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CAUSES OF TIME OVERRUN IN ROAD CONSTRUCTION PROJECTS

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Time overrun is a situation in which construction project exceeds the specified completion date or the period agreed upon by the parties for handover. The concept is also known as overtime and has become a major problem for most construction projects worldwide due to significant waste and missed opportunities for several relevant stakeholders. Therefore, this study aimed to determine the causes of time overrun and mitigate time overrun in road construction projects. The method used includes interviews and questionnaires, which were subjected to focus group discussions (FGDs) with several experts before distribution to competent parties in construction sector. The data collected were analyzed using exploratory factor analysis to ensure accuracy and for optimization. A total of 132 questionnaires were answered correctly and returned. The results identified 7 factors affecting time overrun, which included (1) politics and government, (2) finance and planning, (3) management, (4) resources, (5) delays and errors, (6) projects, and (7) others. A total of 17 causes were also observed including political situations, political interference, economic determinants, land disputes, and late payments for additional work by the owner, followed by 12 other causes. Moreover, mitigation efforts were recommended to prevent and reduce the causes of project time overrun.

Keywords: causes of time overrun, road construction projects, exploratory factor analysis, time overrun, time overrun mitigation

HIGHLIGHTS

- This study analyzed the causes of time overrun in road construction projects using focus group discussions (FGDs) and questionnaires, with the data analyzed using exploratory factor analysis (EFA).
- The study was conducted in Indonesia in three provinces of Jakarta, West Java, and Banten.
- The results showed seven of the ten variables studied including (1) politics and government, (2) finance and planning, (3) management, (4) resources, (5) delays and errors, (6) projects, and (7) others affected time overrun.
- Time overrun mitigation was implemented by considering these seven variables which led to 17 causes of time overrun.

1 Introduction

1.1 Background

Time overrun is a situation when a construction project exceeds the specified completion date or the period agreed upon by the stakeholders for the handover [1]. The concept is also called overtime and has become a major problem for most construction projects worldwide. However, the nature and causes of overtime vary between developing and developed countries [2, 3]. An example of a developing country is Indonesia which is urgently committed to increasing quality employment, promoting entrepreneurship, developing creative industries, and continuing infrastructure development. The need to ensure the continuous development of the infrastructure in Indonesia requires special attention to the varying nature and causes of time overrun in line with previous observation of [4] in [5]. The study by [4] identified factors contributing to project overtime in Ghana, which included late payments to contractors or suppliers, lack of funding from sponsors or clients, order variations, and poor financial or capital market conditions. Moreover, the variation in the duration of construction projects from start to completion has become very important recently in Ghana, specifically among clients and other stakeholders. This was observed to be due to rising interest rates, inflation and other commercial pressures, development plan targets, and other factors [3]. Project time overrun leading to cost overrun has become common in the public sector [5] in [3]. Another study showed that schedule overrun in construction projects in South Africa was caused by late decision-making, late material delivery, shortage of skilled equipment operators, low productivity levels, and delays in obtaining permits from the government [6]. Furthermore, the study conducted in Addis Ababa, Ethiopia, reported that time overrun occurred due to consultant delays and inaccurate contract durations [7]. Rachid et al. [8] also showed that the five main causes of time overrun in Algeria included slow change orders and unrealistic project durations.

1.2 Research gap

The literature review shows that several studies have documented the causes of time overrun project, but none have focused on road construction projects and road construction project mitigation. Therefore, this study aims to identify the causes of road construction project delays in Indonesia with a particular focus on DKI Jakarta, West Java, and Banten with the help of EFA and targeted mitigation. The socio-economic conditions in Indonesia, which have a fairly high population density with a low economic level and the geography of DKI

Jakarta, Banten, and West Java which is prone to flooding and natural disasters that differ from other regions in Indonesia, cause road projects to always be a problem every year.

2 Methodology

The process was initiated through the review of previous studies on road construction project time overrun followed by the conduct of focus group discussions (FGDs) and interviews with construction experts. The trends identified from the discussions were used to draft a questionnaire which was subsequently distributed to relevant parties. A Likert scale ranging from 1 to 6 which represented "very uninfluential" to "very influential" was used to design the responses to the question items. Furthermore, exploratory factor analysis was used to analyze the data with the aim of determining the structure and latent factors causing time overrun on road construction projects in Indonesia. The method has been previously applied in several studies [10-14]. The preference for the method was because the data obtained exceeded 100 responses [15]. The standard EFA (Exploratory Factor Analysis) procedures applied were data suitability assessment, factor extraction method determination, factor rotation justification, interpretation, and reliability check [16]. A previous study by [17] used EFA to identify the causes of time overrun in free-standing building construction projects.

2.1 Dimensional exploration

An in-depth investigation was conducted to examine different dimensions contributing to time overrun in construction projects. The process led to the identification of 49 causes with 10 variables, followed by FGDs with seven construction experts consisting of three contractors and four consultants to ensure none considered relevant to Indonesian context were overlooked.

2.2 Questionnaire draft

Questionnaire draft was generated from several sources, including [3]; [18-23]; [7-8]; The product of the drafting process is presented in the following Table 1 with a total of 49 causes identified.

Table 1. Causes of time overrun that have been validated by experts

Num	Causes of Time Overrun	Source
1	Financial problems, late payments	[3]
2	Unrealistic durations imposed by the owner	[3]
3	Poorly defined scope	[3]
4	Owner-initiated variations	[3]
5	Owner intervention	[3]
6	Underestimation of project costs	[3]
7	Poor inspection/supervision	[3]
8	Poor contract management	[3]
9	Slowness in providing instructions	[3]
10	Underestimation of project complexity	[3]
11	Financial problems (difficulty accessing credit)	[3]
12	Poor site management	[3]
13	Construction methods	[3]
14	Poor preparation and planning (material/labor estimation)	[3]
15	Financial problems faced by the contractor	[21,22]
16	Inexperienced contractor	[21]
17	Delays in material supplies	[21,22]
18	Poor project management	[21]
19	Design errors	[21]
20	Weather conditions	[21,22]
21	Skilled labor shortage	[21]
22	Slow change orders	[8]

Num	Causes of Time Overrun	Source
23	Slow variation orders for additional quantities	[8]
24	Poor planning and scheduling	[8]
25	Delays in the settlement of contractor claims by the owner	[2]
26	Delays in payment for additional work/variations by the owner	[2]
27	Delays in payments from contractors to subcontractors or suppliers	[2]
28	Variation orders/scope changes by the owner during construction	[2]
29	Political situation	[23]
30	Governance	[23]
31	Economic determinants	[23]
32	Project determinants	[23]
33	Designs that do not meet the client and consultant's wishes	[18]
34	Unrealistic schedules and completion dates were projected by the client	[18]
35	Delays in obtaining government permits and approvals	[18]
36	Change orders by the owner	[18]
37	Consultant reluctance	[7]
38	Inaccurate contract duration estimates	[7]
39	Delays in approvals and decision-making	[7]
40	Slow labor mobility	[7]
41	Lack of enforcement of contract provisions	[20]
42	Political interference	[20]
43	Construction design	[19]
44	Connecting works	[19]
45	External conditions	[19]
46	Labor	[19]
47	Components and materials	[19]
48	Space	[19]
49	Equipment and machinery	[19]

Several meetings were conducted with the experts led to the drafting of a more suitable and appropriate questionnaire. This led to the reduction of the causes to 36, with 10 variables related to road construction projects as presented in Table 2.

Table 2. Causes of time overrun that have been validated by experts (final)

Num	Causes of Time Overrun	Source	Variable
1	Financial issues such as late payments	[3]	1. consultant
2	Poor inspection/supervision	[3]	1. consultant
3	Poor contract management	[3]	1. consultant
4	Design errors	[21]	1. consultant
5	Poor project management	[22]	1. consultant
6	Design that does not meet client and consultant expectations	[18]	1. consultant
7	Unrealistic contract durations imposed by the owner	[3]	2. owner
8	Poorly defines scope	[3]	2. owner

Num	Causes of Time Overrun	Source	Variable
9	Owner intervention	[3]	2. owner
10	Delayed approvals and late decision making	[22]	2. owner
11	Underestimating the complexity of the project	[3]	3. contractor
12	Financial issues (difficulty accessing credit)	[3]	3. contractor
13	Construction methods	[3]	3. contractor
14	Poor preparation and planning (material/labor estimation)	[3]	3. contractor
15	Financial issues faced by the contractor	[21-22]	3. contractor
16	Inexperiences contractor	[22]	3. contractor
17	Delays in the settlement of contractor claims by the owner	[2]	4. financial
18	Delays in payments for additional work/ variations by the owner	[2]	4. financial
19	Delays in payments from contractors to subcontractors or suppliers	[21]	4. financial
20	Shortage of skilled labor	[21]	5. workforce
21	Slow labor mobilization	[22]	5. workforce
22	Political situations are causing regulatory changes	[23]	6. government
23	Delays in obtaining government permits and approvals	[18]	6. government
24	Political interference	[20]	6. government
25	Slow handling of change orders	[21]	7. Management contract
26	Variation orders/scope changes by the owner during construction	[19]	7. Management contract
27	Lack of enforcement of contract provisions	[22]	7. Management contract
28	Weather conditions	[21-22]	8. External
29	Natural disasters	[18]	8. External
30	Delays in material supplies	[21-22]	9. Resource
31	Connecting works	[19]	9. Resource
32	Labor	[19]	9. Resource
33	Equipment and machinery	[19]	9. Resource
34	Economic determinants	[23]	10. The others
35	Project determinants	[23]	10. The others
36	Land disputes	New	10. The others

3 Results and discussion

3.1 Respondent characteristic

Questionnaire was distributed and 132 were returned with respondents identified to include 39 having a master's degree (29.05%) and 93 with a bachelor's degree (70.04%). Based on work experience, 48% had less than 5 years and 52% had between 5 and 10 years. The trend showed that respondents with 5-10 years of experience provided more input for this study.

3.2 Exploratory factor analysis

EFA was used to reduce the causes of time overrun and determine the most significant factors. The analysis showed Kaiser Meyer Olkin (KMO) value of 0.709, which was considered to be better than the 0.5 required to establish

sample adequacy. Moreover, the Bartlett's test produced 2720.962 at a significance of 0.00 to reflect the necessary significant difference in variance [15], [24].

Table 3. KMO Barlett's test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.709
Bartlett's Test of Sphericity	Approx. Chi-Square	2720.962
	df	300
	Sig.	.000

A total of 12 causes of time overrun with Measuring Sampling Adequacy (MSA) value below 0.5 were removed to reduce the number to 24 from 36. The 24 causes were further retained after the communality extraction analysis because the results showed values that exceeded 0.5. Further tests through established factorability, root criterion of varimax orthogonal rotation, and principal component analysis led to the identification of seven basic factors, latent constructs or variables which accounted for 77.125% of the total variance explained.

Table 4. Total variance explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.988	33.282	33.282	7.988	33.282	33.282	3.839	15.995	15.995
2	2.950	12.290	45.572	2.950	12.290	45.572	3.564	14.848	30.843
3	2.184	9.098	54.670	2.184	9.098	54.670	2.895	12.062	42.906
4	1.645	6.855	61.526	1.645	6.855	61.526	2.375	9.897	52.802
5	1.436	5.982	67.508	1.436	5.982	67.508	1.985	8.271	61.073
6	1.249	5.204	72.712	1.249	5.204	72.712	1.931	8.047	69.120
7	1.059	4.413	77.125	1.059	4.413	77.125	1.921	8.005	77.125
8	.844	3.518	80.643						
9	.721	3.004	83.648						
10	.585	2.437	86.085						
11	.559	2.330	88.415						
12	.519	2.162	90.577						
13	.423	1.761	92.338						
14	.383	1.596	93.934						
15	.313	1.305	95.240						
16	.274	1.143	96.382						
17	.206	.860	97.242						
18	.182	.758	98.000						
19	.123	.512	98.512						
20	.116	.484	98.996						
21	.084	.349	99.345						
22	.070	.290	99.635						
23	.052	.216	99.851						
24	.036	.149	100.000						

Extraction Method: Principal Component Analysis

The eigenvalue for factor 1 is 33.852%, factor 2 is 12.290%, factor 3 is 9.098%, factor 4 is 6.855%, factor 5 is 5.982%, factor 6 is 5.204%, and factor 7 is 4.413% as presented in Table 4. The trend shows that the values for the seven factors are greater than 1 so that there are 17 variables that are part of the 7 factors and the other 7 variables remain in the 7 factors as well so that there is a total of 24 variables that are combined in the 7 factors. Furthermore, the factor matrix after rotation is presented in Table 5.

Table 5. Grouping of results after the component matrix was rotated for the factors

Group/Factors	Politics and government	Finance and planning	Management	Resource	Project	Delays and errors	The others
Political situation	X6.3 (0,894)						
Political interference	X6.2 (0,860)						
Economic Determinants	X10.1 (0,839)						
Land disputes	X10.3 (0,833)						
Additional work delays		X4.2 (0,790)					
Late payments from contractors to subcontractors		X4.3 (0,763)					
Connecting Works		X9.2 (0,678)					
Scope variation/change order		X7.2 (0,629)					
Slow handling of change orders		X7.1 (0,620)					
Poor preparation and planning		X3.4 (0,576)					
Poor contract management			X1.3 (0,897)				
Poorly defined scope of work			X2.2 (0,699)				
Labor productivity			X9.3 (0,615)				
Poor project management			X1.5 (0,542)				
Skilled labor shortage				X5.1 (0,701)			
Equipment and machines				X9.4 (0,679)			
Inexperienced contractor				X3.6 (0,572)			
Financial problems (difficulty accessing credit)					X6.2 (0,746)		
Underestimating project complexity					X1.4 (0,729)		
Delay in obtaining permits						X3.2 (0,853)	

Group/Factors	Politics and government	Finance and planning	Management	Resource	Project	Delays and errors	The others
Error in design						X3.1 (0,593)	
Slow labor mobilization							X5.2 (0,746)
Natural disaster conditions							X8.2 (0,729)
Delay in the settlement of contractor claims							X4.1 (0,531)

3.3 Factors formed (established variables)

The seven factors identified in the analysis are politics and governance, finance and planning, management, resources, delays and errors, projects, and others. Each of these factors is further explained in the following subsections. Of the 24 variables identified, 17 were selected because seven of them had values below 0.629. Therefore, only 17 variables are discussed at this stage which can be seen in Table 5.

3.3.1 Factor 1. Politics and government

Factor 1 contributed 33.282% to the total explained variance and the variables with the highest loadings were the political situation, political interference, economic determinants, and land disputes. This showed that politics and government had a significant influence on time overrun. The trend is related to the significant influence of the political situation, political interference, and economic determinants on the continuity of construction in a country, specifically in Indonesia which is actively developing. It was observed that the political situation and interference were dominant causes of time overrun. The situation is related to the fact that approval is associated with quick implementation while disapproval can lead to slow realization or abandonment of the project. A previous study conducted in Portugal reported a similar trend by showing that political situation and economic determinants significantly influenced the sustainability of infrastructure development [23]. Another important cause is land disputes which are closely related to the placement of utilities for a project in Indonesia. An example is the occurrence of a land dispute for construction of a new depot as part of the national strategic projects. Some projects in the transportation sector of India were also delayed due to land acquisition [25].

3.3.2 Factor 2. Financial and planning

Factor 2 had the second largest contribution to the explanation of the variation with 12.292% with a total of six causes. The three largest causes included late payment for additional work or variations by the owner, late payment from the contractor to subcontractors or suppliers, and connecting work with loadings ranging from 0.678 to 0.790. The delay of any form of payment leads to difficulty in completing a project which further affects time overrun. The trend is often observed in developing countries as reported in the previous study conducted by [26]. Another study identified late payments by owners as the second-highest risk of time overrun in construction projects in Saudi Arabia [27]. Connecting work in construction projects is also important and causes project time overrun but not at the level of late payments.

3.3.3 Factor 3. Management

Factor 3 had the third largest contribution to the explanation of the variation with 9.098%. This included four causes and the largest two were poor contract management and poorly defined scope which were in the range of 0.699 and 0.897. Poor contract management can make project implementation fall short of expectations which leads to time overrun. Poorly defined scopes also cause delays in project implementation. A previous study identified poor contract management as a cause of time overrun in Saudi Arabia during construction projects [27]. Moreover, poorly defined scopes during budgeting led to changes by the owner and were ranked as the lowest factor in line with the previous study by [17].

3.3.4 Factor 4. Resources

Factor 4 had the fourth largest contribution to the explanation of the variation with 6.855%. This consists of three causes and the largest two are lack of skilled labor with 0.701 as well as equipment and machinery with 0.699. The two factors are the most important resources because projects require skilled labor, equipment, and machinery. The use of unskilled labor often leads to overrun and the same is observed from the application of inappropriate equipment and machinery. A previous study showed that the shortage of skilled and semi-skilled labor caused overrun in Saudi

Arabia and was ranked as the sixth risk factor for delays [27]. The shortages of materials, equipment, and tools in construction projects were also identified as the reasons for overrun in the United Arab Emirates (UAE) [18].

3.3.5 Factor 5. Delay and errors

Factor 5 had the fifth largest contribution to the explanation of the variation with 5.982%. This contains the two largest correlations which include delays in obtaining government permits and approvals with 0.746 and underestimating project complexity with 0.729. Any delay in obtaining government permits can hinder project progress which further causes construction overrun. A similar trend was reported where early approvals led to quicker construction and delayed permits caused overrun in Portugal [23] and South Korea [17]. Design errors can occur at any stage of a project and are identified as a primary cause of project overruns. The changes in the design because of the errors often increase the costs and time substantially [28]. The changes in the design led to a lesser impact on the subsequent project phases [29] in [25].

3.3.6 Factor 6. Project

Factor 6 had the sixth largest contribution to the explanation of the variation with 5.204%. This consists of two causes which include financial issues or difficulty accessing credit with 0.853 and project complexity with 0.593. Financial issues are important because the difficulty in accessing credit for working capital can lead to project time overrun. Contractors typically require bank credit and any difficulty in the process is capable of leading to time overrun due to the need to wait for a long period. This financial difficulty can prevent the timely completion of projects and is considered the top cause of overrun in Saudi Arabia [27]. Project complexity is also often considered a factor inherent in two key aspects of projects including the difficulty in achieving objectives and the risk or uncertainty. These two key factors significantly influence how a project is managed and executed. Project difficulty is essentially related to the expertise and experience of the project team while the risk explains the unknown features of the project[30].

3.3.7 Factor 7. Miscellaneous

Factor 7 was the smallest variable with 4.413% and had three causes. The two largest correlations were identified to be slow labor mobilization at 0.756 and natural disasters at 0.729. Skilled labor is highly needed and expected but slow mobilization can lead to delayed completion, overrun, and less-than-optimal project performance. Slow labor mobilization prevents the timely completion of projects. It was also the reason for labor shortages which was identified as a high-risk factor contributing to overrun in Saudi Arabia [25]. Moreover, natural disasters were identified as risk factors that caused overtime in the aviation construction projects of Saudi Arabia [31].

3.4 Mitigation of time overrun in road construction projects

The measures to mitigate time overrun in road construction projects were determined through different steps. These included interviews with respondents having 10 to 20 years of experience which consisted of 7 construction experts, 3 contractors, and 4 consultants. References were also made to several related and relevant literatures. The mitigation measures were determined based on the causes identified and explained in the following subsections.

3.4.1 Political situation

- Considering the political situation.
- Considering the affairs and interests of the state.

3.4.2 Political interference

- Maintaining a good relationship with the local government.
- Maintaining good cooperation with the local government.

3.4.3 Economic determinants

- Paying attention to the national economy to determine the best course of action for the project.
- Paying attention to national economic fluctuations and project cash flow.

3.4.4 Land disputes

- Paying attention to the planning process from the start.
- Paying attention to utility systems especially for approach or additional roads as well as the widening process.
- Expediting the land acquisition process when necessary.
- Paying close attention to the surroundings of the project to immediately address any land that needs to be acquired with the relevant parties.
- The initial construction contract needs to consider the land required for project utilities.
- Land acquisition needs to be conducted 2 years before project implementation starts and the process is to be initiated through a feasibility study.

- Alternative land locations that differ from those suggested or proposed are necessary during the initial planning process.

3.4.5 Late payment for additional work or variations by the owner

- The contractor selection policy needs to consider and weigh working capital level, resource capabilities, and financial results as a check to prevent awarding contracts to financially weak contractors [25].
- Payment stages need to be in line with the vendor payment terms of the contractor [25]. This is necessary for unit price contracts with term-based payments.

3.4.6 Late payments from contractors to subcontractors or suppliers

Selecting contractors with adequate cash flow to ensure smooth execution, especially for lump-sum contracts

3.4.7 Connecting works

- Avoiding replacement of key personnel [32].
- Appointing appropriate liaisons for construction work related to other parties.

3.4.8 Limitations and future research

The limitations of this study are:

- The geographic boundaries of Indonesia, represented by three provinces, consist of topography dominated by lowlands, prone to flooding and natural disasters, which are always problematic in these three provinces, although they cannot represent the entire country.
- The sample size of only 132 is sufficient for EFA; however, more respondents would have yielded better results.
- The questionnaire used in this study serves as a subjective perception tool.

4 Conclusions

In conclusion, seven variables with 17 factors were identified to be causing overrun in road construction projects. The factors included 1) political situation, (2) political interference, (3) economic determinants, (4) land disputes, (5) late payment for additional work/variations by the owner, (6) late payment from the contractor to subcontractors or suppliers, (7) connecting work, (8) poor contract management, (9) poorly defined scope, (10) shortage of skilled labor, (11) equipment and machinery, (12) delays in obtaining government permits and approvals, (13) design errors, (14) financial problems (difficulty accessing credit), (15) underestimation of the complexity of the project, (16) slow mobilization of labor, and (17) natural disaster conditions. Moreover, the factors were used to formulate and present mitigation measures for time overrun.

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7 Conflict of interest statement

All authors declare that there are no conflicts of interest.

8 Author contributions

Mega Waty: conceptualization, investigation, methodology, writing, review and editing. Yenny Untari: analysis, writing, editing. Oei Fuk Jin: supervision, writing, editing,analysis.

9 Availability statement

There is no dataset associated with the study or data is not shared.

10 Supplementary materials

There are no supplementary materials to include.

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