Contractor's Perspective on Execution Method Impact to Cost Overrun in Bali's Building Construction

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ABSTRACT

Cost overruns is a common issue frequently encountered in the construction sector in Indonesia. Improper management of execution methods and project resources (equipment, materials, and labor) used can lead to cost overrun. Focusing on building construction projects in Bali from the contractor's perspective, this research employed SEM-LISREL to assess the relationship between execution methods, equipment, materials, labor, and cost overruns. The model development process involved identifying measurement items derived from existing literature regarding execution methods, equipment, materials, labor, and cost overruns. Through a questionnaire distributed to 200 contractor employees. The results show a significant impact of execution methods on cost overruns, mainly through intermediary variables such as materials and labor. In contrast, equipment has no significant influence in either the mediation or direct relationship with cost overruns. This study highlights the significant impact of materials, quantified at 4.63, on cost overruns in construction projects. Labor is found to contribute to cost overrun in construction endeavors by 2.36. Moreover, the analysis underscores that the cost overrun can be linked to various indicators associated with encompassing material delivery, material availability, manipulation of material, as well as labor productivity and quantity. By considering these aspects and implementing appropriate strategies, contractors can optimize resource efficiency, control project costs, and ultimately enhance their competitiveness and profitability in the construction industry.

Keywords: construction project, cost overruns, execution method, project resources, SEM-LISREL

1. INTRODUCTION

Development in Indonesia has progressed significantly in an effort to improve quality of life, drive economic growth, have an influence on improving connectivity and accessibility and creating jobs. Investment in the construction sector drives the supply chain of building materials, equipment, and other related services. The construction of construction in Indonesia contributes 10% to the Gross Domestic Product [1]. Building construction is one of the infrastructures that drive the Indonesian economy as it has a wider complexity of work, the high structure to be built and includes high-risk projects compared to other types of construction projects [2]. Building construction in Bali has different characteristics compared to other regions based on the Regional Regulation of Bali Province Number 5 of 2005 concerning Architectural Requirements for Buildings which includes requirements for the use of local materials, the application of Balinese cultural elements in the design process.

Active construction companies in Bali Province reached 1,857 in the past three years which increased the level of competition between contractors. Throughout the tender process, the contractor's bid price is relatively lower than the project owner's estimate because the contractor prefers to win the tender over the risk during construction even though the cost estimate holds a crucial function in project success [3]. Cost overruns are one of the problems that still often occur in the world of construction in Bali arises from the competition among contractors in the tender process by setting incorrect costs and the increasing construction cost index in Bali due to the scarcity of local materials. Several studies have revealed that cost overruns are often found due to factors such as inaccurate planning and scheduling [4], work delays, and high equipment rental costs [5], fluctuations in the prices of materials [6], insufficient availability of construction materials such as local materials intended for use in the construction process, and poor labor productivity [7]. Hence, it is necessary to analyze the influence of execution methods on cost overruns through equipment, materials, and labor of building construction projects.

Structural Equation Modelling- Linear Structural Relations (SEM-LISREL) is a method used in analyzing how execution methods affect cost overruns through equipment, materials, and labor. LISREL tests SEM models and derives parameters used in hypothesis testing [8]. The SEM-LISREL method can accommodate a sample size of 200. This study aims to assess how execution methods influence cost overruns attributed to materials, equipment, and labor, while also analyzing the causative indicators of cost overruns in building construction endeavors in Bali based on contractor’s perspective.

2. THEORY AND METHODS

2.1 Theory

A project is a temporary endeavor undertaken to create a unique product, service, or outcome in achieving project goals [9]. The construction project process begins with preparation, during which the service provider assesses site conditions, plans construction activities, and establishes quality and safety standards. In the execution of building construction projects, complexities frequently arise, leading to challenges such as cost overrun.

Cost overruns is an issue that may arise in a construction project, where the incurred costs exceed the planned expenses, stemming from various factors such as inadequate analysis in developing project cost estimates, poorly defined scopes during the initial project budgeting, and deliberate misrepresentation of costs or project schedules due to political pressures [10], delayed payment by project owners, fluctuations in material prices [4], frequent work delays, high equipment rental costs [5], market price inflation, lack of coordination and stakeholder management [11], mismatched payment systems per contract, low labor productivity [7], poor project waste management, and project environment disputes [6]. These issues pose significant challenges in construction project budgeting and are major concerns for owners and contractors.

2.2 Methods

Incorporating linear structural relationships in SEM, this study strengthens the proposed model, analyzing the relationship between execution methods associated with cost overruns on construction projects in Bali. The analysis covers materials, equipment, and labor with an emphasis on the contractor's perspective.

Model Concepts and Hypothesis

Research concepts based on theoretical objectives in previous studies and developed by researchers as a construct model that explains the research hypothesis. Figure 1 dan Table 1 explain the conceptual model and hypotheses that will be analyzed at the structural model evaluation stage using the SEM-LISREL method.

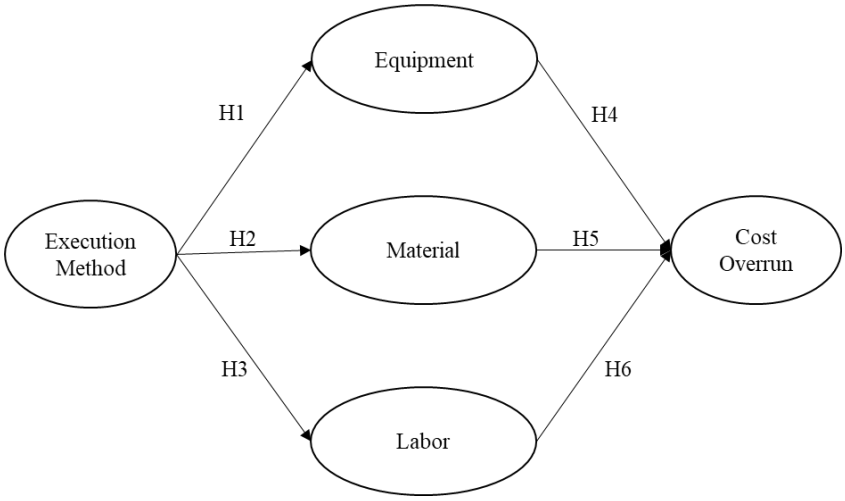


Table 1. Hypothesis

Hypothesis	
H1	The Execution method has a positive response to the Equipment
H2	The Execution method has a positive response to the Material
H3	The Execution method has a positive response to the Labor
H4	Equipment has a positive response to the Cost Overrun
H5	Material has a positive response to the Cost Overrun
H6	Labor has a positive response to Cost Overruns
H7	Equipment plays a role in mediating the Execution method on Cost Overruns
H8	Material plays a role in mediating the Execution method on Cost Overruns
H9	Labor plays a role in mediating the Execution method on Cost Overruns

Data Collection

Table 2 represents variables and indicators that are obtained from the synthesis of variables and indicators from were specifically associated with the circumstances of building construction projects in Bali, then evaluated through the construction of preliminary surveys focused on five project managers who provided suitability assessments and comments for the measurement indicators of each variable and could submit additional indicators that could measure related variables and main questionnaires both offline by visiting directly and online

via google form to contractors in Bali with a total of 200 respondents which is the minimum sample size required in SEM-LISREL [12].

Table 2. Variable and Indicators

Indicators	Operational Definition
Execution method	
Design Changes	The design based on the agreement of the owner and contractor has changed
Scheduling	The construction and completion time of the work exceeds the predetermined time
Scope of Work	The scope of work of the project has changed
Changes in Field Conditions	Field conditions change at the time of work construction
Quality Standards and Specifications	Quality standards and specifications do not match or change
Repetition of Work	High frequency of repetition of work
Equipment	
Equipment Price/Rental	High price/rental of equipment required
Equipment Mobilization	High cost of mobilization and demobilization of equipment
Equipment Quality	The quality of equipment used in project construction is not appropriate
Equipment Productivity	Ineffective productivity in the use of tools
Equipment Availability	The availability of equipment required to carry out the work is minimal
Material	
Material Quality	Inappropriate quality of materials and materials
Material Price	The occurrence of changes in the price of materials and materials during the project period
Material Delivery	Delivery of materials and materials is delayed
Material Availability	Insufficient supply of materials required for construction projects
Material Manipulation	Manipulation of materials and materials from suppliers on the amount of materials and materials ordered
Material Specifications	The specifications of materials and materials used in the project have changed
Labor	
Labor Quality	The abilities, skills, knowledge, and attitudes of workers involved in construction projects are minimal
Labor Productivity	Low labor productivity
Labor Quantity	The amount of labor that is not suitable for carrying out work
Labor Wages	An increase in wages or additional labor costs
Cost Overrun	
Cash Flow	Cash flow or cash flow during project construction has decreased
Project Profit	The profit or profit obtained at the end of the project has decreased
Financial Obligation	The specifications of materials and materials used in the project have changed

Data Analysis

The initial stages of data analysis began with evaluating the characteristics of questionnaire respondents, evaluating the distribution of research data, evaluating the measurement model and evaluating the structural model.

3. RESULTS AND DISCUSSION

The results of the study are divided into four stages, namely evaluating the characteristics of respondents, evaluating the questionnaire result, evaluating the distribution of research data, evaluating the measurement model, and evaluating the structural model.

The main questionnaire respondents exhibit characteristics consisting of 76% males and 24% females. The majority of respondents fall within the age range of 20 to 40 years. The work experience of respondents varies from 0-5 years, 6-10 years, 11-15 years, to over fifteen years, with percentages of 43%, 21%, 23%, and 14% respectively. 186 respondents work for private

contractor companies while 14 others work for government contractor companies. The researchers obtained questionnaire responses from 36 respondents holding the position of Project Manager, 25 Site Managers, 52 Quantity Surveyors, 35 Quality Control personnel, 9 Cost Control personnel, and 43 Supervisors). There are 109 respondents with experience working on 1 to 8 projects, and 91 respondents with experience working on more than 8 building construction projects. The results of the questionnaire distributed to staff of contractor in Bali explained that respondents relatively agreed and strongly agreed with each measurement indicator of the variable, as depicted by average scores exceeding four.

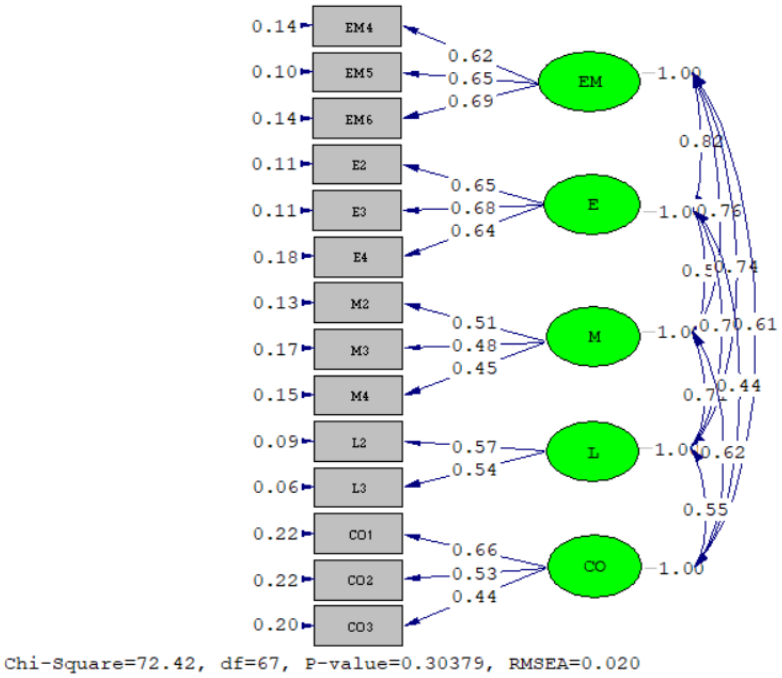
The study assessed research variables using tests for normality and multicollinearity. The results revealed non-normal data distribution with a P-Value below 0.05. The multicollinearity test confirmed the absence of multicollinearity, ensuring stable and unbiased parameter estimation in SEM.

Proceeding to the subsequent phase involves the evaluation of the measurement model to represent the effectiveness of the indicators of each research variable Loading Factor as shown in Table 3 and Figure 2, refers to the correlation between variables and measurement indicators applied to measure specific dimensions or aspects of research variables and has a rule of thumb value of more than equal to 0.7 [13].

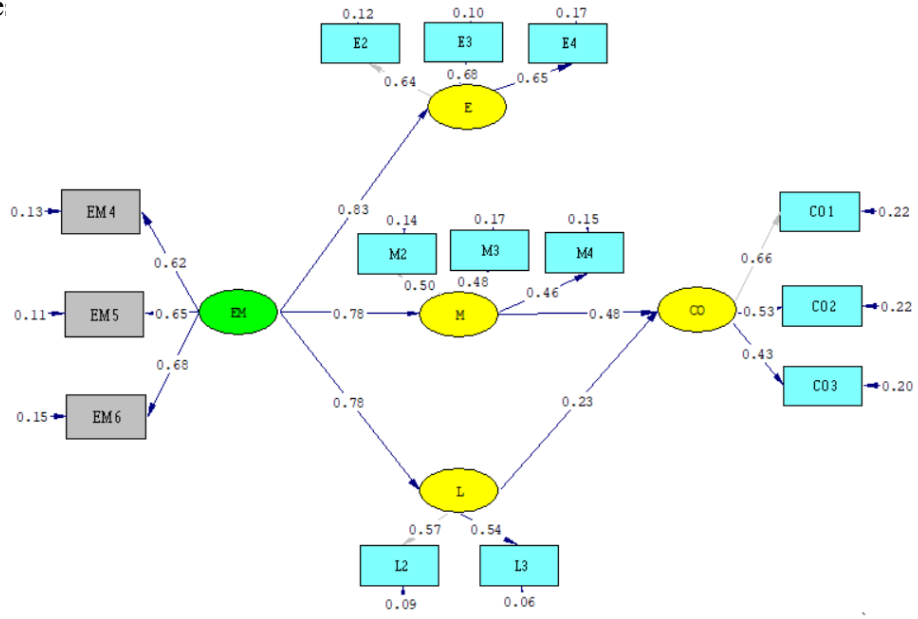
Table 3. Loading Factor of Indicators

Variable	Indicator	Loading Factor	Information
Execution method (EM)	EM4	0,86	Valid
	EM5	0,90	Valid
	EM6	0,88	Valid
Equipment (E)	E2	0,89	Valid
	E3	0,90	Valid
	E4	0,84	Valid
Material (M)	M2	0,81	Valid
	M3	0,76	Valid
	M4	0,76	Valid
Labor (L)	L2	0,89	Valid
	L3	0,90	Valid
Cost Overrun (CO)	CO1	0,81	Valid
	CO2	0,75	Valid
	CO3	0,70	Valid

The Construct Reliability value on the variables shows that each indicator of the research variable presents a consistent and reliable measurement of the construct because it has exceeded 0.7. The level of convergence measured by Variance Extracted has a value limit of more than equal to 0.5 [13] which described based on how the level of convergence between a group of items/indicators that represent research variables.



The SEM-LISREL method concludes with an evaluation of the structural model's suitability demonstrate in Figure 3 which represent the final structural model and hypothesis result. The outcome of hypothesis testing reveals the extent of direct and indirect relationships between re



Discussion

Based on the analysis of the data, it was found that the execution method variable which has three measurement indicators, namely changes in field conditions, quality standards and specifications and repetition of work, shows a positive and significant direct relationship to equipment, materials and labor as well as the significant role of materials and labor in mediating the relationship between execution methods and cost overruns.

In contrast, equipment is considered not to have an important role in providing direct and indirect effects on cost overruns. This phenomenon is attributed to the ownership of construction equipment by contractors in the building construction sector in Bali. Ownership of equipment is more significantly beneficial than renting and supports the productivity of construction equipment considering the value and duration of the project so that they can fully control the schedule of equipment use and maintenance, increasing operational efficiency [14].

Construction projects in Bali often occur in areas with challenging geographical features like steep cliffs, necessitating additional efforts to mobilize equipment to project sites and resulting in higher mobilization costs. Moreover, working in such difficult terrains requires specialized equipment, which may not be as advanced as the standard equipment used in construction projects elsewhere.

Material has a very high role in influencing cost overruns both direct impact and as mediation of the relationship between execution methods and cost overruns supported by [6], that availability of construction materials has significant potential in strengthening the influence of changes in the scope of work and field conditions on project cost increases. The scarcity of materials on site is often due to inadequate quality control on purchase orders or invoices. This highlights the importance of meticulous oversight and adherence to procurement processes to mitigate challenges related to material availability and cost management in construction projects.

Labor assessed using two criteria: productivity and quantity. Outcome of hypothesis testing illustrate the significant effect of labor's direct relationship on cost overruns. Less labor productivity has the potential to strengthen the link between design changes and environmental instability to project cost overruns [15]. Assessing the field conditions in Bali, particularly in steep locations like cliffs, presents a significant challenge in the construction of Balinese architecture and the use of red bricks. Labor productivity is significantly impacted as work progresses slowly due to the lack of necessary skills.

4. CONCLUSIONS

Based on the results of the overall analysis, it was found that there a substantial correlation between project execution methods and equipment, materials, and labor. Among these factors, materials exhibit the highest impact at 4.63 on cost overrun, while labor demonstrates a significant influence at 2.36. The execution methods notably influence cost overrun through materials and labor. However, equipment does not significantly contribute to cost overrun. Additionally, the analysis underscores that the cost overrun can be attributed to various indicators associated with encompassing material delivery, material availability, manipulation

of material, as well as labor productivity and quantity. The outcomes of the study may provide valuable insights for contractors operating in Bali to examine the underlying causes of cost overrun in building construction endeavors, while considering execution methodologies, equipment, materials, and labor. This is anticipated to enhance resource efficiency and effectively manage project costs.

5. ACKNOWLEDGEMENTS

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