INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY: APPLIED BUSINESS AND EDUCATION RESEARCH
2024, Vol. 5, No. 12, 5360 – 5370
http://dx.doi.org/10.11594/ijmaber.05.12.30

Research Article

Cost and Time Overrun of Public Infrastructure Project in The Philippines: Inhibiting Factors and Mitigating Measures

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Article history:
Submission 10 October 2024
Revised 07 December 2024
Accepted 23 December 2024

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ABSTRACT

Time and cost overruns in the implementation of infrastructure projects are endless, as appears in all the implementing agencies of the government. According to the recent report of the state auditor, projects were not completed within the specific contract time, while the socioeconomic planning body reported cost overruns on several big-ticket projects. This study proposes a frame of factors influencing overruns and mitigation actions as a contribution to the risk analysis of the implementation of projects as well as the project management initiative in monitoring and control of projects. By analyzing the datasets from Metro Manila, this study identified the most prevalent influencing factor of cost and time overruns faced in the implementation of infrastructure projects and developed measures to mitigate overruns. A total of 196 professionals responded to a questionnaire, and 12 participants were involved in unstructured interviews, which supported the data and results. To interpret and validate the data gathered, a relative importance index and a one-way analysis of variance test were used. The study revealed that the influencing factors leading to time overruns are inaccurate budgeting, location of site, suspension of work, land acquisition, and variation order, while for the cost overrun factors, inaccurate budgeting, variation order, inadequate project planning, market conditions, and inadequate site investigations prevail. A relationship between the perceptions of the 3 groups, namely the contractor, consultant, and implementing agency, with regards to the cost overrun factors was significant. However, with regards to the time overrun factors, they are not significant.

Keywords: *Time Overrun, Cost Overrun, Construction, Public Infrastructure Project, Construction Management*

How to cite:
Layno, J. D. J. & Famadico, J. J. F. (2024). Cost and Time Overrun of Public Infrastructure Project in The Philippines: Inhibiting Factors and Mitigating Measures. *International Journal of Multidisciplinary: Applied Business and Education Research*. *5*(12), 5360 – 5370. doi: 10.11594/ijmaber.05.12.30

Introduction

The construction industry plays a crucial role in the development and economic growth of any country, and it has been attested that the construction industry has turned out to be one of the leading industries around the globe (Vaardini et al., 2016). In the Philippines, the continued expansion of the economy will get a further boost from the PHP 8.3-trillion "Build Better More" Program, with the Philippine government underscoring that the bulk of the 194 infrastructure projects are new projects.

An infrastructure investment is considered solid backing for the economy, given its long-term impact that can sustain the economy's expansion. The government's growth assumption for 2023 ranges between 6% and 7%. In the first three months of 2023, economic growth, as measured by GDP, rose by 6.4%, exceeding projections. When completed, these projects are expected to bring important benefits to the Philippine economy and the lives of ordinary citizens. Better transportation, for example, would help farmers bring their produce, such as palay, corn, bananas, and mangoes, to markets and raise the income of the rural population. More generally, improvements in the quality of infrastructure services will help cut the cost of doing business, attract more investment, and enhance productivity around the country.

Projects completed beyond their stipulated time and budget are a chronic problem in public infrastructure projects in the Philippines. Based on the 2022 COA annual audit report on the DPWH, a total of 1,798 projects out of 2,395 projects amounting to PHP 60.07 billion were not finished or completed within the specific contract time or completion date. These "significant delays" in the projects were caused by numerous suspension orders, time extensions, and variation orders by the DPWH offices, according to state auditors. The list of reported delayed infrastructure project implementations is endless.

The NEDA's Official Development Assistance (ODA) Portfolio Review 2018 report mentioned that the total cost overrun, or additional costs over and above the Investment Coordination Committee's (ICC)-approved project cost, increased to PHP 24.79 billion in 2018, or a 264.02% growth from PHP 6.81 billion in 2017. It may be noted that inflation in 2018 averaged 5.2%, with September and October posting the highest inflation rate of 6.7% for the year.

Our neighboring developing country, Indonesia, is also facing problems related to cost overruns and time delays. In 2017, 460 infrastructure single-year projects in Aceh, Indonesia, progressed to under 75% completion. In Jordan, most infrastructure projects experience cost overruns and time delays. Similar to Jordan, delays and cost overruns were faced by most construction projects in Iran and India (Al-Hazim et al., 2017).

The problem of overruns in construction is not only prevalent in the Philippines. It is global. In a study by Aljohani (2017), it was claimed that the construction industry has a poor reputation for finishing projects on budget, and nine out of ten projects normally experience cost overruns. Delays increase the cost of construction because of price adjustments and fluctuations in the prices of various components, such as labor, fuel, cement, and miscellaneous materials (Hanif et al., 2016).

Time and cost overruns in the project implementation of public infrastructure are endless and affect all implementing agencies of the Philippine government. How can there be expected development if this problem continues to prevail in the implementation of infrastructure projects in the Philippines? It is imperative that attention be given to the challenge of cost and time overruns in construction projects. It is noteworthy that studies have resulted in some published literature on the cost and time overruns during the implementation of public infrastructure projects in the Philippines.

Findings revealed that four factors caused delays in road construction projects in Northern Mindanao, Philippines: road right of way, changes in quantity, peace and order, and heavy rain (Cabahug et al., 2018). The result of the survey revealed that the most significant risk factors contributing to the overruns of vertical construction were inflation, high-cost fluctuation, delays in the manufacturing of materials, material damage, the client's lack of

construction project experience, slow decision-making approvals, delays caused by subcontractors or suppliers, delays in the transportation of materials, lack and shortage of construction supplies, and construction changes or variation orders (Bascon, Gangcuangco, and Carreon, 2023).

The influencing factors were then identified and analyzed from previous studies in the Philippines. Thus, it is very important to address the factors of time and cost overruns to ensure the success of public infrastructure projects.

This study aimed to identify the most prevalent causes of cost and time overruns faced in the implementation of infrastructure projects in the Philippines and to determine the significant differences in the perception among construction professionals with regard to the causes of cost and time overruns. This study also aimed to propose a framework of factors influencing overruns and mitigation actions as a contribution to the risk analysis of project implementation and as part of the project management initiative in monitoring and controlling projects.

Methods

The systematic methodological process undertaken in this study is shown in Figure 1, which explains what the researchers did to answer the research questions. The questionnaire was established based on the identified variables of the study objectives. The factors influencing cost and time overruns were identified through a review of related literature. The survey questionnaire was developed by industry experts and validated using Cronbach's alpha.

A dry-run survey was conducted to determine the validity of the survey questions. Cronbach's alpha is frequently used to prove that instruments and survey assessments created or used for research are appropriate to serve their purpose (Taber, 2017).

After the questionnaire was validated, it was distributed to the target sample. The target sample for this study consisted of 200 professionals who had prior experience in public infrastructure projects, either as implementing agencies (clients), consultants, or contractors.

The completed survey questionnaires were retrieved, and the gathered data were collated, interpreted, and analyzed using statistical tools. To evaluate the factors according to their level of significance, a hierarchical assessment of the factors was conducted. The Relative Importance Index (RII) value was computed for all respondents. A one-way ANOVA was used to determine significant differences in perception among the respondent groups.

The survey output identified the top five prevailing factors contributing to cost and time overruns during the implementation of infrastructure projects. After identifying these factors, a literature review for mitigating measures was conducted. At the same time, interviews were scheduled based on the availability of the respondents to collect expert opinions on the mitigation measures for the top five influencing factors of cost and time overruns.

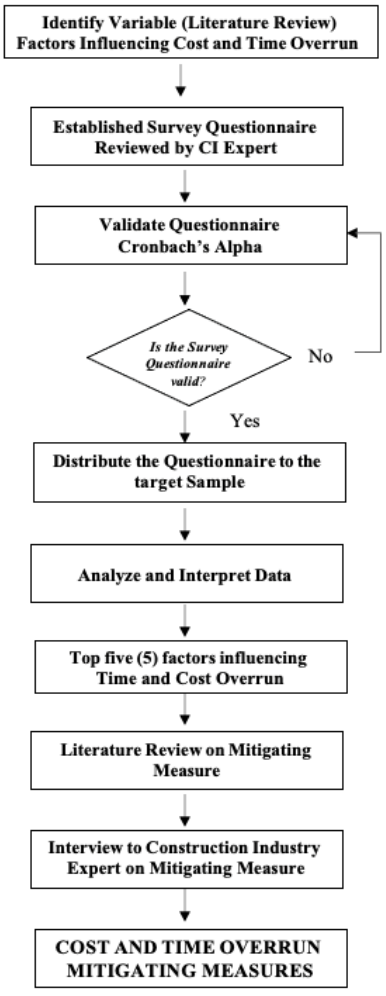

Figure 1. Systematic methodological process

Result and Discussion

This section presents the qualitative and statistical data aligned with the study's specific objectives. Likewise, it includes a comprehensive analysis and interpretation of the findings.

Ranking the Factors influencing Time Overruns

Table 1. Ranking the factors influencing cost overrun based on the overall perception of key players in the implementation of infrastructure projects.

Time Over Run Factors	Mean	Overall RII	Rank
Inaccurate budgeting and resource planning	4.61	0.921	**1**
Location of site/ Terrain conditions	4.59	0.918	**2**
Land Acquisition and Compensation delay	4.56	0.911	**3.5**
Suspension of work (Due to weather, Peace and Order).	4.56	0.911	**3.5**
Variation Order	4.53	0.905	**5**
Market Condition/Shortage of materials and equipment	3.68	0.736	**6**
Insufficient number of staff (Contractor)	3.62	0.723	**7**
Price escalation of materials,	3.40	0.680	**8**
Contractor, Subcontractors and vendors performance.	3.33	0.665	**9**
Delay of approval /Unavailability of Drawings, Designs, RFA/RPI on Time	3.29	0.657	**10**
Poor Communication withs Stakeholders	3.24	0.649	**11**
Payment delays to contractor	3.23	0.646	**12**
Changes in design specifications	3.20	0.641	**13**
Poor Site management and Supervision	3.11	0.622	**14**
Financial difficulties of contractor	3.05	0.609	**15**

Table 1 reveals that Inaccurate budgeting ranked first among factors influencing time overrun during the implementation of public infrastructure projects, respectively, ranked by the overall respondents namely implementing, contractors, and consultants with their RII numerical value. This is followed by the factors (2) Location of site/Terrain conditions, (3) Suspension of work (Due to weather, Peace and Order), (3) Land Acquisition and Compensation delay, (5) Variation Order. Factors ranked to be least significant include; Changes in design specifications, Poor Site management and Supervision, and financial difficulties of the contractor.

The data indicate that "inaccurate budgeting and resource planning" is the most critical factor influencing time overruns in public infrastructure projects in the Philippines, with a Relative Importance Index (RII) of 0.921. This finding aligns with the work of Susanti (2019), who emphasizes that budgeting inaccuracies are a dominant contributor to delays in construction projects. When project costs exceed initial estimates, contractors face significant challenges in maintaining financial feasibility and project timelines. Cost overruns, including expenses for materials, rentals, and specialized project needs, often lead to operational delays. Moreover, the inability to forecast expenses adequately exacerbates resource constraints, hindering timely project completion.

The "location of site/terrain conditions" ranks as the second most influential factor, with an RII of 0.918. This finding is consistent with Al-Hazim et al. (2017), who noted that challenging site conditions, such as difficult terrain, remote locations, and inadequate access, significantly delay construction activities. In the Philippine context, geographic and environmental constraints, including susceptibility to natural calamities, further compound the issue. These factors can impede the transport of materials, equipment, and labor, thereby increasing project timelines.

The suspension of work due to factors such as adverse weather conditions and peace and

order issues ranks as the third factor contributing to time overruns, with an RII of 0.911. Adverse weather conditions, particularly in a country like the Philippines, are frequent and unpredictable, often leading to significant delays in construction schedules (Schuldt et al., 2016). Moreover, peace and order issues, such as labor strikes or security threats in certain areas, further compound these delays. These interruptions disrupt resource allocation and increase idle time, resulting in heightened project costs and extended timelines. To mitigate these issues, proactive risk management strategies, such as establishing safety measures and flexible project schedules, are critical.

Delays in land acquisition and compensation are ranked third, with an RII of 0.911. Acquiring land for infrastructure projects is often fraught with legal disputes and bureaucratic inefficiencies (Noor, 2021). The complexity of negotiating fair compensation adds another layer of difficulty, leading to significant delays before construction can even commence. This issue is especially relevant in the Philippines, where land disputes are a recurring challenge. Addressing this requires a more streamlined legal framework and enhanced communication with stakeholders to ensure timely resolution of acquisition issues.

Variation orders, which rank fifth with an RII of 0.905, represent a critical factor influencing project delays and cost overruns. A variation order typically arises from changes in project scope, design modifications, or unforeseen conditions during construction. As noted by Hanna et al. (2004), such changes disrupt project continuity, increase administrative burdens, and often necessitate additional budget allocations and time extensions. In the context of the Philippines, inadequate initial project planning and coordination among stakeholders frequently result in such orders. Strengthening planning protocols and fostering collaboration during the design phase can minimize the occurrence of variation orders.

This major result concurs with the findings of Cabahug et al, (2018) that four factors caused the delay of the road construction project in Northern Mindanao, Philippines namely Land Acquisition and Compensation delay or commonly known as road right of way issue, change in quantity or variation order in general, peace and order situation, and heavy rain/weather condition.

Ranking the Factors influencing Cost Overruns

Table 2. Ranking the factors influencing cost overrun based on the overall perception of key players in the implementation of infrastructure projects

Cost Over Run Factors	Overall		
	Mean	**RII**	**Rank**
Inaccurate budgeting/Costing of Original Cost	4.71	0.943	**1**
Variation orders	4.36	0.872	**2**
Inadequate Project planning	4.32	0.864	**3**
Market conditions (availability of resources)/Economic Climate	4.32	0.863	**4**
Inadequate site investigations/Unexpected ground conditions	4.09	0.818	**5**
Design and Specification changes	3.24	0.649	**6**
Price fluctuation of materials and labor,	3.17	0.635	**7**
Project scope changes	3.09	0.618	**8**
Failures in design	3.02	0.604	**9**
Inadequate bidding method / Policy in accepting the lowest tender	2.91	0.583	**10**
Lack of consistency between bill of quantities and drawings	2.90	0.581	**11**
Lack of information flow between parties/ Communication	2.83	0.566	**12**
Client's shortage of Finance or delayed payments to contractors.	2.62	0.523	**13**
Terrain conditions/ Location of site	2.56	0.511	**14**
Late decision-making by the owner	2.49	0.498	**15**

The factor "Inaccurate Budgeting/Costing of Original Cost" emerged as the most significant contributor to cost overruns, with an RII value of 0.943. This finding aligns with the study by Seidu et al. (2022), which highlighted substantial agreement among contractors, consultants, and clients on the role of inaccurate budgeting in project delays. Often, project budgets are developed by referencing costs from similar projects; however, this approach neglects the unique characteristics of each project. Employing more accurate and tailored costing methodologies is vital for ensuring precise and reliable estimates. Inaccurate budgets not only affect profitability but also exacerbate delays as adjustments are made to address funding shortfalls.

"Variation Orders" ranked second among the cost overrun factors, with an RII value of 0.872. Variation orders are often the result of changes in scope or design, as reflected in the findings of Quiniquini (2017). A study of 874 projects by the Department of Public Works and Highways (DPWH) revealed variation orders amounting to approximately ₱1.29 billion, with variances between +5% to +10% from the original contract amounts. These changes disrupt project continuity and lead to additional administrative burdens, often inflating costs. Enhanced coordination during the design phase and stricter controls on scope changes are essential in mitigating this issue.

Ranked third with an RII of 0.864, "Inadequate Project Planning" is a critical factor leading to cost overruns. Westerveld (2003) emphasized that poor planning often leads to project failure. In the Philippines, infrastructure projects frequently proceed without completing feasibility and engineering studies due to time constraints or political considerations. This leads to escalating costs as project details are later refined. Effective project planning involves developing clear objectives and ensuring sufficient time for feasibility studies and plan preparation to reduce the risk of overruns.

The fourth-ranked factor, "Market Conditions (Availability of Resources/Economic Climate)," has an RII value of 0.863. The effect of inflation is also having on the construction industry, where many studies have highlighted the role of inflation in project cost overrun. Due to inflation the building material prices, labour wages and machinery hire rates changes every year, resulting in the project's initial budget being deviated from the final budget. Musarat, M. et al., (2021).

"Inadequate Site Investigations" also ranked fifth, with an RII value of 0.818. Site investigations are critical for providing essential geotechnical data to ensure safe and cost-effective project designs. As Ali Albatal (2013) demonstrated, inadequate site investigations in a recycling factory project in Egypt led to a cost overrun of 64.2% due to the absence of sufficient geotechnical data. Poor site investigations result in either over-designed foundations, wasting resources, or under-designed foundations, risking structural failures. Comprehensive soil and subsurface investigations are crucial for minimizing delays, disputes, and unexpected costs during construction.

Table 3. Test of difference in the perception of construction professionals

Var.	Source of Variation	SS	df	MS	F	P value	Decision	Interpretation
Time	Bet. Groups	3.73	2	1.86	19.33	.000	Reject	Significant
	w/in Groups	18.62	193	0.10				
	Total	**22.35**	**195**					
Cost	Bet. Groups	0.22	2	0.11	2.58	.079	Accept Ho	Not significant
	w/in Groups	8.05	193	0.04				
	Total	**8.27**	**195**					

Table 3 shows the ANOVA analysis of the relationship between the perception of the three-category group namely, the contractor, consultant and implementing agency with regards to cost and time overruns factors. The cost overruns factor for the 3-category group

were not statistically significant at a significance level of 0.05. These confirmed the result of the RII Ranking for each group which show common perception in ranking the top five factors namely (1) Inaccurate budgeting/Costing of Original Cost (2) Variation Order, (3) Inadequate Project planning, (4) Market conditions Economic Climate, (5) Inadequate site investigations/Unexpected ground conditions are commonly selected for the to five (5) most influencing factors. On the other hand, the Time overrun factor for the category group were statistically significant at a significance level of 0.05. To identify the reason of these significant different Post Hoc Test is conducted for the Time factor as shown in the table.

Table 4. Post hoc test for time

Group	Mean	Comparison	Mean Diff.	Critical Value	Decision	Interpretation
Contractor	3.63	Contractor and IM Agency	0.25	0.13	Reject Ho	Significant
IM Agency	3.88	Contractor and Consultant	0.33	0.15	Reject Ho	Significant
Consultant	3.96	IM Agency and Consultant	0.08	0.18	Accept Ho	Not Significant

Table 4 show the Post Hoc Test for Time since we reject the null hypothesis, the researchers conducted a post-hoc test to determine which specific groups' means (wheat varieties) are different from each other. The perception on time overruns factor between "Contractor & IM Agency group" and "Contractor and Consultant group" were statistically significant at a significance level of 0.05. On the other hand, the perception on time overruns factor between IM Agency and Consultant were not statistically significant at a significance level of 0.05. These result shows that IM Agency and Consultant has common perception with regard on the factor influencing time since both of these groups are representing the owner or the government side of the project.

Policies Recommended by the Respondents for Mitigation of Time and Cost Overrun

The analysis of the survey results identified the top project control inhibiting factors, which were subsequently examined in greater depth through interviews with experienced practitioners. These interviews aimed to uncover the underlying reasons these factors hinder effective project control. This process facilitated the development of a set of measures to mitigate these challenges. As outlined in the research methods section, this phase of the study involved a series of in-depth interviews. To ensure sufficient depth of analysis, the scope was deliberately limited to the top five inhibiting factors. These factors were prioritized due to their significance and their shared impact on both cost and time control.

Variation Order

Variation orders, a persistent issue in Philippine construction projects, often result in time extensions, delays, and cost increases (Famadico & Baccay, 2019). To address this, the following strategies were emphasized:

1. Comprehensive Design and Contract Documentation: Consultants should ensure finalized designs and contracts during the planning stage to reduce variations (Arain & Pheng, 2005).
2. Complete Drawings at Tender Stage: Incomplete drawings often necessitate costly changes during construction. Finalized designs during tendering reduce risks of variations.
3. Experienced Supervision: Supervisors with expertise can foresee challenges and make timely decisions, minimizing design changes and on-site issues.

4. Enhanced Communication: Clear, consistent communication among stakeholders improves project coordination and reduces variations (Gomez, 2022).
5. Thorough Site Investigations: Conduct detailed soil and site analyses before tendering to prevent variations arising from unexpected site conditions.

Location of site/ Terrain conditions/ Inadequate site investigations/ Unexpected ground conditions

Unexpected site conditions, such as soil instability or underground obstacles, frequently lead to cost overruns and project delays. Recommended measures include:

1. Comprehensive Pre-construction Investigations: Utilize advanced tools like 3D mapping and ground-penetrating radar to detect hidden risks (Azis et al., 2013).
2. Flexible Project Planning: Incorporate contingency budgets and adaptable designs to address unforeseen challenges.
3. Transparent Communication: Frequent updates among stakeholders ensure timely responses to site issues and prevent escalations (Azis et al., 2013).

Suspension of work (Due to weather, Peace and Order)

Weather-related delays impact costs, schedules, and material quality. Mitigation strategies include:

1. Prefabrication and Modular Construction: These methods offer faster timelines and reduce dependence on on-site activities during adverse weather (Rocha et al., 2022).
2. Weather-resistant Materials: Use innovative techniques and materials, such as insulated concrete forms, to improve durability.
3. Adaptive Scheduling: Break projects into smaller components to minimize weather disruptions.
4. Proactive Forecasting: Employ advanced weather prediction tools to adjust project timelines preemptively.
5. Innovation and Resilience: Foster adaptive construction practices to navigate weather-induced challenges effectively.

Market conditions (availability of resources) /Economic Climate

Market price fluctuations create financial pressures on construction projects. Experts suggest:

1. Contract Provisions for Price Adjustments: Contracts should specify mechanisms for price adjustments to mitigate financial risks during volatile economic conditions.
2. Claim Management: Establish systems for managing change claims and communicating effectively with stakeholders to secure compensation.
3. Internal Controls: Strengthen internal cost control mechanisms and sign fixed-unit price contracts to achieve risk-sharing.
4. Resource Allocation: Proactively manage resource allocation to minimize waste and adapt to market trends.

Inaccurate Budgeting and Resource Planning

To address issues of inaccurate budgeting and resource planning, the following measures are recommended:

1. Conduct Earned Value Analysis: Use earned value analysis to track project performance and improve cost estimation accuracy.
2. Leverage Historical Data: Refer to data from previous projects to make more informed budgeting decisions.
3. Perform Risk Assessments: Include potential risks, such as material price increases or labor shortages, in the budgeting phase and create contingency plans.
4. Use Advanced Estimation Software: Employ modern estimation tools to generate more precise and dynamic cost predictions.

Land Acquisition and Compensation Delays

To reduce delays caused by land acquisition and compensation issues, the following steps are suggested:

1. Amend the Right of Way Act (RA 10752): Ensure all Right-of-Way (ROW) expenses are settled before starting the project.
2. Fast-track Property Appraisals: Expedite the valuation of properties affected by the project.

3. Streamline Payment Processes: Speed up the disbursement of payments for ROW claims.
4. Improve Stakeholder Coordination: Work closely with project stakeholders, including local government units (LGUs), to address ROW challenges effectively.

Lack of Project Planning

For effective project planning, the following actions are recommended:

1. Develop Detailed Plans: Create clear timelines, milestones, and deliverables before starting the project.
2. Adopt Advanced Project Management Techniques: Use modern methodologies to better handle challenges during execution.
3. Monitor Progress Regularly: Establish systems to track and address delays or issues early.
4. Provide Adequate Resources: Ensure all necessary resources, including labor and materials, are planned and allocated properly

Conclusion

The study identified the most influential factors contributing to time and cost overruns in public infrastructure projects in the Philippines. Based on the perceptions of contractors, consultants, and implementing agencies, the top factors affecting time overruns are inaccurate budgeting (RII = 0.921), location of site/terrain conditions (RII = 0.918), suspension of work due to weather, peace and order (RII = 0.911), land acquisition and compensation delay (RII = 0.911), and variation order (RII = 0.905). Similarly, the factors most associated with cost overruns include inaccurate budgeting/costing of original cost and resource planning (RII = 0.921), variation order (RII = 0.872), inadequate project planning (RII = 0.864), market conditions/economic climate (RII = 0.863), and inadequate site investigations/unexpected ground conditions (RII = 0.818).

The analysis of perceptions among contractors, consultants, and implementing agencies revealed no significant differences regarding cost overrun factors. This indicates a shared understanding across all groups about the primary factors influencing cost overruns. However, for time overrun factors, a significant difference was observed. Specifically, implementing agencies and consultants shared similar views, likely due to their common roles in representing the project owner or government side.

Lastly, the perception of respondents regarding cost overrun factors was not significantly influenced by their designation or years of experience. This suggests that the factors identified as critical to cost overruns are universally recognized regardless of professional background or tenure in the industry.

Recommended Policy Measure to Reduce Cost Overrun and Time Overrun

I. Implementing Agency

1. The implementing agency must allocate a proper budget based on cost estimation, including contingencies.
2. The implementing agency should appoint a dedicated construction management consultant to facilitate quick decision-making, especially for major projects.
3. The scope of projects should be adequately defined to minimize variations during project implementation.
4. Variations and change orders should be reduced through proper evaluation of the necessity of additional work and the application of value engineering to minimize increases in the quantity of existing pay items.

II. Contractor

1. Resource planning, including equipment and labor, should align with project milestones and duration.
2. Contractors should develop proper work methodologies to improve the productivity of labor and equipment.
3. Contractors should adopt appropriate innovations and technologies to enhance the performance of infrastructure projects.

III. Consultant

1. Consultants must provide complete designs and cost estimations as required by the implementing agency.

2. Mechanisms should be developed to resolve disputes between the client and contractor, such as implementing preventive measures to avoid construction disputes or establishing an internal conflict management process.
3. Project-specific strategies should be developed to monitor progress and inspect key developments. This includes involving the entire team at the start of the project for effective monitoring. Deploying expert quantity surveyors or cost engineers to monitor the financial aspects of the project, along with expert planners to track schedule progress, will help ensure that the project stays on track.

The stakeholders should adopt the research-validated policy to control time and cost overruns. Further research is needed to investigate a larger scale of construction projects, particularly those that are foreign-funded or implemented under Public-Private Partnerships (PPP). As the current research is limited to public projects, future studies should explore private projects and compare the factors influencing both cost and time overruns.

Acknowledgement

The researchers would like to thank Almighty God for His grace, guidance, and protection throughout this project. Special thanks to Engr. Jerome Jordan Famadico for his continuous support, motivation, and guidance and for being a co-author in this study. Gratitude is also extended to the researcher's parents for their unwavering support and encouragement. Sincere appreciation goes to Dr. Thomas Ganiron Jr. for his guidance and advice, as well as to Engr. Albert A. Griño, Engr. Crispin Lictao, and Engr. Brian G. Eurolfan for their insightful feedback. Finally, thanks to the respondents for their valuable contributions to this study.

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