 95% level of confidence with a level of error at 5%. Hence, in this study, the obtained sample size was 130 (including rejected responded questionnaire) which imply it attained above a 95% level of confidence. As part of the administered survey, there were 130 responses from the individuals within the companies (from professionals, working in public construction projects) which are above the required response threshold (Hogg et al., 2013). As a result of the sample size it was exceeding the estimate; the researchers adopted the following formula to determine the confidence level and limit of error for the actual responses received.

$$\varepsilon^2 = \frac{z^2 * p * (1-p)}{n} - \frac{z^2 * p * (1-p)}{N} \quad (3)$$

$$\varepsilon = \sqrt{0.001423} = 0.037723 = 0.037723 * 100 = 3.8\%$$

The results show that a 95% confidence level has an error limit of approximately 3.8%. According to (Yin, 2008) a 95% confidence level with an error limit of 10% is acceptable. Therefore, having a lower error margin of 3.8% increases the validity of the data. On the other hand, the general public was selected using simple random sampling with a snowball strategy to get in touch with those unreachable public constructions found in Ethiopia. For the sample size, due to the large population of Ethiopia, the formula could not be used and therefore quota sampling is applied here. Thus, 130 samples (to regions and cities in Ethiopia) were used.

### 3.3 Model Development and Research Hypotheses

In the construction domain, the causes for delay in completion of any activity over the construction phase and that subsequently affect the completion time are known as delay factors. Research published over the past few decades has identified numerous factors affecting delay in construction projects. Upon summarizing the findings and analyzing them strictly, a total of seven factors have been identified as most common in the majority of Ethiopian public sector construction projects. In deciding the seven factors the current socio-economic status of Ethiopia was taken into consideration. These identified factors adopted for the present work to design the questionnaire. The relationship between public construction delay, their factors and effects can be conceptualized as shown in the figure 1. The conceptual framework is developed based on research objectives of the study and involves points stated in questionnaires and semi-structured interview conducted for this study that categorized delay causing factors in seven groups and identifies effects of delay.

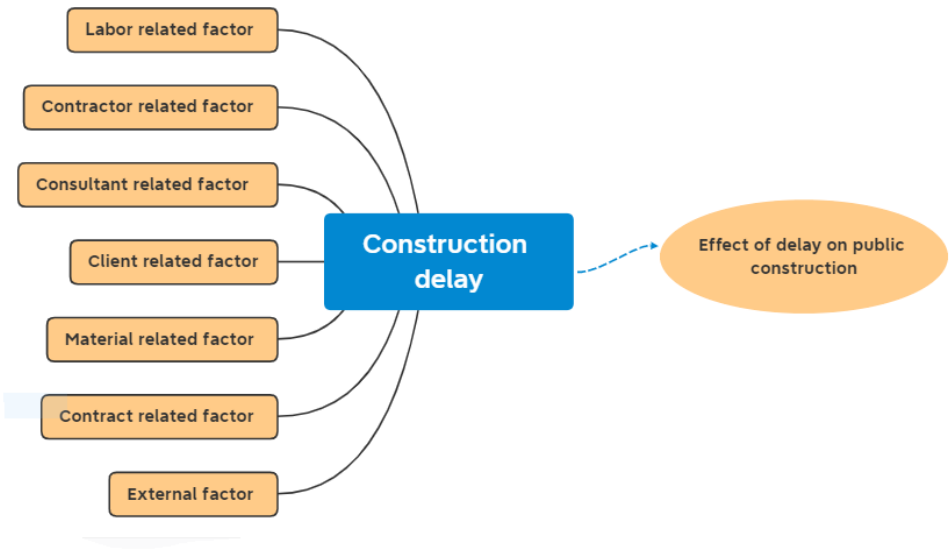


Fig. 1. Conceptual framework for Causes of Delay.

### 3.3.1 Model development

The perspective of all parties that were participated in the public construction projects was first analyzed from each stakeholder's perspectives and then the overall result was computed. The causes of delay were discussed based on the Structural Equation Modeling (SEM) that integrated with IBM SPSS Amos software. The theoretical model is basis for testing the relationships of independent and dependent variables (Fellows & Liu, 2015). Hence, a structural model of factors and effects of delay in public construction project is developed. Each of the 14 variables (factors and effects of delay) includes a number of separate indicators or sub variables which are as listed in Table 1.

A theoretical model was constructed to represent delay factors in the Ethiopian public construction projects. Factor analysis was used to generate 41 delay indicators categorized into 7 latent delay factors and 7 effects of delay. The model demonstrates the concept with its key elements [i.e. constructed from collected valid data via questionnaire and semi-structured interview and make compatible for the engineering tool utilized viz. SEM integrated with IBM SPSS statistics version 23 Amos software].

### 3.3.2 Theoretical framework

The above review provides the theoretical basis to develop the research framework for this study. It is hypothesized that contractor related factor [CR], Client related factors [CL], Consultant related factors [CS], Material-related Factors [MR], Labor related factors [LR], Contract-related factors [CT] , and External factors [EX] collectively affect the time performance in projects.

In order to explore the influences of latent factors on construction delay, the research sets out seven hypotheses as follows:

***Hypothesis H1***: Frequency of occurrence of contractor-related factor [CR] influences overall impact on construction delay [CD].

***Hypothesis H2***: Frequency of occurrence of consultant-related factor [CS] influences overall impact on construction delay [CD].

***Hypothesis H3***: Client-related factors [CL] have significant effects on Construction delay [CD].

***Hypothesis H4***: Material-related factors [MR] have significant effects on Construction delay.

***Hypothesis H5***: Frequency of occurrence of External factor [EX] influences overall impact on construction delay [CD].

***Hypothesis H6***: In the constructions labor-related factors [LR], will have direct effect on construction delay [CD].

***Hypothesis H7***: Contract-related factors [CT] have significant effects on Construction delay [CD].

Table 1. Latent delay factors and delay effects with sub-variable on public construction delay

| Latent Factor | Sub-variables | Observed variables |
|---|---|---|
| Client related factors [CL] | CL1 | Delay in delivering construction site to the contractors |
| | CL2 | Lack of experience of owner |
| | CL3 | Delay in progress payments |
| | CL4 | Slow decision making process |
| | CL5 | Unrealistic contract duration and requirements imposed |
| | CL6 | Poor communication & coordination of the owner with other |
| | CL7 | Lack of coordination with the contractor and utility providers |
| | CL8 | Change orders by owner during construction |
| | CL9 | Type of project bidding and award (least bidder type) |
| | CL10 | delay in right of way clearance(delay in fixing boundary) |
| Consultant related factors [CS] | CS1 | Poor communication and coordination of the consultant with |
| | CS2 | Delay in inspection and testing by the consultant |
| | CS3 | Lack of consultant's site staff |
| | CS4 | Inadequate experience of consultant; |
| | CS5 | Mistakes and discrepancies in design documents |
| | CS6 | Poor contract management |
| | CS7 | Delay in design documents preparation by consultant |
| | CS8 | Inaccurate site investigation |
| Contractor related factors [CR] | CR1 | Poor qualification of the contractor's technical staff |
| | CR2 | Shortage of contractors' materials on site |
| | CR3 | Mistakes during construction stage |
| | CR4 | Inadequate contractor experience |
| | CR5 | Poor financing way for the construction project by the contractor |
| | CR6 | Inadequate planning and scheduling of work by contractor |
| | CR7 | Conflicts with sub-contractors |
| | CR8 | Poor site management and supervision by contractors |
| | CR9 | Weak in follow up the planned work schedule by the contractor |
| | CR10 | Rework due to error during construction |
| | CR11 | Poor communication & coordination with other parties |
| | CR12 | Poor management skills |
| Material-related [MR] | MR1 | Unavailability around project |
| | MR2 | Change due to quality |
| Labor related [LR] | LR1 | Un availability around project |
| | LR2 | Efficiency |
| Contract-related [CT] | CT1 | Inaccurate initial estimation |
| | CT2 | Form of contract |
| External factors [EX] | EX1 | Political instability |
| | EX2 | Foreign currency rate/Inflation |
| | EX3 | Inadequate funding |
| | EX4 | Environmental factors |
| | EX5 | Social factor |
| | ED1 | Time overrun |
| | ED2 | Cost overrun |
| | ED3 | Dispute between parties involved |
| | ED4 | Arbitration |
| | ED5 | Litigation and court case |

| | | |
|---|---|---|
| Effects of delay [ED] | ED6 | Total abandonment of the project |
| | ED7 | Wastage and underutilization of resources |

While testing the direct influences of the above seven key factors on construction delay, the interdependence and/or correlation of one factor with another in the structural equation model is also an important aspect for investigation. The interdependent relationships of these factors and their potential influence on one another have been reported in numerous other research works (Hailemarkos, 2020; Patrick et al., 2021; Shabbar et al., 2016). Thus the following additional hypotheses have been further developed to test the relative impacts of factors on one another:

***Hypothesis H8***: Frequency of occurrence of consultant-related factor [CS] triggers the frequency of occurrence of contractor-related factor [CR].

***Hypothesis H9***: Frequency of occurrence of consultant-related factor [CS] triggers the frequency of occurrence of client-related factor [CL].

***Hypothesis H10***: Frequency of occurrence of external factor [EX] triggers the frequency of occurrence of client-related factor [CL].

***Hypothesis H11***: Frequency of occurrence of material-related factor [MR] triggers the frequency of occurrence of contractor-related factor [CR].

***Hypothesis H12***: Frequency of occurrence of contract type factor [CT] triggers the frequency of occurrence of client-related factor [CL].

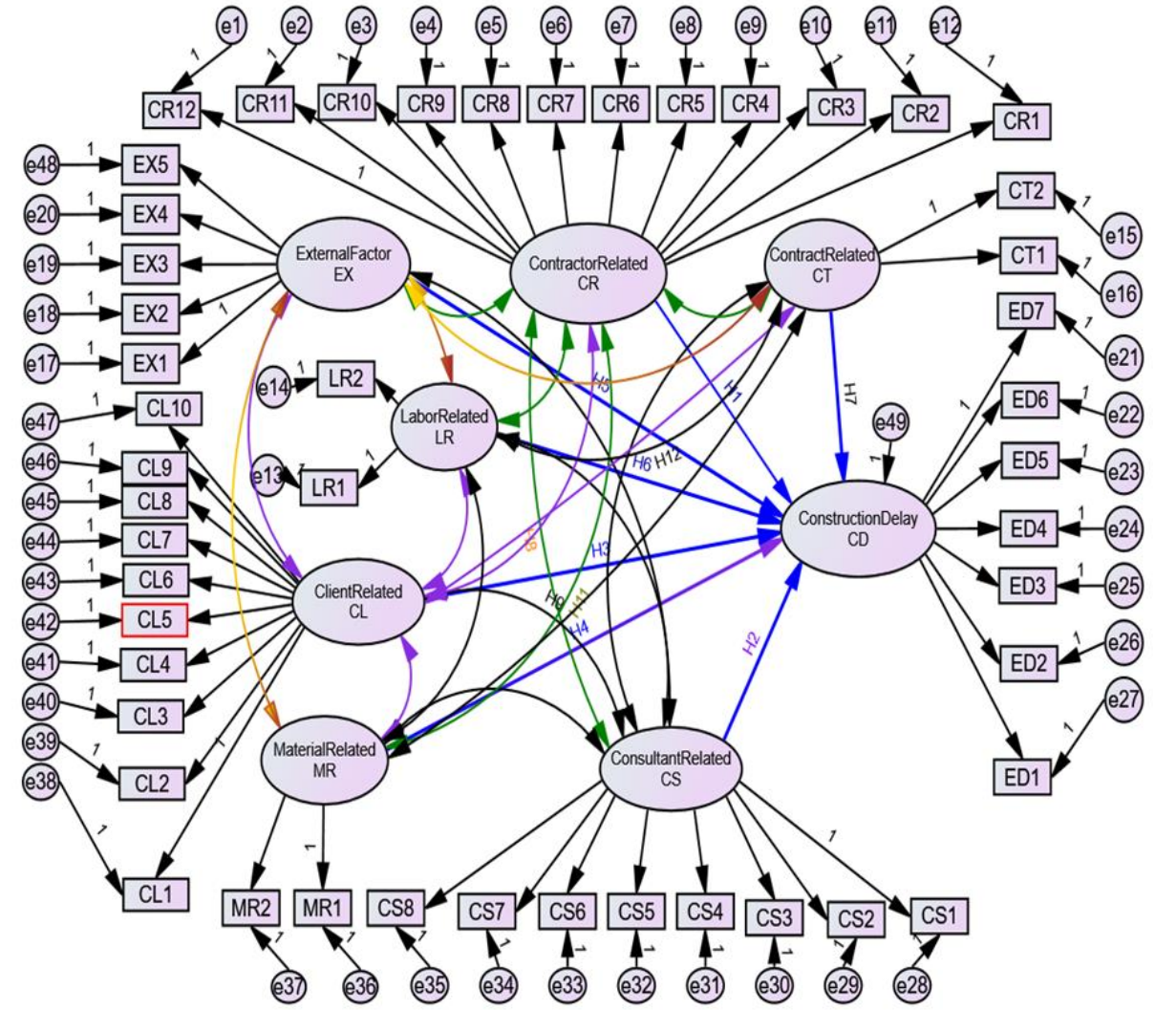


Fig. 2. Hypothetical model of the factors that have impacts on construction delay

## 4. RESULTS AND DISCUSSION

The results and discussion contain the findings of the questions directed towards identifying delay causes and ranking them in the level of their importance/effects. Correlation and variances are modeled by AMOS V23 software and relations can be seen in number value so that it can be seen in the relational strength of dependent and independent variables in the estimated model. Similarly, the most important and frequent effects of delay were analyzed by SPSS. A total of 161 questionnaires were distributed to the targeted sample population of which 130 were completed and returned. Before analyzing the data collected, questionnaires were checked for their response validity and reliability and accordingly 121 out of 130 questionnaires were properly filled and returned and found to be valid as shown in Table 2

Table 2. Questionnaire response rate

| S.No | Respondents Category | Distributed | Returned | Valid Response | Response rate (%) |
|---|---|---|---|---|---|
| **1** | Contractor | 65 | 55 | 53 | 84.62% |
| **2** | Client | 48 | 33 | 29 | 68.75% |
| **3** | Consultant | 45 | 40 | 37 | 88.89% |
| **4** | Other | 3 | 2 | 2 | 66.67% |
| | Total | 161 | 130 | 121 | 80.75% |

The male respondents account for 68.6%. 25% of the respondents were between the age of 18 and 30, while 44% and 22 % of the respondents were between the ages of 1-40 and 40-50, respectively.

The data show that the respondents have good experience in the area of Ethiopian construction. The respondents' work experience shows that 38 (31.4%) have 6 – 10 years, 28 (23.1%) have 11 – 15 years, 22 (18.2%) have 1 – 5 years, 19 (15.7%) have 16 – 20 years, and 14 (11.6%) of the respondents have more than above 21 years work experience in the construction sector. Furthermore, 43.8% of the respondents are professionals and individuals who work in the contractors' side of construction, while those with the consultant, clients' and others constitute 30.6%, 24.0% and 1.7% of the respondents respectively. The theoretical model is the basis for testing the relationships between independent and de-pendent variables (Fellows & Liu, 2015). Hence, the Amos V23 software output of a structural model of factors and effects of delay in public construction project is as presented in Figure 4. Table 3 shows the input summary of the model.

Table 3. Input Summary of the Model

| | |
|---|---|
| Number of variables in the model: | 105 |
| Number of observed variables: | 48 |
| Number of unobserved variables: | 57 |
| Number of exogenous variables: | 56 |
| Number of endogenous variables: | 49 |

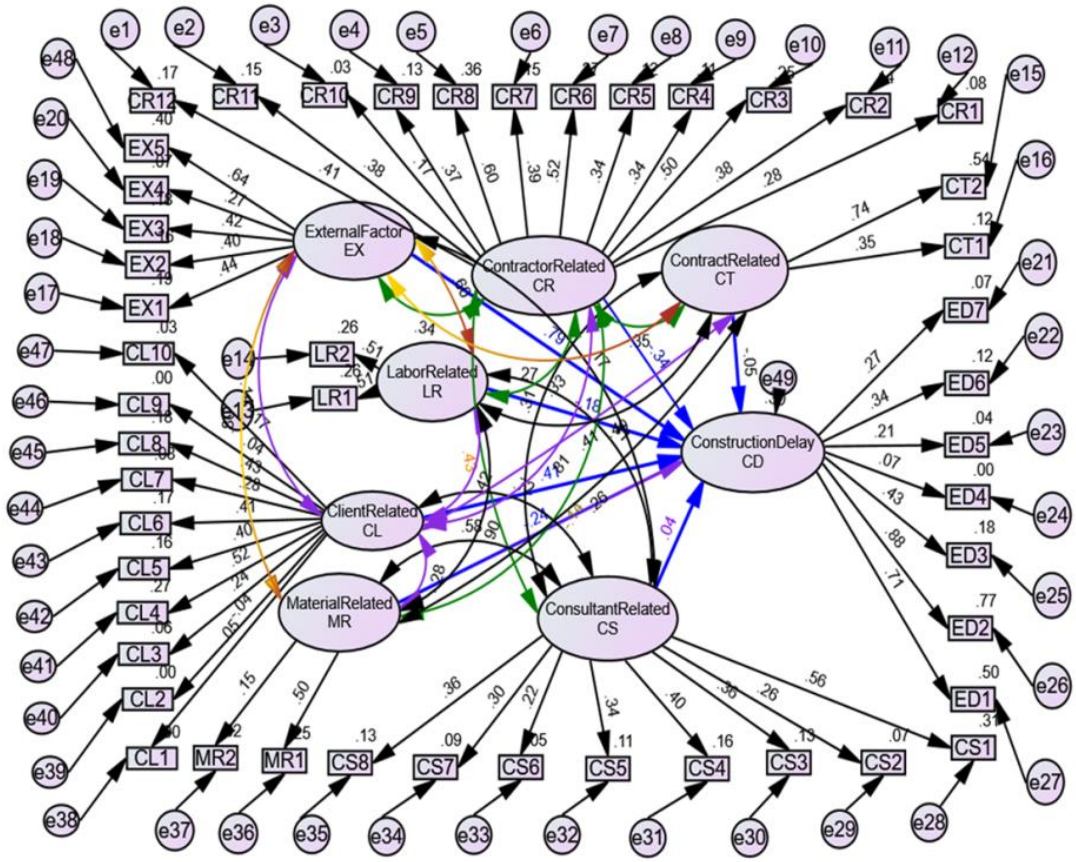


Fig. 3. Results from the simulation process for Covariance and regression weight model

The standardized total (direct and indirect) effect of contractor related factors (CR) on construction delay (CD) is -0.338. That is, due to both direct (unmediated) and indirect (mediated) effects of contractor related (CR) on construction delay (CD), when contractor related (CR) goes up by 1 standard deviation, construction delay (CD) goes down by 0.338 standard deviations. The result implies frequency of occurrence of contractor-related factor (CR) has influences indirectly on overall impact on construction delay (CD), so hypothesis H1 was accepted. The standardized total (direct and indirect) effect of client related (CL) on construction delay (CD) is 0.414. That is, due to both direct (unmediated) and indirect (mediated) effects of client related (CL) on construction delay (CD), when client related (CL) goes up by 1 standard deviation, construction delay (CD) goes up by 0.414 standard deviations. Which implies the Frequency of occurrence of client-related factors [CL] direct positive influences overall impact on construction delay [CD]. Therefore hypothesis H3 was accepted. The intercept in the equation for predicting 'Foreign currency rate/Inflation' is estimated to be 3.298 and, has a standard error of about 0.107. Dividing the estimate of the intercept by the estimate of its standard error gives z = 3.298/.107 = 30.721. In other words, the estimate of the intercept is 30.721 standard errors above zero. The probability of getting a critical ratio as large as 30.721 in absolute value is less than 0.001. In other words, the intercept in the equation for predicting 'Foreign currency rate/Inflation' is significantly

different from zero at the 0.001 level, implying the major delay causing variables in respect of 'external related (EX)' factor. From those public construction delay factors, mostly delay causing were selected out by using AMOS standardized model estimation and intercepts. The significance level (P-value) of each intercept estimation of observed variables were less than 0.001. In hypothesis H11 (Table 1) the correlation coefficient for contractor related (CR) and material related (MR) was 0.057, for the covariance between contractor related (CR) and material Related (MR) is estimated to be -0.057. Implies frequency of occurrence of material-related factor (MR) had a negative correlation with contractor-related factor (CR). Therefore hypothesis H11 was rejected, thus, material related (MR) factors had no direct significant impact on delay of construction projects directly. However, it can be observed that the indirect effects remained.

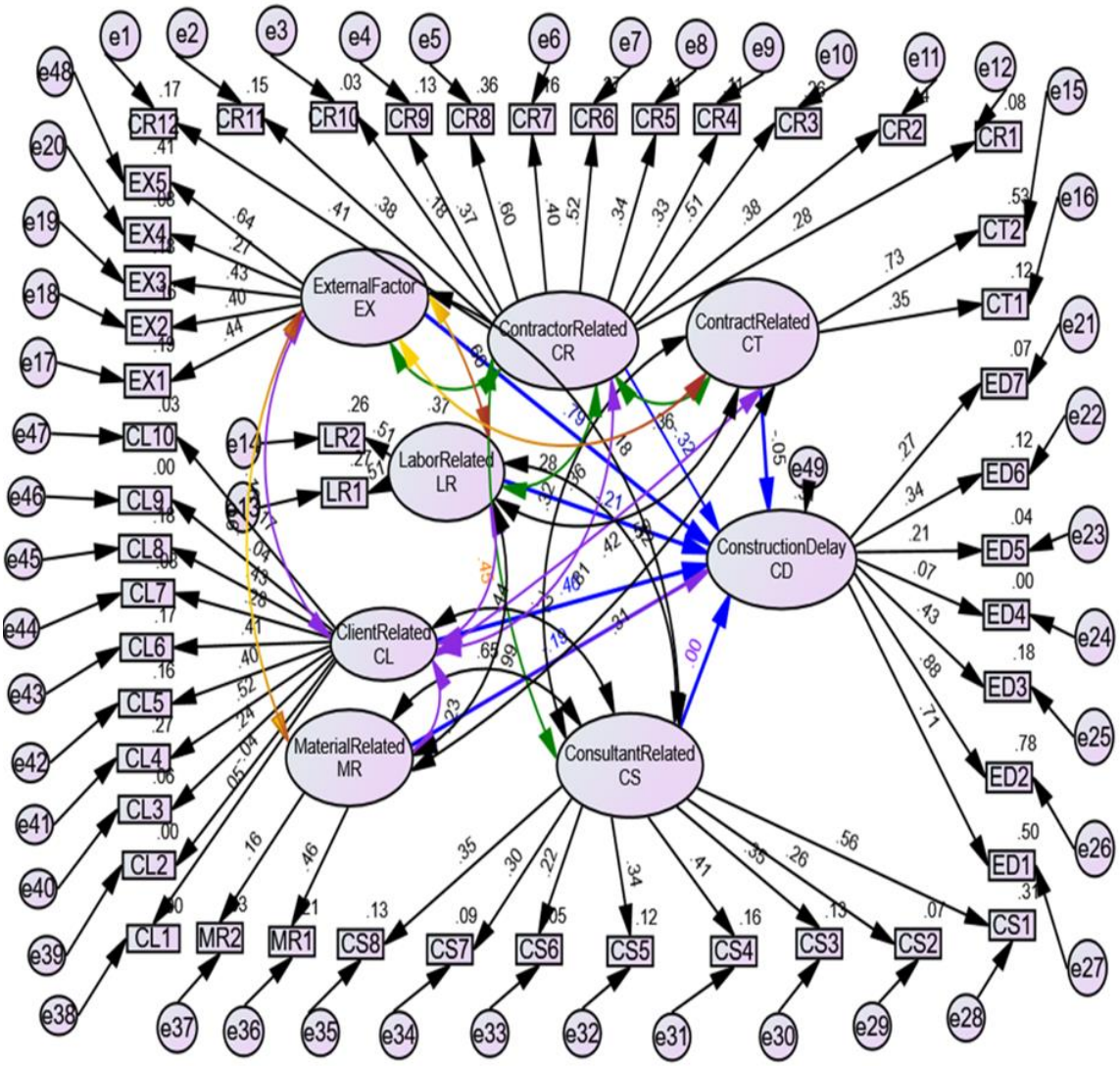


Fig. 4. Modified Structural Equation Model – [Cause-Effects] of Public Construction Delay

## 5. CONCLUSION AND FUTURE STUDIES

Public construction projects in Ethiopia are parts of the country's development initiative that it shares considerable amount of the country's scarce financial resources. Delay in the completion of a construction project are one of the biggest problems facing the construction industry and can be a major problem for construction's project participant leading to costly disputes and adverse relationships amongst project participants. In Ethiopia, most construction projects subject to delays especially in some government-run projects. Hence it is important to identify the precise relationship between various key factors of delay and their interactions in relation to overall delay in projects. In this study, the relationship between 48 variables (41 factors and 7 effects) previously identified as causing public construction delays in the Ethiopian construction industry and the adverse consequences of these delays were studied using structural equation modelling (SEM). These factors were, consultant related (CS), contractor related (CR), external factor (EX), labor related factor (LR), material related factor (MR), contract related (CT), and cause of delay (CD). The model's evaluation reveals that every sub-variable in the outer model is accurate and dependable. The β-value of the contractor related (CR) component, which is 'shortage of contractor's materials on site,' is projected to be 3.405 according to the path analysis. External related (EX) factors component, 'environmental factors', on the other hand, has the least influence on building delays, with a β-value of 3.132. Additionally, this study identified seven consequences of delays on public construction projects in Ethiopia, ranging from the most significant to the least significant: (1) time overrun, (2) cost overrun, (3) disagreement between the parties involved, (4) arbitration, (5) litigation and court case, (6) complete project abandonment, and (7) resource waste and underutilization. Hence, the model can be applied as a depiction of the challenges encountered in the public construction sector of Ethiopia. This model holds value for individuals working in the construction industry, particularly in Ethiopia, as it enables them to analyze the risks associated with delays. Additionally, researchers in the construction field can benefit from utilizing this model for their studies and investigations. However, the research was constrained to the public construction sector, and it is recommended to conduct further investigations that encompass the private construction sector as well to provide a comprehensive understanding of the issue from various perspectives. In light of the study's findings, it is suggested to conduct additional research to quantify the impact of contractor-related factors, specifically the "shortage of contractor's materials on site," which has been identified as the primary cause of delays.

## References

Aibinu, A. A., & Jagboro, G. O. (2002). The effects of construction delays on project delivery in Nigerian construction industry. *International Journal of Project Management*, *20*(8), 593–599. https://doi.org/10.1016/S0263-7863(02)00028-5

Alfakhri, A. Y. Y., Ismail, A., Khoiry, M. A., & Albrka, S. I. (2018). *A Study of Identifying Significant Variables of Delays in Road Construction Via Structural Equation Modelling ( SEM )*. *7*, 893–898.

Amare, Y., Quezon, E. T., & Busier, M. (2017). *Causes of Delays During Construction Phase of Road Projects due to The Failures of Contractor, Consultant, And Employer in Addis Ababa City Road Authority*. *8*(3).

Assaf, S. A., & Al-hejji, S. (2006). *PROJECT Causes of delay in large construction projects*. *24*, 2005–2007. https://doi.org/10.1016/j.ijproman.2005.11.010

Bajjou, M. S., & Chafi, A. (2018). *Empirical study of schedule delay in Moroccan construction projects*. *3599*.

Bril, A., Kalinina, O., & Ilin, I. (2017). Small innovative company's valuation within venture capital financing of projects in the construction industry. *MATEC Web of Conferences*, *106*. https://doi.org/10.1051/matecconf/201710608010

Burr, A. (2016). *Delay and Disruption in Construction Contracts* (Fifth Edit). Informa Law from Routledge.

Damoah, I. S. (2015). *An Investigation into the Causes and Effects of Project Failure in Government Projects in Developing Countries : Ghana as a Case Study.*

Doloi, H., Sawhney, A., & Iyer, K. C. (2012). *Structural equation model for investigating factors affecting delay in Indian construction projects*. *October*, 869–884.

Fellows, R., & Liu, A. (2015). *Research Methods for Construction* (Fourth Edi). John Wiley & Sons, Ltd Registered.

Hailemarkos, H. T. (2020). *Ethiopian Construction Project Management Maturity Model Determination and Correlational Prediction of Project Success*. 210. https://scholarworks.waldenu.edu/dissertations

Hogg, R. V., Tanis, E. A., & Zimmerman, D. L. (2013). Probability and Statistica Inference. In D. Lynch (Ed.), *Understanding Significance Testing* (9th ed). Pearson Education, Inc. https://doi.org/10.4135/9781412986434.n4

Ismail, A., Y. Y. Alfakhri, A., Azry Khoiry, M., M Abdelsalam, H., & Elhub, B. (2018). Investigating Delays in Libyan Road Construction Projects Using Structural Equation Modelling (SEM). *International Journal of Engineering & Technology*, *7*(2.29), 858. https://doi.org/10.14419/ijet.v7i2.29.14272

Koshe, W., & Jha, K. N. (2016). *Investigating Causes of Construction Delay in Ethiopian Construction Industries*. *1*(1), 18–29. https://doi.org/10.11648/j.jccee.20160101.13

Kullaya, D. M., Alemu, M. K., & Yeom, C. H. (2022). *An Analysis of the Main Causes of Delays in the Completion of Road Construction Projects : A Case Study of Tanzania Abstract : i*, 1–9. https://doi.org/10.2174/18744478-v16-e2208190

Kumar, N., Acharya and Young Dai Lee, & Im, H. M. (2006). *Conflicting factors in construction projects : Korean perspective*. https://doi.org/10.1108/09699980610712364

Mbala, M., Aigbavboa, C., & Aliu, J. (2019). Causes of delay in various construction projects: A literature review. In *Advances in Intelligent Systems and Computing* (Vol. 788). Springer International Publishing. https://doi.org/10.1007/978-3-319-94199-8_47

Memon, A. H., Memon, A. Q., Khahro, S. H., & Javed, Y. (2023). Investigation of Project Delays: Towards a Sustainable Construction Industry. *Sustainability (Switzerland)*, *15*(2), 1–17. https://doi.org/10.3390/su15021457

Mizanur, R., Dai, L. Y., & Khanh, H. D. (2014). *Investigating Main Causes for Schedule Delay in Construction Projects in Bangladesh*.

MoFED. (2006). *Ministry of Finance and Economic Development, Ethiopia : Building on Progress : A Plan for Accelerated and Sustained Development to End Poverty ( PASDEP )*.

Mohsen Alawag, A., Salah Alaloul, W., Liew, M. S., Ali Musarat, M., Baarimah, A. O., Saad, S., & Ammad, S. (2023). Critical Success Factors Influencing Total Quality Management In Industrialised Building System: A Case Of Malaysian Construction Industry. *Ain Shams Engineering Journal*, *14*(2), 101877. https://doi.org/10.1016/j.asej.2022.101877

P.J.Keane, & A.F.Caletka. (2015). *Delay Analysis in Construction Contracts* (2nd Editio). Blackwell Publishing Ltd.

Patrick, O., Ewa, W., & Stephen, G. (2021). Construction Project Management in the Niger-Delta: Delays and Consequences 1. *Quest Journals Journal of Architecture and Civil Engineering*, *6*(3), 1–19. www.questjournals.org

Sambasivan, M., Deepak, T. J., Salim, A. N., & Ponniah, V. (2017). Analysis of delays in Tanzanian construction industry Transaction cost economics (TCE) and structural equation modeling (SEM) approach. *Engineering, Construction and Architectural Management*, *24*(2), 308–325. https://doi.org/10.1108/ECAM-09-2015-0145

Shabbar, H., Ullah, F., Ayub, B., Asce, A. M., Thaheem, M. J., Ph, D., Asce, A. M., Gabriel, H. F., & Ph, D. (2016). *Empirical Evidence of Extension of Time in Construction Projects*. https://doi.org/10.1061/(ASCE)LA.1943-4170.0000217.

Yin, R. K. (2008). *Case study research: Design and method*. SAGE Publications, Inc.

Yohannes, A., & Mohammed, I. (2023). *Construction Project Delay Factors of Public Universities in Ethiopia : A Structural Equation Modeling Approach*. *29*(3), 16–34. https://doi.org/10.9734/JEMT/2023/v29i31081