Evaluation Of Design Change Risks On Time And Quality Control In Apartment Projects In Samarinda City

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ABSTRACT

Design change is a common risk in construction projects and can significantly impact the efficiency of time control and work quality. This study aims to evaluate the impact of design change risk on time and quality control in a flat construction project in Samarinda. The research method used is a case study with a quantitative and qualitative descriptive approach, through interviews with the project team and analysis of project documents such as shop drawings, implementation schedules, and work progress reports. The results show that design changes that occurred in structural and architectural work caused a delay of 32 days from the initial schedule (from 365 days to 397 days). In addition, a decrease in quality efficiency was found due to revisions to working drawings and adjustments to technical specifications in the field. This impact can be minimized through the implementation of more intensive design coordination between planning consultants, supervisors, and contractors before work begins. This study emphasizes the importance of implementing design change risk management to maintain time control and quality in construction projects.

Keywords: *Risk, Design Changes, Time Control, Quality Control, Construction Projects*

I. INTRODUCTION

The construction of apartment buildings is one of the government's priority programs to provide decent housing for low- and middle-income communities. In Samarinda City, apartment construction is a solution to limited land and the increasing need for housing due to population growth. Apartment projects are also characterized by complex work, involving multiple disciplines and coordination between parties, including planners, implementers, and project supervisors.

However, during implementation, construction projects often encounter design changes, both before and during the construction phase. These changes can be caused by revised user requirements, adjustments to field conditions, or errors in initial planning. While design changes are sometimes necessary to accommodate actual conditions, poorly managed changes can pose significant risks to project time and quality control.(Miang, 2015).

In a multi-storey apartment project in Samarinda, several cases of design changes caused delays in structural and architectural work due to late approval of revised working drawings. Design changes and delayed drawing revisions are among the highest-priority risks in multi-storey building projects (Hu, Z., & Chong, H.-Y, 2019). Furthermore, work already completed requires rework, disrupting the project schedule and reducing field efficiency. From a quality perspective, design changes can also impact the consistency of material specifications and the final product.

Given these conditions, an evaluation of the risks posed by design changes is necessary, particularly in relation to time and quality control of the apartment project in Samarinda. This research was conducted using a case study approach, so that the analysis results can provide a concrete picture of how design changes affect the effectiveness of the construction project control system in the field.

II. RESEARCH METHODOLOGY

Types and Approaches of Research

This research uses a qualitative descriptive method with a case study approach. This method was chosen because the research focuses on an in-depth analysis of a real-life project, namely a flats project in Samarinda City, which underwent design changes during the implementation phase.

Location and Object of Research

This research was conducted on a flat construction project in Samarinda City, East Kalimantan Province. The research objects include:

1. The process of implementing an apartment project that has undergone a design change.
2. Project documents such as working drawings, daily/weekly reports, and minutes of coordination meetings.
3. The parties directly involved in project implementation are the implementing contractor, supervising consultant and planner.

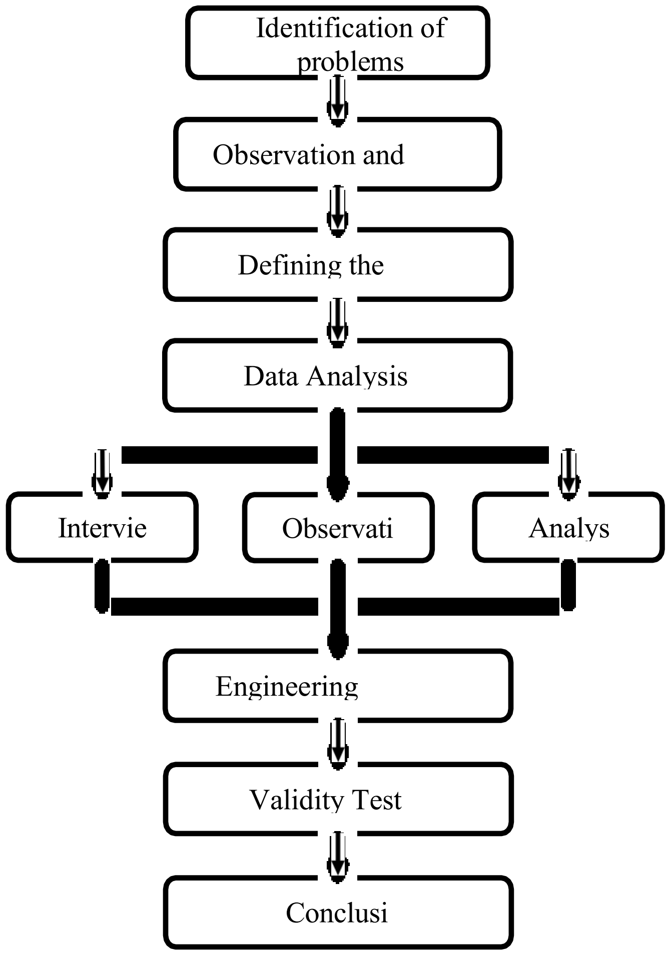
The selection of this location was based on the consideration that the apartment project had a high level of complexity and there were several design changes during implementation that affected the schedule and quality of the work.

Data Sources and Types

The data used in this study consists of primary data and secondary data, namely:

1. Primary Data
   Obtained directly from the field through:
   - Interviews with contractors, consultants, and project supervisors.
   - Observation of the implementation of work affected by design changes.
   - Photographic documentation or field notes related to construction activities.
2. Secondary Data
   Obtained from relevant documents and references, including:
   - Contract documents, working drawings, shop drawings, and project progress reports.
   - Design change report and new design approval minutes.
   - Literature, journals, and books on risk management and project control.

Research Flowchart



III. RESULT AND DISCUSSION

Forms and Causes of Design Change

Based on the results of interviews and project documents, several forms of design changes were found that occurred in this apartment project, including:

Table 4.1. Design Change

No	Types of Changes	Affected Areas	Reason	Time of Occurrence
1	Changes to the emergency staircase layout	Structure & Architecture	Revision of the fire department for evacuation safety	3rd month
2	Ground floor elevation adjustment	Foundation & sloof work	Field soil conditions differ from the initial results of soil investigations.	2nd month
3	Changing wall finishing materials	Architectural work	Cost efficiency policy from the owner	6th month
4	Addition of a canopy in the parking area	Architecture & light steel work	User requests for additional convenience	8th month

Impact of Design Changes on Project Time

Each design change results in adjustments to the implementation schedule. Based on the evaluation of the project's weekly reports, the following impacts of delays were identified:

Table 4.2. Impact of Delays

Types of Changes	Delay Duration (Days)	Percentage of Total Contract Duration (%)	Information
Changes to the emergency staircase layout	12	3.33	Revision of drawings and rework of formwork
Ground floor elevation adjustment	10	2.78	Differences in actual soil conditions
Replacement of finishing materials	6	1.67	Waiting for new material approval
Addition of parking canopy	4	1.11	Additional work at the end of the project
Total delay	32	8.89	

According to PMI (2017), measuring time efficiency can be done using the formula:

$$E_{waktu} = \frac{Waktu\ rencana}{Waktu\ aktual} \times 100\%$$

$$E_{waktu} = \frac{365}{397} \times 100\% = 91{,}9\%$$

Information:
Ewaktu : Project time efficiency
Plan time :Duration of project implementation according to contract
Actual Time : Actual implementation duration in the field
This value indicates that the project time efficiency is 91.9%, or there is a decrease in efficiency of 8.1% due to design changes.
These results are in line with the findings of Hanna et al. (1999) that design changes have a direct impact on work delays due to drawing revisions and additional coordination.

Analysis of the Impact of Design Change on Quality

Quality assessment is carried out based on the results of work inspections and monitoring reports regarding compliance with technical specifications. According to Soeharto (1999), quality values are calculated using:

$$I_{mutu} = \frac{jumlah\ item\ sesuai}{jumlah\ item\ diperiksa} \times 100\%$$

Information:
I_{mutu} :Job quality index
Number of items as per :number of work items that meet specifications
Number of items checked : total itemswork being checked

Table 4.3. Impact of Design Change on Quality

Stage	Number of items checked	As per specifications	Quality Index
Before design change	45	43	95.6
After design change	45	41	91.1

Therefore, it can be concluded that design changes cause a 4.5% decrease in work quality, particularly in the finishing section where materials are changed. This finding is supported by Al Tekreeti (2024), who stated that design changes without effective coordination can reduce quality due to rework and differences in material specifications.

Data Analysis and Interpretation
Risk Analysis (Risk Matrix)

According to the Project Management Institute (PMI, 2017), the Risk Matrix method is the most practical method for construction projects in Indonesia. Risk evaluation using the Risk Matrix method uses two parameters:

- *Likelihood*(L)
- *Impact*(I)

The Risk Matrix value is calculated using the following formula:

$$\text{Risk Score} = \text{Likelihood} \times \text{Impact}$$

Information:
Risk Score : Markcombined risk
Likelihood(L) :Possibility of risk
occurring *Impact*(I) :Impact of risks on
the project

Table 4.4. Risks Due to Design Change

No	Types of Risks Due to Design Change	L	I	*Risk Score*	Risk Category
1	Delay in revision of working drawings	5	4	20	Tall
2	*Rework*due to structural changes	4	4	16	Tall
3	Delay in approval of new materials	3	3	9	Currently
4	Decrease in finishing quality	3	2	6	Low
5	Additional work costs	4	3	12	Currently

From the table above, risks with a score of ≥ 15 are categorized as high and are the primary focus of project control. The most significant risks are delays in revising working drawings (score 20) and structural rework (score 16).

Quantitative Risk Evaluation – Risk Priority Index (RPI)

According to PMI (2017), to determine risk priorities, the following formula is used:

$$RPI = \frac{Risk\ score}{Risk\ score_{max}} \times 100\%$$

Risks with RPI > 70% are categorized as high priority and must be mitigated immediately.

Control System Evaluation

RPI is a direct derivative of the Risk Ranking method where:

- Risk Score: $L \times I$
- Risk Scoremax : the maximum value of the highest combination

Table 4.5. Risk Priority Index (RPI)

No	Types of Risk	Risk Score	RPI(%)	Priority
1	Delay in revision of working drawings	20	100	1
2	Rework due to structural changes	16	80	2
3	Additional work costs	12	60	3
4	Delay in material approval	9	45	4
5	Decrease in finishing quality	6	30	5

1. Time Control
   - The contractor applies rescheduling and crashing schedule methods to non- critical work.
   - Additional overtime hours are used to catch up on delays.
   - Using the Microsoft Project application helps monitor schedule deviations.
2. Quality Control
   - Any replacement material is verified and approved by the supervising consultant.
   - Concrete compressive strength tests (K-250 quality) and wall plaster finishing checks were carried out after rework.
   - Field inspections show that the quality of work is still within tolerance limits.
3. Risk Control
   - There is no formal Change Management Procedure system in this project.
   - The design revision process is still manual, resulting in slow response times.
   - A document digitization system is needed to speed up approvals.

Data Validity and Validity Test

The validity of the research was tested using the trustworthiness approach according to Lincoln & Guba (1985).

The test results show that the data is credible and valid, with a level of conformity in the field reaching > 90% against the overall project documents.

Table 6. Data Validity and Validity Test

Test Type	Implementation Method	Results
Source Triangulation	Comparing interview results with documents and observations	Data is consistent (image revisions have been shown to cause delays)
Engineering Triangulation	Interview + Observation + Documentation	These three techniques produce the same findings or results.
Member Check	Confirm the analysis results to the contractor and project supervisor	Respondents agreed with the analysis results
Peer debriefing	Discussion of results with project management experts	Validation of academically accepted results

IV. CONCLUSION

Based on the results of the analysis of the discussion in Chapter IV above, the following conclusions were obtained:

1. Design change is a dominant risk that arises during the project implementation phase. The main contributing factors include architectural revisions by the project owner, inconsistencies in working drawings, changes in material specifications, and the need to adapt to field conditions.
2. From the risk identification results, there are four main types of design changes with Risk Score values between 6 and 16, where the highest risk is in the revision of the emergency staircase layout (score 16 – high category).
3. The impact of design change risk on project time control is measured by the increase in implementation duration. Calculations show that the delay was 32 days out of the total 360- day contract duration, or 8.9%. This indicates that time control was not effective due to design revisions requiring re-coordination between work disciplines and additional time for new design approvals.
4. The impact of design change risk on project quality control is evident in the decline in the Quality Performance Index (QPI). The evaluation results showed a decrease from 93.3% to 90.0%, indicating a 3.3% decrease in quality due to time constraints and adjustments to work methods in the field after the design revision was implemented.
5. The efficiency evaluation results showed that time control efficiency (Etime) was 91.8% and quality control efficiency (Equality) was 96.5%. These values indicate that project control effectiveness has decreased due to the risk of design changes, although quality can still be maintained relatively well through strict supervision.
6. Overall, design changes have been shown to have a significant negative impact on project performance, particularly on implementation time. Therefore, a more integrated risk management system and design coordination between planners, implementers, and project owners are needed to minimize design changes from the planning stage.

REFERENCES

Al Tekreeti, AMA (2024). Developing a new model to control risk and improve quality in the construction industry by integrating risk management and quality function deployment. Periodicals of Engineering and Natural Sciences, 12(1), 101–122.https://doi.org/10.21533/pen.v12.i1.24

Collins, S.P., Storrow, A., Liu, D., Jenkins, C.A., Miller, K.F., Kampe, C., & Butler, J. (2021). What's Up With: Risk Management. 1(1), 167–186.

Hanna, A.S., Russell, J.S., Nordheim, E.V., & Bruggink, M.J. (1999). Impact of change orders on labor efficiency for mechanical construction. Journal of Construction Engineering and Management, 125(3), 176–184.https://doi.org/10.1061/(ASCE)0733-9364(1999)125:3(176)

Hu, Z., & Chong, H.-Y. (2019). A risk assessment framework for construction projects using risk matrix and fuzzy logic. Journal of Civil Engineering and Management, 25(3), 241–252.https://doi.org/10.3846/jcem.2019.8590

Kerzner, H. (2017). Project Management: A Systems Approach to Planning, Scheduling, and Controlling (12th ed.). John Wiley & Sons

Lincoln, Y.S., & Guba, E.G. (1985). Naturalistic inquiry. Sage Publications.

Miang, G.Y. (2015). Empirical Investigation of The Average Deployment Force of Personal Fall-Arest Energy Absorbers. Journal Of Construction Engineering and Management, 141(1), 4014059.https://doi.org/10.1061/(ASCE)CO.1943-7862.0000910

PMI (Project Management Institute). (2017). A Guide to the Project Management Body of Knowledge (PMBOK® Guide) (6th ed.). Project Management Institute, Inc.

Simanjuntak, Manlian, Manurung, Edison Hatoguan, Naibaho, Pio Ranap, Faslih, Arman, Puro, Sarjono, Wardiningsih, Sitti, & Suripto (2023). Construction Project Management. Cendikia Mulia Mandiri

Shoar, S., & Chileshe, N. (2021). Exploring the Causes of Design Changes in Building Construction Projects: An Interpretive Structural Modeling Approach. Sustainability, 13(17), 9578.https://doi.org/10.3390/su13179578

Soeharto, I. (1999). Project Management: From Conceptual to Operational. Erlangga.