Engineering and Technology Journal e-ISSN: 2456-3358

Volume 10 Issue 12 December-2025, Page No.-8235-8240

DOI: 10.47191/etj/v10i12.23, I.F. – 8.482

The Impact of Design Changes on Cost and Time Performance in Luxury Residential Construction Projects in South Jakarta

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ABSTRACT: Design changes are among the most common factors affecting construction project performance, particularly in terms of cost and schedule. This study aims to analyze the impact of design changes on project cost and duration in several luxury residential construction projects located in South Jakarta. Data were collected through questionnaires distributed to 30 respondents consisting of contractors, consultants, and site supervisors involved in these projects. The collected data were analyzed using descriptive statistics, correlation analysis, and simple linear regression with SPSS software.

The results of the analysis show that design changes have a moderate and statistically significant positive relationship with project duration (r = 0.486, Sig. = 0.006), indicating that more frequent or extensive design revisions tend to extend project completion time. Conversely, the correlation between design changes and project cost was found to be weak and statistically insignificant (r = 0.212, Sig. = 0.261), implying that design modifications do not significantly contribute to cost escalation in these projects. The regression equation obtained for project duration is $Y = 13.591 + 0.465X$, indicating that each unit increase in design changes adds 0.465 units of time to project completion.

These findings suggest that while design changes are inevitable in high-end residential projects, their time impact is more pronounced than their cost impact. Therefore, effective design coordination, early design finalization, and structured change management are essential to mitigate schedule delays and enhance project performance.

KEYWORDS: Design Changes; Cost; Time; Luxury Residential Projects

INTRODUCTION

Design change is an inevitable phenomenon in the construction industry, particularly in residential projects where the involvement of the client is highly intensive. Unlike large-scale infrastructure or industrial projects that typically adhere strictly to predetermined specifications, residential projects are often influenced by aesthetic preferences, functional requirements, and budget adjustments made during the construction process. As a result, modifications to the original design are common and can have a cascading impact on the project's performance indicators, especially cost and time.

The introduction of new or revised design elements during construction disrupts the established workflow, necessitates rework, and leads to additional procurement or labor requirements. These unplanned activities not only increase direct costs but also extend the project timeline. In some cases, design changes may also affect the quality of workmanship and client satisfaction if not properly managed through effective change control mechanisms.

In the context of residential construction, design changes often originate from multiple sources: owners, consultants, or contractors. Owner-initiated changes typically stem from evolving preferences, financial considerations, or miscommunication during the design stage. Consultant-related changes may arise due to design errors, omissions, or improvements based on site conditions, while contractor-initiated changes often relate to constructability issues or material availability.

Each of these change sources introduces different levels of risk and requires distinct management approaches.

Moreover, residential construction projects generally have shorter durations and smaller budgets compared to commercial projects, which makes them more sensitive to any variation in scope. Even minor alterations in design can lead to disproportionate increases in cost and delays if not anticipated properly. Therefore, it becomes essential to establish a systematic approach to identify, evaluate, and manage design changes throughout the project lifecycle.

Given these challenges, analyzing the relationship between design changes and project performance in residential building construction provides valuable insights into improving cost and schedule control. A better understanding of the types, causes, and impacts of design changes will enable project stakeholders to develop preventive measures, enhance communication among project participants, and implement effective design management strategies. Consequently, this research seeks to evaluate how design modifications influence cost and time performance in residential projects, aiming to contribute to more sustainable

and efficient project delivery in the housing construction sector.

LITERATURE REVIEW

1. Concept and Classification of Design Changes

Design changes are modifications, additions, or omissions to the originally approved design documents that occur during the project lifecycle and affect scope, cost, schedule, or quality. Modern literature emphasizes classification by source (owner, consultant/designer, contractor), timing (pre-construction vs construction phase), and nature (additive, substitutive, or reductive), karena masing-masing kategori membawa implikasi manajerial yang berbeda. Recent reviews also stress that the frequency and impact of changes vary substantially between project types—residential projects typically experience more owner-driven, late-stage changes due to high owner involvement. (Shoar et al, 2021)

2. Causes of design changes (recent evidence)

Contemporary empirical studies (2020–2024) repeatedly identify incomplete/inaccurate client requirements, design errors/omissions, poor interdisciplinary coordination, and owner-initiated preference changes as primary drivers of design change. Shoar et al. (2021) used interpretive structural modeling to show that unclear requirements and insufficient stakeholder alignment are root causes that propagate secondary causes (e.g., rework, variation orders). Field studies from 2022–2024 confirm that supply-chain disruptions and regulatory updates have become more important triggers in the post-COVID era. (Shoar et al, 2021)

3. Impact on cost — direct and indirect effects

Recent quantitative and review studies (2020–2025) confirm that design changes produce both direct costs (rework, extra materials, change-order pricing) and indirect costs (productivity loss, equipment idling, cash-flow stress, claims and dispute handling). New modelling work (e.g., Qasem et al., 2025) developed impact-index models showing how change orders degrade contractor cash flow and magnify cost risk—particularly when changes are frequent or occur late in the schedule. Aggregate industry analyses and practitioner reports (2023–2024) estimate that design changes commonly contribute materially to overall cost overruns (single-digit to low-teens percentage points on project budget, depending on context and timing). (Qasem, 2025)

4. Impact on schedule and productivity

Studies from 2020–2025 provide clearer quantitative evidence of schedule effects. Simulation and empirical analyses indicate that simultaneous or cascading design changes can extend project durations substantially by creating rework loops, interrupting sequences on the critical path, and reducing crew productivity due to remobilization and learning-recovery time. A 2025 quantitative study on schedule impact showed that overlapping design modifications during execution produce cumulative schedule slippage and measurable efficiency loss in affected trades. Large engineering reports and manuals also note that slow approval and implementation of change orders is a major cause of schedule freeze and critical-path delay. (Kim et al, 2025)

5. Integrated assessment: combined cost–time effects

Recent literature increasingly treats cost and time impacts jointly rather than separately. Multi-criteria models and impact-index frameworks (2024–2025) allow practitioners to estimate how a single change order propagates through cash flow, schedule floats, and productivity—thereby producing a combined cost–time consequence rather than isolated metrics. This integrated approach is particularly helpful in residential projects where small schedule slips often translate quickly into disproportional cost increases (administrative overheads, penalties, owner claims). (Qasem, 2025)

6. Mitigation and management approaches (BIM, 4D, process & contractual controls)

Recent applied research (2021–2024) highlights several promising interventions:

- **BIM-enhanced change visualization and clash detection** reduces the likelihood of late design changes by improving early detection of coordination problems; interactive BIM/VR platforms also speed stakeholder decisions on alternatives, lowering rework. (Panya et al, 2023)
- **4D/4D+ change-management models** (integrating time and model changes) support simulation of sequence impacts and help quantify schedule consequences of proposed modifications before execution. ASCE/industry studies in 2024 proposed integrated 4D design-change management models that link model updates to schedule and cost databases. (Wang et al, 2024)
- **Contractual and process measures** — early design freeze milestones, clearer change-order workflows, faster review/approval SLAs, and predefined pricing mechanisms — remain effective administrative controls endorsed by practitioner guidance (2022–2025). Policy/agency technical reports also stress that streamlined procedures for handling change orders reduce downstream disputes and schedule slip. (volpe.dot.gov, 2025)

7. Gaps in recent literature and relevance to residential projects

Although many 2020–2025 studies advance methods for quantifying change impacts and propose BIM/4D solutions, two gaps persist: (1) context-specific empirical studies for residential building projects—most quantitative models are calibrated on larger commercial or infrastructure projects, and (2) empirical evidence linking owner behavior,

decision timing, and measurable cost/time multipliers in small-scale housing projects. Given the high owner involvement and tighter budgets in residential projects, there is a need for context-tailored indices and lightweight 4D/BIM workflows that are affordable for small contractors and homeowners. This study aims to address these gaps by focusing explicitly on residential projects and combining field survey data with a simple impact-index model. (Qasem, 2025).

RESEARCH METHODOLOGY

Case Study Description

This research adopts a case study approach focusing on several luxury residential building projects located in South Jakarta, Indonesia**.** The selected projects represent privately owned high-end housing developments characterized by customized architectural designs and intensive client involvement during the construction phase. Such projects are particularly prone to design changes due to evolving client preferences, material availability, and functional adjustments during execution.

Data Collection Method

Primary data were collected through a structured questionnaire survey distributed to key project stakeholders, including contractors, consultants, and site supervisors directly involved in the selected residential projects. The questionnaire was designed to capture respondents' perceptions regarding the frequency, causes, and impacts of design changes on project cost and time performance.

A total of 30 respondents participated in the survey. The questionnaire was distributed via Google Forms to ensure accessibility and efficient data collection. The responses were then compiled, validated, and analyzed using quantitative statistical techniques to evaluate the relationship between design changes and project performance indicators.

Research Objective and Hypothesis

The questionnaire aims to provide an empirical overview of how design changes influence the cost escalation **and** schedule delays in luxury residential projects. Based on the conceptual framework and previous studies, the research tests the following hypotheses:

- Null Hypothesis (H_0):
  Design changes have no significant impact on the increase in cost and time performance of residential building projects.
- Alternative Hypothesis (H_1):
  Design changes have a significant impact on the increase in cost and time performance of residential building projects.

The hypothesis testing seeks to statistically determine whether variations in project outcomes can be attributed to the occurrence and magnitude of design changes. The results will provide insights into how effectively design change management can mitigate cost and schedule risks in the context of residential construction in Jakarta.

RESULT AND DISCUSSION

To further examine the impact of design modifications on project performance, a statistical analysis was conducted using SPSS software. This analysis aimed to identify and quantify the relationship between Design Changes and key project performance indicators, namely Project Cost and Project Duration, based on data collected from several luxury residential construction projects in South Jakarta.

1. Regression Analysis

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	13.591	3.280		4.143	<.001
	Perubahan Desain	.465	.158	.486	2.945	.006

a. Dependent Variable: Waktu Pelaksanaan

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	86.233	1	86.233	8.671	.006[b]
	Residual	278.467	28	9.945		
	Total	364.700	29			

a. Dependent Variable: Waktu Pelaksanaan

b. Predictors: (Constant), Perubahan Desain

Based on the results of the simple linear regression analysis between Design Change (independent variable) and Project Duration (dependent variable), the correlation coefficient (R) was found to be 0.486. This value indicates a positive and moderate relationship between design changes and project duration. The coefficient of determination (R^2) of 0.236 suggests that 23.6% of the variation in project duration can be explained by design changes, while the remaining 76.4% is influenced by other factors not included in this model. The ANOVA test results show an F-value of 8.671 with a significance level (Sig.) of 0.006. Since the significance value is less than 0.05, the regression model is statistically significant. This indicates that design changes have a significant effect on project duration.

The regression equation derived from the analysis is expressed as follows:

$$\text{Project Duration} = 13.591 + 0.465 \times \text{Design Change}$$

This equation indicates that for every one-unit increase in the Design Change variable, the Project Duration is expected to increase by 0.465 units, assuming other factors remain constant. The positive regression coefficient demonstrates that design changes contribute to an extension of project duration, reinforcing the finding that modifications during construction tend to delay project completion.

Thus, the results of this study indicate that Design Changes have a positive and significant effect on Project Duration**.** The greater the extent of design changes made, the longer the time required to complete the project.

2. The Correlation Analysis

To evaluate the strength and direction of the relationship between Design Changes and project performance variables, a correlation analysis was carried out. This analysis aimed to determine how closely variations in design changes are associated with fluctuations in Project Cost and Project Duration.

Correlations

		Perubahan Desain	Biaya Proyek	Waktu Pelaksanaan
Perubahan Desain	Pearson Correlation	1	.212	.486**
	Sig. (2-tailed)		.261	.006
	N	30	30	30
Biaya Proyek	Pearson Correlation	.212	1	.621**
	Sig. (2-tailed)	.261		<,001
	N	30	30	30
Waktu Pelaksanaan	Pearson Correlation	.486**	.621**	1
	Sig. (2-tailed)	.006	<,001	
	N	30	30	30

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

Based on the results of the Pearson correlation test shown in the table above, the relationship between Design Changes and Project Cost shows a correlation coefficient of 0.212 with a significance value of 0.261 (> 0.05). This indicates a very weak positive relationship between Design Changes and Project Cost; however, the relationship is not statistically significant. In other words, the extent of Design Changes is not meaningfully associated with variations in Project Cost.

Meanwhile, the relationship between Design Changes and Project Duration shows a correlation coefficient of 0.486 with a significance value of 0.006 (< 0.05). This result indicates a moderate positive and statistically significant relationship. It can therefore be concluded that the higher the level of Design Changes, the longer the Project Duration required for completion.

3. Analysis of the Relationship Between Design Changes and Project Cost

The regression analysis further supports this finding, showing that fluctuations in project cost cannot be adequately explained by variations in design changes. In practical terms, this suggests that cost increases in these projects are likely influenced by other factors**,** such as material price escalation, changes in market conditions, labor productivity, or project management efficiency, rather than by design modifications alone.

One possible explanation for this result is that many of the design changes implemented during the construction phase were minor adjustments that did not substantially alter the structural or architectural scope of work. In several projects, effective cost control measures and flexible budgeting systems were already in place, allowing contractors and consultants to absorb the financial implications of design revisions without significantly increasing total project costs.

This finding aligns with studies such as Wang et al. (2021) and Abdullah & Ismail (2023)**,** which found that the cost impact of design changes varies depending on the project's complexity, the timing of the modification, and the contractor's ability to manage design revisions efficiently. Therefore, while design changes often pose a financial risk in construction projects, their influence on cost escalation may not always be statistically significant, especially in projects with strong planning, coordination, and cost management practices.

In conclusion, the statistical evidence from this study confirms that design changes did not exert a significant positive influence on project cost for the analyzed luxury residential projects in South Jakarta. This emphasizes the importance of integrated project management and proactive cost monitoring to mitigate potential financial risks associated with design modifications.

4. Analysis of the Relationship Between Design Changes and Project Duration

The positive regression coefficient (0.465) indicates that each additional unit of design change contributes to an average increase of 0.465 units in project duration, assuming other variables remain constant. The coefficient of determination (R^2 = 0.236) shows that 23.6% of the variation in project duration can be explained by design changes, while the remaining 76.4% is influenced by other factors such as site conditions, procurement delays, labor productivity, and project coordination issues.

This finding aligns with prior research by Shoar et al. (2021) and Qasem et al. (2025), which highlighted that late-stage design modifications often lead to project schedule disruptions due to rework, rescheduling, and additional approval processes. In the context of luxury residential projects, these effects are further amplified by the high level of customization requested by clients, frequent design revisions to meet aesthetic preferences, and the need for premium materials that may require longer procurement times.

The statistical evidence and respondent insights suggest that design changes frequently cause interruptions in construction workflows, delayed decision-making, and reduced resource efficiency. Such disruptions contribute cumulatively to overall project delays. Moreover, inadequate communication between designers, contractors, and owners during the construction phase exacerbates these impacts, emphasizing the importance of a clear change management system.

In summary, the findings of this study confirm that design changes significantly and positively influence project

duration in luxury residential construction. Therefore, to minimize schedule overruns, project stakeholders must strengthen design coordination in the early stages, establish firm design approval protocols, and utilize digital design management tools such as Building Information Modeling (BIM) to predict and control the timing effects of design modifications.

CONCLUSION, PRACTICAL IMPLICATIONS AND FUTURE RESEARCH

Conclusion

The findings of this study reveal that design changes have a significant positive effect on project duration, but do not have a significant effect on project cost in luxury residential construction projects in South Jakarta. The correlation and regression analyses demonstrated that while frequent design modifications tend to extend construction time, they do not necessarily lead to notable increases in project expenditure.

One of the main reasons for this result is the unique socio-economic profile of the clients involved in these projects. Since the owners of luxury residential properties generally possess strong financial capacity, cost is not a major constraint during the construction process. Consequently, any additional expenses resulting from design revisions are easily accommodated without significant concern for budget overruns.

Moreover, most design changes were initiated by the owners themselves, often during the construction phase, as they sought to refine aesthetic preferences, upgrade materials, or modify spatial layouts to achieve a more personalized design outcome. While such owner-driven changes rarely affect the financial feasibility of the project, they tend to disrupt construction sequencing, procurement schedules, and coordination among project stakeholders — ultimately causing project delays rather than cost increases.

Therefore, it can be concluded that in the context of high-end residential construction, time performance is more sensitive than cost performance to design changes. To minimize schedule disruptions, it is recommended that project teams strengthen early-stage design coordination, establish firm approval procedures, and maintain continuous communication with clients throughout the construction phase to manage late-stage modifications effectively.

Practical Implications

The findings of this study have several important implications for practitioners in the construction industry, particularly those involved in luxury residential projects**:**

1. **Owner-Driven Design Changes:**
   Since most design changes originate from the homeowners themselves, project teams must anticipate potential modifications and integrate flexibility into both project schedules and procurement plans. Establishing clear communication channels and approval procedures is essential to minimize the negative impact of late design revisions.
2. **Proactive Time Management:**
   Given that design changes significantly affect project duration, contractors and consultants should adopt proactive scheduling techniques such as Critical Path Method (CPM) and 4D BIM simulation to identify and mitigate potential time delays caused by design revisions.
3. **Cost Control Strategies:**
   Although cost impact was statistically insignificant in this study, maintaining detailed cost tracking remains important. Contractors should implement change order documentation and budget monitoring systems to ensure financial transparency and accountability.
4. **Client Communication and Expectation Management:**
   For projects involving high-income clients, managing expectations is as crucial as technical execution. Early design visualization through digital tools can help clients make better-informed decisions, reducing unnecessary changes during construction.

Suggestions for Future Research

While this study provides valuable insights, it also opens avenues for further investigation:

1. **Broader Project Scope:**
   Future research should include a larger sample size covering various types of residential and commercial projects to validate the generalizability of the findings.
2. **Additional Variables:**
   Subsequent studies could incorporate variables such as project complexity**,** contract type**,** procurement system**,** and team communication quality to better understand their moderating effects on the relationship between design changes, cost, and time.
3. **Comparative Analysis Across Project Scales:**
   A comparative study between luxury and middle-income housing projects may reveal different behavioral patterns regarding design change sensitivity and management strategies.
4. **Integration of Qualitative Insights:**
   In-depth interviews or case studies with project stakeholders can complement quantitative findings by exploring underlying decision-making behaviors, motivations for design change, and managerial responses.

In summary, this study highlights the necessity for effective change management, structured communication, and client-centered design coordination in luxury residential construction projects. Future research expanding the analytical scope and methodological depth will contribute to a more comprehensive understanding of design change dynamics in the construction industry.

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