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Factors affecting the time overrun of road construction projects in Ethiopia

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Abstract: This research was carried out to analyse the factors that affect the time overrun of cobblestone paving and canal projects in the South Wollo Zone and Dessie City Administration. The study employed both descriptive and explanatory research design methods. A sample size of 392 respondents was selected from the total target population of 620 clients and contractors. To select the sample, the researchers used a stratified sampling technique. To achieve the objectives of the study, structural equation model was used to determine the relationship between the independent and dependent variables using Statistical Package for Social Sciences (SPSS V.25 and AMOS26). The study found out that labour, material, equipment, finance, design, and project management related factors had a positive and significant effect on the time overrun of the project. Whereas, external environment-related factors found were insignificant for time overrun. The study recommended committing enough time for feasibility study and use resources efficiently and effectively.

Keywords: time variance; structural equation modelling; SEM; road project; South Wollo Zone; Ethiopia.

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1 Introduction

The problem of time overrun is constantly occurring in road construction projects and they could cause a great impact on economic growth. It is one of the common problems that upset the construction companies in terms of competitiveness and long-term sustainability in the global market (Shah, 2016). The problems are more common in road construction activities and their impacts are very high in developing countries compared to developed countries (Rajakumar, 2016). Particularly, micro-scaled construction companies are the most affected company type because they have limited capital and more exposed to risks (Tadewos and Patel, 2018).

Assessment of factors during the planning phase leading to time overruns is crucial for the success of the project (Imad et al., 2018). Traditional contracting is ranked the most effective procurement system for time overrun mitigation partly. Research conducted by Shah (2021), found out that pre-planning, weak material management, financing management, poor site management, problems of the contractor, and problems from the client side are the main cause for time overrun. Similarly, another research found out that the inflation rate is neglected in most of the construction projects economics and budgeting that causes the project cost overrun as the building materials prices, labour wages, and machinery hire rates are changing annually (Musarat et al., 2021). Schedule overrun significantly varied depending on project type, size, duration, location, and awarded years. Time overruns are more common than cost overruns due to the variation orders (Kamaruddeen et al., 2020).

A study conducted by Narayanan et al. (2019), identified the causes as delays in land acquisition and forest clearance, law and order problems, general price escalation, high capital cost, the poor performance of the contractor, and delay in the supply of equipment. On the other hand, Mahamid (2013) indicated that the top risks affecting time overrun in road construction projects in Palestine are: financial status of the contractors, payment delays by the owner, the political situation and segmentation of the West Bank,

poor communication between construction parties, lack of equipment efficiency and high competition in bids.

The Ministry of Finance of Ethiopia, announced that Ethiopia has lost 43 billion birr due to time delays and cost overrun in the last 10 to 15 years in development projects (Tsegaye, 2019). A study conducted on road construction projects in Oromia found out that the projects suffer from many problems in performance such as cost, time, and quality (Bayi, 2018). This study found out that, inaccurate contract quantity and design problems were more critical in affecting the performance of road construction projects as identified by all respondents in all organisations (road owner, consultant and contractor). The study carried out by Zolfaghari et al. (2020) elucidates the critical importance of alignment and prioritises the elements of project strategy in alignment with business strategy to achieve the specific dimensions of project success.

Similarly, inadequate planning and scheduling, poor project management systems by a contractor, and late possession of site by the client were identified as the most important factors causing poor time performance of local contractors in Ethiopia road authorities (Kassaye and Dinku, 2016). Many factors relate to delay discussed in the above paragraphs vary along with types of projects, locations, sizes, and scopes, it is also supported by Le-Hoai et al. (2008).

A study conducted by Kassa (2020) on the determinants of infrastructure project delays and cost escalations more specifically on the cases of federal road and railway construction projects in Ethiopia found out that the top-ranked five delay factors found incomplete to study before project approval, poor project management and coordination, the right of way issues, inaccurate forecasting of schedule, psychological biases, and political interests. Similarly a research conducted in Kenya the study found out that project planning of housing, resource availability, monitoring and evaluation and stakeholder involvement had a positive and significant influence on completion of housing projects (Wachira and Ngari, 2019).

Although there is ample literature on project time overruns within the construction industry, the review of the literature revealed that most of the studies have that been made were on medium and large scale projects and there are a few researches on micro scale projects. The previous researches were based on using descriptive statistics (i.e., mean, standard deviation and RII) and there are very few researches on SEM. In addition to this, very few studies have been conducted within the Ethiopian context particularly in South Wollo and Dessie City administration construction sectors specifically on cobblestone paving and canal projects. Therefore, knowing the cause of any particular delay in a construction project would help to avoid the same problems of time overrun in the cobblestone and canal projects.

This study focused conceptually on factors that affect the time and cost performance of cobblestone and canal projects. Even though many factors affect the time and cost performance of the projects but because of time and cost constraints, this research emphasised only on seven selected variables (labour, material, equipment, finance, project management, design, external environment-related factors). The performance of the project can be explained in terms of many factors like time, cost, satisfaction, and quality but the study focused on the time and cost performance of the road projects. Geographically, the study was restricted in to South Wollo and Dessie City administrations. As a result, this study focused on factors affecting the time overrun of cobblestone and canal projects since they are still suffering from these problems in the

case study areas. The importance of this study is that it inspects the relationship between material, equipment, labour, finance, project management, and design-related factors and the time overrun of cobblestone projects in Ethiopia while no research papers are studying the effect of the above factors and time overrun of projects in Ethiopia. In addition to this, the current study adds to existing knowledge of construction management by including an extensive literature review in the field of uncertainty in construction projects, it established the uncertain event and uncertainty factors through the structural equation model.

2 Literature review

The research conducted by Emoh (2020) has been established that political interference is a cankerworm in project delivery. Timeliness in payment, unionism and external environmental factors contribute immensely to delays in project delivery in the study area.

Project monitoring, management support, project team competency and project funding influence the performance of roads projects at KeNHA (Irfan et al., 2020). Financial flow, planning and scheduling have positive and significant influence on delivery delay of water projects in Zanzibar whereas for contract management the study did not find the relationship between contract management and delivery delays of water projects (Hassan, 2019).

Project delays beyond contract dates are predominantly caused by contractors and are usually associated with financial factors. 'Cash flow problems faced by the contractors' was found the major factor, which contributed to project delays, whereas 'storage on site' was seen as the least significant factor (Shehu et al., 2014). The most influential factor for time is unsettled or lack of project funding; errors or omissions in consultant material; and for quality, errors or omissions in construction work (Larsen et al., 2016). The analysis showed that delay of infrastructure projects were caused by 20 factors according to the records in the collected final reports of projects. The results showed that terrain and weather conditions are the top factors causing completion delay in infrastructure projects in Jordan (Al-Hazim and Abusalem, 2015). The possibility of schedule overruns increases with the levels of complexity and damage. Hurricanes in particular cause sudden shortages of resources (experts, suppliers, labourers, materials, and equipment) that reduce the productivity and increase the duration of reconstruction projects (Safapour et al., 2020). Another study found a significant relationship between planning, resource scheduling, project communication, and project monitoring and evaluation, and project performance. The study concluded that planning, project communication, resource allocation, and M&E were essential to project performance (Ronoh, 2020).

A study on causes of delay in road construction projects across 25 developing countries the lack of experience of the construction manager, inadequate planning/scheduling, and influence on people's land alongside the road construction project (expropriation for the construction of the project) have more significant impacts than frequent changes in the design (Rivera et al., 2020).

The availability of funds affects completion of construction projects; adequate funding allocation enhances completion of construction. Involvement of stakeholders in construction projects has an influence on its completion, through their level of involvement and way on involvement (Mwirabua and Mohinder, 2020).

Research conducted on critical overrun causations in marine projects found out the following significant, including communication issues amongst stakeholders, inadequate planning, safety issues, deficient technical instructions and inappropriate management approaches (Karami and Olatunji, 2020).

The top five critical success factors for the timely completion of public construction projects in Afghanistan are the availability of resources, the project manager's competence, regular monitoring and control, the project being in the public interest, and proper planning (Kakar et al., 2020). Another study was the causes of project delays in Oman. Its major findings indicate that change of scope and delay in making decisions are the most important client-related causes of project delays. Regarding the contractor-related factors, the study found that poor contract management and lack of experienced workers were the most common causes of project delays. Delayed approval of drawings was also found to be an important consultant-related cause of project delay (Amri and Marey-Pérez, 2020).

The causes of time overruns differ from project to project and in different situations. The top universal delay factors are delay in payment of contractor(s), poor planning and scheduling, design changes during construction, inadequate contractor experience and approaches, sponsor/owner/client's financial difficulties, improper or incomplete design, poor site management and supervision, shortage of skills and poor productivity (Zidane and Andersen, 2018).

In Algerians construction projects, the five most important causes are unrealistic contract duration, slow change orders, delay in payment of performed work ineffective planning and scheduling by contractors, and slow variation orders in extra quantities (Rachid et al., 2019). Lack of maintenance of the equipment, poor procurement programming of materials, strikes, riots, and other external factors was the most critical factor that influences project delay (Deshmukh and Menkudle, 2019).

Delay in land acquisition, delay in equipment erection, inadequate mobilisation by the contractor, delay in forest clearance, fund constraints, change in scope of work, cancellation of tender, law and order problem, delay in supply of equipment, slow progress of civil work, escalation in cost Realising the importance of the subject, construction delay not only results in time overrun but also in cost overrun (Deshmukh and Menkudle, 2019). Slow site clearance, contractors' financial problems, Inflation, progress payments delay by the owner, inaccurate cost estimation, and delay in commencement were the major causes of time overrun in Addis Ababa road construction (Siraw, 2014).

2.1 Material related factors

A study on factors causing cost overrun of construction projects in Sarawak, Malaysia found out that, shortage of material was ranked the highest out of the total factors, and it was categorised under external factors. Most of the respondents strongly agreed that it was a significant factor (Kamaruddeen et al., 2020). Another studies also found out that delay of material delivery to site, insufficient number of staffs, no adherence with materials standards that is stored in the site were found as the main causes for time overrun (Patil, 2019).

2.2 Equipment related factors

Shortage of plant and spare parts of equipment was ranked second out of the total factors, and this factor was categorised under external factors (Kamaruddeen et al., 2020). A research conducted on analysis of delay factors and their effects on construction projects found out a significant positive impact of equipment was found on the delay of construction projects of Pakistan (Rashid, 2020).

2.3 Labour related factors

The comparison of the studies revealed that construction professionals were unable to distinguish between the less and the low frequent factors causing time-overrun. Shortage of skilled labour was ranked eighth out of the total factors, and it was categorised under contractor-related factors (Kamaruddeen et al., 2020). Another study found out that, inexperienced contractors and an unproductive workforce were the main cause for time overrun (Mahamid, 2021; Zafar et al., 2019). Many challenges are facing the construction industry, but one of the most significant is the low productivity of labour.

2.4 Finance related factors

The contractor's financial difficulties, delay in payment for extra work/variations, and late payment from contractor to subcontractors/suppliers were found to be the most critical causes of delay in all the types of projects (Prasad et al., 2019). A study on construction material wastage and time overrun indicated that money problem during the construction of the project was the main problem for time overrun (Patil, 2019). Inadequate comprehension of the scope of work at the bidding stage is also found as the cause for time overrun. Delays in contractors' progress payment, financial problems, and contractor's difficulties in financing the project were the causes for time overrun. Client financial problems, delay in work approval, the contractor submits claims with mistakes, contractors' failure to do work based on bill of quantity, and contractors' failure to follow the certain guidelines in claims found as the causes for time overrun (Mahamid, 2021). A study carried out by Ashish (2018) reveals that financial capability and past performance of contractor, two of the most commonly used criteria for contractor prequalification, are inadequate for competent contractor short-listing due to their strong dependence on other criteria. So these factors will help in increasing the performance. Another study in India was conducted to evaluate the cost and time overrun in government construction projects. The results showed that payment delay by the client, low financial availability to pass the running bill, and delay in payment to the contractor (Roy et al., 2018).

2.5 Project management related factors

Poor project management was ranked as the 9th out of the total factors, and it was categorised under client-related factors (Kamaruddeen et al., 2020). Poor planning, scheduling, and management by consultants, prolonged procedures of inspections by consultants were the main factors for time overrun in construction projects (Johnson and Babu, 2020). Similar study found out that ineffective project planning and contractual arrangement were the main reason for project time overrun (Zafar et al., 2019). Ineffective planning and scheduling of the project, poor site management were the causes

for time overrun (Patil, 2019). Similarly, inadequate contractor's work experience, suspension of work by owner or contractor, unethical behaviour used by contractors to achieve the highest possible level of profit, and discrepancies between contract documents were the top ten factors for time overrun (Patil, 2019). The most important delay category has been identified to scheduling and control related parts of project management. Inadequate planning, safety issues, deficient technical instructions, and inappropriate management approaches (Karami and Olatunji, 2020). Alvanchi et al. (2020) conducted a research study and found among 21 identified risks, nine contract risk responses were found reasonable, nine risk responses were found partial, no contract risk response was found for three risks.

Inadequate planning and scheduling, slow decision making and rain, payment delay by the client, claims, and bureaucracy in client organisation were the top five sources of delay (Seboru, 2015). Financial problems, improper planning, land acquisition, and construction delay, design changes, fewer materials, and equipment supply by contractors, incomplete design are the main sources of delay and cost overrun respectively (Tadewos and Patel, 2018). The primary factors influencing them are the terrible website online management and supervision, troubles with sub-contractors, inadequate planning and scheduling of undertaking, trouble associated with material management, and absence of coordination amongst stakeholders (Subramani and Sivakumar, 2018). Similarly, in Malaysia, the research found that design issues, project management and contract administration, ineffective project planning and scheduling, contractor's site management, financial resource management were the major factors that cause the time overrun (Othman et al., 2017). A study conducted by Deshpande et al. (2020) suggested quantitative, holistic contract award framework for public projects and suggests a measure for performance of oil and gas projects. Large numbers of parameters of contract award and project performance are reduced to significant factors using factor analysis where extraction of components is by PCA. Using these extracted factors and their component score, contract award index (CAI) and project performance index (PPI) are constructed by UNDP indexing method using geometric mean. Study found out eight significant factors and their 32 parameters along with component weight for contract award. A single point CAI is computed using these factors to rank bids. Ten factors and their 45 parameters along with component weight are found out to measure project performance. A single point PPI is computed using these factors to score project performance. Analysis of CAI and PPI revealed percentage variation of project performance due to contract award is 22.8%.

Major factors of consultants are delay in preparation and approval of drawings, Inadequate planning and scheduling, material shortage, change in the scope of the project, cost of rework, inaccurate time and cost estimate, shortage of labour, poor site management, conformance to specification, incomplete design at the time of tender and financial difficulties by the contractor (Sarda and Gupta, 2018). On the other hand, 'lack of maintenance of the equipment', poor procurement programming of materials, strikes, riots and other external factors was the most critical factor that influence project delay (Deshmukh and Menkudle, 2019). The study by Jahromi et al. (2018) is done with the intention of studying interactional function of value engineering and risk management in civil projects while Dallas model is considered as theoretical model. In this study implementation of value engineering and risk management was done in a unified practical way. Findings indicate that implementation of his model in construction phase

of building project will lead to decrease in approximately certain costs as much as 24.77% while project temporary delivery and finalising the project are getting near, decrease rate of final costs will reach 21.32%. After procedures and studying results of tables, it can be concluded that interactional function of risk management and value engineering in this project was accompanied with 7.35% of savings. Furthermore, a study conducted by Raykar and Ghadge (2016) found that, poor site management and supervision, problems with sub-contractors, inadequate planning and scheduling of the project, the problem associated with material management, lack of coordination among stakeholders, etc.

2.6 Design related factors

The site manager's focus should be avoiding the factors that most often are found to cause time-overrun, which are construction design and connecting work that constitutes about 60% of the time-overruns. The major causes of time overrun as design variation, scope changes incomplete drawings, and details provided by the consultant from client and consultant (Johnson and Babu, 2020). The factors that contribute to causing time overrun in a construction project are frequent design changes, impractical and complicated design, and poor design and delays in design (Gopang and Rahman, 2020).

2.7 External related factors

Change in prices of raw materials was ranked 6th out of the total factors, and it was categorised under external factors (Kamaruddeen et al., 2020). The most common causes of time and cost overrun in all types of educational buildings were: Price instability and Price escalation of material. Kähkönen et al. (2018) their study investigated the effect of total cost components, supply management capability and the status of supply management on risk management performance in the context of project business. A survey was conducted to collect data from companies engaged in project business in Finland. Based on the responses from 99 firms, it was found that the strategic status of supply management, supply capability, costs before and after purchasing and project duration have a significant effect on risk management. All the factors if it is studied well it will help in taking the right decisions at the right time (Thomran et al., 2021). This gives a specific indication of where to focus risk management actions. Risk mitigation strategies, however, seem to be systemic in their nature in the sense that simultaneous strategies are probably needed to assure the effective flow of supply. Issues with project organisational structures, political and cultural factors, environmental uncertainties, and complexity in resource management are also found as the causes for time overrun (Karami and Olatunji, 2020).

Therefore, the following research hypotheses were developed based on the literature review:

Ha_1 Material related factors have a significant and positive effect on time performance of road projects in South Wollo Zone and Dessie City administration.

Ha_2 Labour-related factors have a significant and positive effect on time performance of road projects in South Wollo Zone and Dessie City administration.

Ha_3 Equipment related factors have a significant and positive effect on time performance of road projects in South Wollo Zone and Dessie City administration.

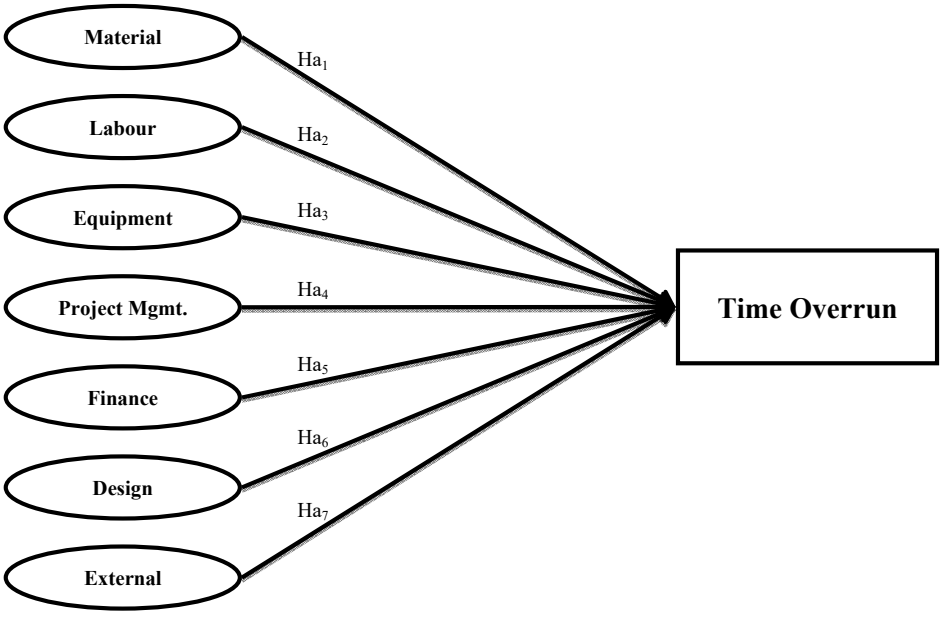
Ha_4 Project management related factors have a significant and positive effect on time performance of road projects in South Wollo Zone and Dessie City administration.

Ha_5 Finance-related factors have a significant and positive effect on time performance of road projects in South Wollo Zone and Dessie City administration.

Ha_6 Design related factors have a significant and positive on time performance of road projects in South Wollo Zone and Dessie City administration.

Ha_7 External related factors have a significant and positive effect on time performance of road projects in South Wollo Zone and Dessie City administration.

Figure 1 Conceptual framework



Source: Developed from the literature (2020)

3 Research methodology

3.1 Research approach

The research approach is the way in which the research objectives can be questioned. The study was carried out through a quantitative and qualitative research approach. The quantitative research approach aims to answer queries of numerical quantification and it gives us a solid foundation for explaining the phenomenon. This type of research technique allows a researcher to find significant factors and the extent to which they are associated. It also allows explanatory assertions and inferences to be made regarding the

sample and population at large. Therefore, the quantitative research was chosen for this study to know the relationship, significance, and influence of selected factors on the cobblestone project time overrun.

3.2 Research design

The research design provides a plan or framework for data collection and its analysis. This research adopted explanatory type of research design. An explanatory type of research design was used to find out the relationship, significance and influence of the independent variables on time overrun of cobblestone and canal projects. The research also conducted using a cross-sectional survey research design through the use of questionnaires to obtain primary data at a single point of time.

3.3 Population and sample size

3.3.1 Population of the study

The research population was drawn from enterprises that are participating in South Wollo and Dessie City administration cobblestone paving and canal contractors and client. Based on the information obtained from each office and enterprise, there are 155 employees in the urban development and construction agency, and 465 employees who participated in 2019 and 2020 GC road constructions (cobblestone paving, and canal enterprises). The total population of the study was 620 employees and managers. A total of 51 projects were completed in these years from these 17 projects were canal and the remaining 34 were cobblestone projects.

3.3.2 Determination of sample size

To determine the sample size the study areas were selected purposively based on their size of investment on the road project and their convenience for the researchers. The size of the sample reflects the degree of being representative of the entire population from which it is drawn and how confidently researchers can make a generalisation of the research findings. The sample size of this study was determined using Bartlett's (1954) formula for the finite population:

$$n = \frac{\frac{Z^2 * (P(1-P))}{e^2}}{1 + \frac{\left(Z^2 * (P(1-P))\right)}{e^2 N}}$$

where

n is the required sample size

P is the percentage occurrence of a state or condition (50%)

E is the percentage maximum error required (3%)

Z is the value corresponding to level of confidence required (95% or 1.96).

$$\frac{\frac{1.96^2 * 0.5 * 0.5}{0.03^2}}{1 + \frac{1.96^2 * 0.5 * 0.5}{0.03^2 (620)}}$$

The sample size given the population of 620 was 392 respondents.

3.4 Sampling technique

Firstly, purposive sampling was used by the researchers to select three sample areas (Dessie City administration, Kombolcha Town and Haike Town) from the total areas of the study. Secondly, to select sample respondents from a total of 51 canal and cobblestone projects which is completed in 2019 and 2020 GC, (11 samples from 17 total canal projects) and (25 from 34 total cobblestone projects) a total of 36 projects were included using a stratified sampling method. Thirdly, from the total population of 620 respondents, 98 employees from client organisations and 294 contractor respondents participated in three different case study areas. A stratified sampling technique was applied to select the final sample so that everyone in the target population. To select the final respondent from each strata proportional sampling method was applied.

3.5 Data gathering methods

To achieve the objective of the study, the researchers used primary data. Primary data was obtained through closed-ended questionnaires and semi-structured interviews. A self-administered questionnaire comprising of 5-point Likert scale was used. This helps to get a standardised and honest answer/opinion of the respondent and it allows the respondent to fill the questioner at the connivance of the respondent. A questionnaire was designed using existing questions used in the previous study for time overrun analysis (Doloi et al., 2012). The questionnaire was used because of its appropriateness to gather relevant information, opinions, and attitudes from many numbers of respondents within a less period of time (Ahmed and Ahmed, 2021).

3.6 Validity and reliability of the instrument

3.6.1 Validity of the instrument

The validity of a questionnaire refers to the extent to which it measures what it claims to measure. It is the degree to which results obtained from the analysis of the data represent the phenomena under the study. To ensure the validity of the study the researchers used content criterion to evaluate the questioner whether it contains different factors (material, equipment, labour, project management, financial, design, and external related factors) and performance indicators that measure the performance of the cobblestone and canal projects. In addition to this, the researchers distributed a pilot test before the instrument is distributed to the respondents. As a result of the response from the pilot study, some content modification was made. Finally, the researchers made a personal evaluation of the variables and criteria and try to get advice from peers and experts from the subject matter. Kline (2011) proposed a two-step model-building approach to structural equation modelling (SEM), develop a measurement model and test its validity, and then develop a

structural model and test its validity. The following six goodness-of-fit (GOF) indices were used to validate the measurement and structural models: chi-square (CMIN), a value closer to zero, indicating non-significance, would indicate a good fit; goodness-of-fit index (GFI), it ranges between 0 and 1, with a cut-off value of 0.9 generally indicating acceptable model fit; root mean square error of approximation (RMSEA), ranges from 0 to 1, with lower values indicating better model fit, and a value of 0.06 or less being indicative of acceptable model fit; normed fit index (NFI), the values for the NFI should range between 0 and 1, while Hair et al. (2010) recommend a level of 0.90 or above as indicating a good model fit; Tucker-Lewis index (TLI), the value of 0.90 or above as indicating a good model fit; comparative fit index (CFI), it range from 0 to 1, with higher values indicating better fit, while a value of 0.90 or above is generally considered to indicate acceptable model fit. All these goodness of fit indices were found satisfactory for the model.

3.6.2 Reliability of the instrument

Mugenda and Mugenda (2003) suggest that the piloting sample should represent 10% of the study sample depending on the study sample size. As a result, sample sizes of 30 questioners were distributed in the selected case study areas. The piloting test helped revealing vague questions that allow for their review until they convey the same meaning to all the subjects. Besides, the researchers used a Cronbach's alpha test to measure the reliability of the instrument. A construct composite reliability coefficient (Cronbach's alpha) of was above 0.817, for all the constructs, was considered to be adequate for this study.

3.7 Data analysis techniques

The researchers used both qualitative and quantitative data. Quantitative data was coded and entered into Statistical Packages for Social Scientists (SPSS Version 25 and Amos 26) and analysed using descriptive and inferential statistics.

Structural equation modelling (SEM) using AMOS 26 has been used for path coefficient modelling due to its capability of testing the effects of several interaction items (Lowry and Gaskin, 2014). According to Hair et al. (1998), SEM refers to a multivariate technique combining aspects of multiple regression and factor analysis to estimate a series of interrelated dependence relationships simultaneously. To achieve the above purpose of SEM, the following are the main stages of the approach that were conducted in this study:

Stage 1 The development of a theoretical model: This initial stage involves using all available relevant theory, research and information to construct the theoretical model of the construct (Hair et al., 1998).

Stage 2 Constructing a path diagram of causal relationships: It is essential to specify the relationships between the relevant variables describing the phenomenon of study; using graphs with one-headed arrows indicating causal relationships or two-headed arched arrows indicating mutual dependencies (correlation) (Kline, 1998).

Stage 3 Converting the path diagram into a set of structural and measurement models.

Stage 4 Choosing the input matrix type and estimating the proposed model and assessing the identification of the structural model. A correlation matrix was used because the purpose of this study was to explore the pattern of interrelationships between the latent and manifest variables (Hair et al., 1998). Once the structural and measurement model have been specified and the input data selected, the AMOS technique of the SPSS computer program can be used to actually estimate the model. The goodness-of-fit of this model is assessed for the overall model and the proposed model is verified and required modifications of the model are explored.

Stage 5 The evaluation of goodness-of-fit (GFI): The GFI statistics determine if the data fit the model (Hair et al., 1998), focusing on the degree to which the specified indicators represent the hypothesised constructs. It also evaluates each construct to examine the indicator loadings for statistical significance and to assess the construct's reliability and variance extracted. The following five indices are used to evaluate the model. Firstly, goodness-of-fit index (GFI) meaning a value of 0 reflects no fit, while a value of 1 is a perfect fit and values close to 0.90 reflect an acceptable fit. Secondly, normed fit index (NFI) indicating a value of 0 reflects no fit, while a value of 1 is a perfect fit and values close to 0.90 reflect an acceptable fit. Thirdly, incremental fit index (IFI) indicates that a value of 0 reflects no fit, while a value of 1 is a perfect fit and values close to 0.90 reflect an acceptable fit. Fourthly, comparative fit index (CFI) is a value of 0 reflects no fit, while a value of 1 is a perfect fit and values close to 0.90 reflect an acceptable fit. Lastly, roots mean squared error of approximation (RMSEA) indicating that a value of 0.05 represents a close approximate fit; values between 0.05 and 0.08 suggest a reasonably approximate fit and values greater than 0.10 suggest a poor fit.

Stage 6 Interpreting and modifying the mode: This is the final stage of SEM and it entails interpreting and modifying the model. According to Hair et al. (1998), possible modifications to the proposed model may be indicated through examination of the normalised residuals and the modification indices. The modification index from AMOS exists for each fixed parameter in the model and it is used to estimate or predict improvement in the model fit by setting the parameters free (Hair et al., 1998).

The study also employed a multivariate regression model to study the influence of independent variables on time overrun of road projects. The regression method is useful for its ability to test the nature of the influence of independent variables on a dependent variable.

Regression can estimate the coefficients of the linear equation, involving one or more independent variables, which best predicted the value of the dependent variable.

The regression models are as follows:

$$Y_t = \beta 0 + \beta 1X1 + \beta 2X2 + \beta 3X3 + \beta 4X4 + \beta 5X5 + \beta 6X6 + \beta 7X7 + \varepsilon$$

where

- Y_t – projects time variance
- β0 – constant term
- β1, β2, β3, β4, β5, β6 and β7 – beta coefficients
- X1 – labour related factors
- X2 – material related factors
- X3 – equipment related factors
- X4 – finance related factors
- X5 – project management related factors
- X7 – external environment related factors;
- ε – error term.

4 Data analysis and discussion

4.1 Demographic statistics of the respondent

Table 1 shows that 269 (72.3%) of the respondents had undergraduate degrees, 87 (23.4%) had Diploma and the remaining 16 (4.3%) of the respondents were Master's degree holders. Thus the minimum level of education of the respondents was diploma level. These results as shown in the table above indicate that the majority of respondents were well learned. Accordingly, they can fill a self-administered questionnaire easily.

Table 1 Respondents' profile

		Frequency	*Percent*	*Cumulative percent*
Education	Diploma	87	23.4	23.4
	Degree	269	72.3	95.7
	Masters	16	4.3	100.0
	Total	372	100.0	
Experience	1 to 3 years	211	56.7	56.7
	3 to 6 years	50	13.4	70.2
	6 to 9 years	88	23.7	93.8
	Greater than 9 years	23	6.2	100.0
	Total	372	100.0	
Type	Client	91	24.5	24.5
	Contractor	281	75.5	100.0
	Total	372	100.0	
Engage	Cobblestone	245	65.9	65.9
	Canal	127	34.1	100.0
	Total	372	100.0	

Source: Own research survey (2020)

Table 1 shows that 211 (56.7%) of the respondents have experienced less than 3 years at construction works and 50 (13.4 %) of the respondents experience between 3 to 6 years, 88 (23.7 %) of respondents have experience from 6 to 9 years and 23 (6.2 %) who have experience more than 9 years. This shows that the respondents are less experienced on cobblestone and canal construction, it may affect the performance of road construction in South Woll and Dessie City administration.

Table 1 shows the type of respondents' organisation: In this study, 281 (75.5%) contractors, and 91 (24.5%) clients have participated in the questionnaire. The general response rate for contractors and clients was 94.9 % and the total numbers of respondents for the two parties were 372 respondents. It implies that the client and contractor respondents were taken from each construction projects it is sufficient to find out the important factors influencing the road project in South Wollo and Dessie City administration.

Table 1 shows the type of project the respondents engaged in: In this study, 127 (34.1%) of the respondents were engaged in canal construction, and the remaining 245 (65.9%) have participated in cobblestone construction. It implies that most of the respondents were from cobblestone construction and it is the main source of employment opportunity for the respondents.

4.2 Correlation analysis

The results in Table 2 indicated that there is a positive and significant correlation among labour related factors with time variance (r = . 537**, p < 0.000). According to Hair et al. (2010), magnitude of the correlation, the relationships among the variables are moderate. Similar result also revealed by Gunduz and Maki (2018) and Meena and Suresh (2015). The correlation among equipment related factor with time variance was positive and significant (r = 0.466**, p < 0.000). According to this result, moderate and statistically significant positive correlations are found among equipment with time variance. The result also supported by Berhanu (2018) and Deshmukh and Menkudle (2019).

Table 2 Correlation analysis

Correlations										
		Labour	*Equipment*	*Material*	*Finance*	*Project*	*Design*	*External*	*Time*	*Cost*
Time variance	Pearson correlation	.537**	.466**	.459**	.557**	.561**	.534**	.507**	1	.697**
	Sig. (t-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000
	N	372	372	372	372	372	372	372	372	372

Note: **Correlation is significant at the 0.01 level (2-tailed).

Source: Own research survey (2020)

The result showed in Table 2 the material related factors was positive and significantly correlated with time variance of a projects (r = 0.466**, p < 0.000). According to this result, moderate and statistically significant positive correlations are found among material related factors with time and cost variance. Similar results have been revealed (Ullah et al., 2018; Subramani and Sivakumar, 2018). A statistically significant and positive correlations are found among finance related factor and time variance with

(r = 0.557**, p < 0.000). The result supported by similar studies conducted by Kazaz (2012) and Johnson and Babu (2020). A positive and statistically significant correlation between project related factor with time variance with (r = 0.561**, p < 0.000). Similar results have been revealed by Sohu et al. (2018) and Gunduz and Maki (2018).

The results indicated that there are a positive and statistically significant correlation between design related factor with time with (r = 0.534**, p < 0.000). According to this result, moderate and statistically significant positive correlations are found between project related factors with variance. Similar results have been revealed (Berhanu, 2018; Divya and Ramya, 2015). The results indicated that there is a positive and significant correlation among external related factors with time and cost variance (r = –0.507**, p < 0.000) and (r = –0.572**, p < 0.000) respectively. The result supported by Meena and Suresh (2015), Gunduz and Maki (2018) and Derakhshanalavijeh and Teixeira (2017). A positive and statistically significant correlation between time variance and cost variance with (r = 0.697**, p < 0.000). According to this result, a moderate and statistically significant positive correlations was found between time variance and cost variance.

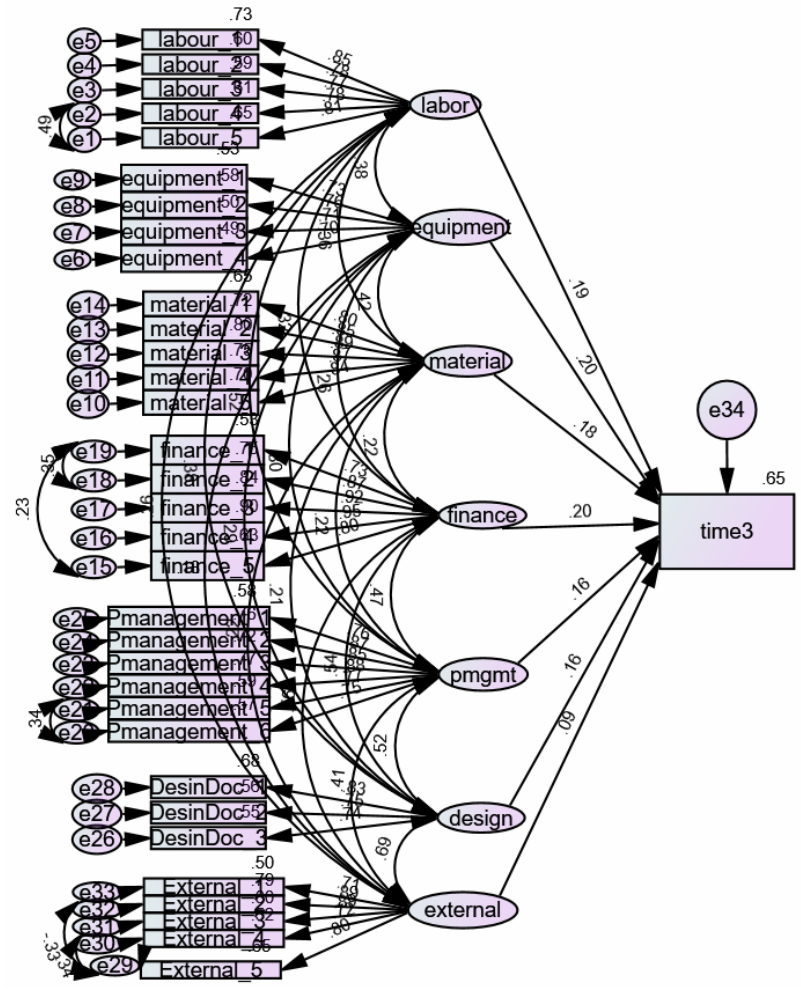
4.3 Assessment of the structural model for time variance

The measurement model had adequate findings; therefore, the researchers continued with the assessment of the structural model. The complete effect size and variance explained in the dependent (time variance) construct for the structural model is measured through the coefficient of determination (R^2), which measured the explanatory power of the model and its value is 0.65. This means 65% of the variance in the endogenous variable is explained by the exogenous variables in the model that directly pointed towards it. Though there is no 'cut-off' rule to determine the coefficients explanatory power, Chin (1998) considers values of approximately .65 as substantial, .33 as an average, and .19 and lower as weak coefficients. The result showed that the R^2 value was .65 in the current study, as illustrated in Figure 2. This implies that the seven exogenous latent constructs such as labour, material, equipment, finance, project management, design, and external environment-related factors considerably explain 65.0% of the variance in the time overrun. As suggested by Chin (1998), the R^2 value in the current study was substantial.

The evaluation of the path coefficients was the next important analysis to validate the theoretically assumed relationship between the latent variables. Individual path coefficients of the structural model can be interpreted as standardised beta coefficients and it was mandatory to check the path coefficient's algebraic sign, magnitude, and significance for complete empirical validation (Lowery and Gaskin, 2014). Similar algebraic sign with a priori postulated algebraic signs provide partial empirical validation of the theoretically assumed positive relationships between the independent and dependent variables. If it is in the contrary, the assumed hypothesis is not supported. As it is shown in Figure 2 the path coefficient between the independent (latent variables) and the dependent variables were have a positive relationship. The absolute magnitude of the path coefficient indicates the relationship strength between the independent and dependent variables. The path coefficients should exceed .1 to account for a certain impact within the model. Furthermore, the path coefficients should be significant at least at .05 (Henseler et al., 2009). Accordingly, the path coefficient of material (0.18), equipment (0.20), project management (0.16), finance (0.20), and design (0.16) had positive and strong relationship with time variance of a project. It supported the stated

hypothesis. But the path coefficient between external factors and time variance was 0.09 which is weak and not strong enough to support the hypothesis.

Figure 2 AMOS graphics output for the structural model with the time variance (see online version for colours)



Source: Own research survey (2020)

The above figure only depicts estimates for the hypothesised direct effects and R^2 values, and do not indicate which paths are significant. Due to this reason, the parameter estimates, standard errors, t-values, and p-values are generated from the model and it is presented in Table 2. All the figures and tables provide results about the hypothesised direct effects in the study.

4.4 The regression weights

The results depicted in Table 3 pertain to the seven hypothesised relationships tested in the time variance Model. The analysis of the paths in the model reveals that the direct effects of labour-related factors on time variance was significant at $p < 0.05$ level. When the labour-related factors increased by 1 unit, the time variance will increase by 2.83 days with a standard error of 0.659. And the regression weight estimate is 4.297 standard error above zero. The regression weight estimate for labour-related factors in the prediction of time variance is significantly different from zero at the 0.001 level. This result supports the hypothesis of labour related factors have a significant positive effect on-time performance of road projects in South Wollo and Dessie City administration. Previous researches works confirm the same results, and they found out that, labour supply, labour shortages, lack of experience, labour incompetence were identified as the most important delay factors (Le-Hoai et al., 2008; Sambasivan and Soon, 2007).

Table 3 The regression weights for exogenous variables in predicting time variance

Path		*Path*	*Stand. beta*	*Unstandardised beta value*	*S.E*	*C.R (t-value)*	*P-value*	*Result*
time3	←	Labour	0.194	2.83	0.659	4.297	***	Significant
time3	←	Equipment	0.2	3.068	0.683	4.492	***	Significant
time3	←	Material	0.184	2.829	0.611	4.629	***	Significant
time3	←	Finance	0.2	3.903	0.872	4.477	***	Significant
time3	←	Pmgmt	0.158	2.764	0.812	3.404	***	Significant
time3	←	Design	0.165	4.021	1.515	2.655	0.008	Significant
time3	←	External	0.088	1.662	1.021	1.627	0.104	Not significant

Source: Own research survey (2020)

The analysis of the paths in the model also reveals that the direct effects of equipment related factors on time variance was significant at $p < 0.05$ level. When the equipment related factors increased by 1 unit, the time variance will increase by 3.068 days with a standard error of 0.683. And the regression weight estimate is 4.492 standard error above zero. The regression weight estimate for equipment related factors in the prediction of time variance is significantly different from zero at the 0.001 level. As a result, the hypothesis of Equipment related factors has a significant positive effect on the time performance of road projects in South Wollo and Dessie City administration is supported. Similar results have been revealed by Berhanu (2018) and Ren and Jones (2008) and they found that equipment breakdowns, shortage of equipment, low level of equipment operators' skill, low productivity and efficiency of equipment, lack of high-technology mechanical equipment, wrong selection.

When the material related factors increased by 1 unit, the time variance will increased by 2.829 days with a standard error of 0.611. And the regression weight estimate is 4.629 standard error above zero. The regression weight estimate for material related factors in the prediction of time variance is significantly different from zero at the 0.001 level. Based on this, the hypothesis of material related factors has a significant positive effect on the time performance of road projects in South Wollo and Dessie City administration is supported. It is found that the most common factors of delay which is repeated in most

of the project are the price of materials, material shortage, material changes, the availability and usage of materials (Kazaz, 2012; Sambasivan and Soon, 2007).

When the finance-related factors increased by 1 unit, the time variance will increased by 3.903 days with a standard error of 0.872, and the regression weight estimate is 4.477 standard error above zero. The regression weight estimate for finance-related factors in the prediction of time variance is significantly different from zero at the 0.001 level. The hypothesis of Finance- related factors has a significant positive effect on the time performance of road projects in South Wollo and Dessie City administration is supported. The result is in line with previous researchers. lack of funds to finance the project to completion, contractor's financial problems, poor cost estimates, financial capabilities, late payments, financial difficulties, were found as a major determinant of project delay (Meena and Suresh, 2015; Kazaz, 2012; Le-Hoai et al., 2008).

When the project management related factors increased by 1 unit, the time variance will increase by 2.764 days with a standard error of 0.812, and the regression weight estimate is 3.404 standard error above zero. The regression weight estimate for project management related factors in the prediction of time variance is significantly different from zero at the 0.001 level. The hypothesis of project management related factors has a significant positive effect on the time performance of road projects in South Wollo and Dessie City administration is supported. Previous similar studies also revealed that, poor site management and supervision, project management knowledge, inefficient contractor management, poor project planning (Amir and Shadab, 2014).

When the design related factors increased by 1 unit, the time variance will increased by 4.021 days with a standard error of 1.515, and the regression weight estimate is 2.655 standard error above zero. The regression weight estimate for design related factor in the prediction of time variance is significantly different from zero at the 0.01 level. The research hypothesis of design related factors have a significant positive effect on-time performance of road projects in South Wollo and Dessie City administration also supported. Delay in approval of design documents, delay in producing design documents, design team experience, changes in design/design error, poor design, late in revising and approving design documents by owner, mistakes, and discrepancies in design documents, Inaccurate contract quantity, and design problem (Berhanu, 2018; Divya and Ramya, 2015).

When the external environment-related factors increased by 1 unit, the time variance will increase by 1.662 days with a standard error of 1.021 and the regression weight estimate is 1.627 standard error above zero. The regression weight estimate for external related factors in the prediction of time variance was found insignificant. As a result, the hypothesis of External related factors has a significant positive effect on the time performance of road projects in South Wollo, and Dessie City administration was not supported. This result was in contrary with previous researches work (Meena and Suresh, 2015).

From the seven exogenous variables, finance-related factors found the most important determinants of time overrun. And the regression model for the time variance was developed.

$$Y_t = \beta 0 + \beta 1X1 + \beta 2X2 + \beta 3X3 + \beta 4X4 + \beta 5X5 + \beta 6X6 + \beta 7X7 + \varepsilon$$

$$\text{Time variance} = -32 + 2.83X1 + 3.068X2 + 2.829X3 + 3.903X4 + 2.764X5 + 4.021X6$$

5 Conclusions and recommendations

The SEM result showed labour, equipment, material, finance, project management, and design have a positive and significant effect on the time variance of cobblestone and canal projects. This implies that labour related factors were one of the important factors for time variance of projects.

- The client organisation and management recommended allocating adequate financial resources, promote timely disbursement and enhance procurement to ensure all resources required for project implementation are provided just in time. This helps to overcome the shortage of equipment, material and labour resources.
- Contractors are recommended to have a proper planning and good site management system in the different activities of the project to avoid any mistakes that may lead to rework of activities, resulting in time overrun. To perform site management and supervision accordingly administrative and technical personnel should be assigned as soon as the project is awarded to make arrangements to achieve completion within specified time and cost. They should also ensure that time estimated for the project is not superseded.
- Before the construction starts the client has to fulfil all the requirements of delivering the site. Failure to deliver the site will affect time performance.
- Human resource capacity, technical and financial feasibility be carried out before implementation of cobblestone and canal projects to avoid project from stalling midway by ensuring there are adequate funds and sufficient personnel.
- The client organisation is recommended giving attention to quality of the project design as well as to do deep investigation during the preparation of design, which overcomes errors in the specification, drawing, and design. They are recommended minimising change in scope of project and to give prompt responses whenever there is a change in the scope of a project.

6 Implication of the study

The firms can build strategies in managing cobblestone and canal projects while focusing on project time overrun factors and their effects. The study will help in reducing conflict between client and contractors through timely project progress update to reduce conflicts. It will guide the clients and concerned bodies in analysing the capability of contractors carefully to handle the project. The study gave ore attention to handle materials and know the effect of change management in place, which ensures the smooth supply of materials in various project phases. In addition to that, the mitigation measures provided in this research serves as a checklist of best practices and will aid project managers and professionals to control delay causes and improve construction project delivery. There will be aware of the time delay factors that can result in the delay of projects right from the inception phase to project closing.

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Availability of data and material

The datasets used and analysed during the current study are available from the corresponding author and you can get any time on your request.

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