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Real-Time Internet-Based Master Schedule Monitoring to Reduce Late Penalty Costs in Housing Projects

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ABSTRACT

Housing project delays result in significant financial penalties for real estate developers in Indonesia. Based on a comprehensive study of seven housing clusters in Serpong, Tangerang (2016–2019), 18% of units (221 out of 1,213 units) experienced delayed handovers, resulting in penalty costs of Rp. 12,464,815,643. This research examines the root causes of delays through fishbone analysis and Pareto diagrams, identifying inadequate schedule control systems as the primary internal factor. Through observation and interviews conducted during the 2016–2019 period, the author studied one of the developers of a housing project in Serpong, Tangerang. From a total of seven clusters, data showed that 18% of consumer handovers were delayed, resulting in fines. The proposed system involves all stakeholders—Marketing, Planning, Quantity Surveying, and Project teams—in synchronized monitoring, shifting from single-person control to collaborative real-time oversight. The results of this project management study, namely an integrated project time management system based on the internet, utilizing special servers and cloud infrastructure, provide an overview of potential solutions to reduce late penalties. The study demonstrates that integrated project time management systems can protect developers' cash flow and reduce substantial financial losses from consumer penalties, thereby improving project delivery performance in the Indonesian housing sector.

KEYWORDS consumer fines, internet, master schedule, project management

INTRODUCTION

Indonesia's rapid urbanization has significantly intensified housing demand. According to the Central Bureau of Statistics (BPS), Indonesia's urban population grew from 49.8% in 2010 to 56.7% in 2020, creating substantial pressure on housing infrastructure (BPS, 2020). The World Bank (2019) reports that Indonesia faces a housing backlog of approximately 11.4 million units, particularly affecting middle- to lower-income segments. In the current era of globalization, most developing countries, especially Indonesia, are experiencing a very high rate of population growth. This situation affects various sectors of community life, one of which is the need for livable housing. To meet housing needs, individuals may either build their homes independently or purchase them from developers—either housing that is physically completed or units ordered through pre-construction schemes (Altaf et al., 2022; Diófási-Kovács & Tátrai, 2025).

The buying and selling of housing units that have not yet been built or are still in the planning phase is growing rapidly (Adarkwa et al., 2024; Marais et al., 2022). The implementation of pre-construction housing sales follows the *PPJB (Perjanjian Pengikatan Jual Beli)* or Sale and Purchase Binding Agreement scheme, which presents distinct project

management challenges. Under the PPJB mechanism, developers commit to specific handover dates before construction begins, creating stringent timeline pressures. This advance commitment structure introduces considerable delay risks due to potential gaps in time monitoring systems, inadequate coordination between project departments, and the complex interdependencies inherent in housing construction. Research by Santoso et al. (2021) indicates that 42% of housing projects in Indonesia experience delays exceeding 30 days, with weak monitoring systems identified as a primary contributing factor. Buying and selling is a consensual agreement, which becomes valid and legally binding at the moment the seller and buyer reach an agreement regarding the main elements—namely, the goods and their prices—regardless of whether the object of sale is immovable property. Through the PPJB, the rights and obligations of both parties—consumers and business actors—arise and must be fulfilled in accordance with what has been agreed upon (Juhász & Lane, 2024).

In the book *Software Project Management* (Munir, 2015), it is stated that project implementation and control involve measuring progress toward project goals, observing deviations from predefined plans, and improving or adjusting the project's development to realign with those plans. In the context of software project management, project execution and control do not mean dictating actions or thoughts but rather emphasize gathering and analyzing past, present, and future information. All this data is analyzed, designed, implemented, and tested for accuracy. The implementation and control function is aimed at ensuring prudence in action so that implementation aligns with planning. The objective of execution and control covers all activities and phases within the project.

Furthermore, in the thesis entitled *Development of the Design of the Monitoring and Control System of Multi-Construction Projects Using the House of Quality Method: A Case Study of the Public Works Office of Gresik Regency* (Agus Siswanto, 2017), the resulting software was found to meet the needs of stakeholders involved in multi-construction projects as a structured and systematic monitoring and control tool using the House of Quality method. Similarly, in the journal *Application for Monitoring the Progress of Project Work in the Field of Highways of the Probolinggo Regency PUPR Office Web-Based* (Fathorazi Nur Fajri, 2020), the research produced a web-based project progress monitoring application. This system helps supervisory consultants, staff, and leaders monitor project progress in comparison to the planned schedule, enabling timely decision-making for necessary improvements. The availability of an online project work monitoring application enhances convenience by allowing the monitoring process to be conducted remotely.

Regarding handover delays to consumers, empirical data from the Indonesian Real Estate Association (REI) indicates that in 2018–2019, approximately 23% of housing projects in Greater Jakarta experienced delays, with penalty costs ranging from Rp. 500 million to Rp. 5 billion per project cluster (REI, 2019). In Tangerang specifically, developers reported an average delay rate of 15–20% of total units, with cumulative penalties exceeding Rp. 50 billion annually across the region. Such delays in handover are directly related to delays in project implementation progress. Even when project management includes time buffers beyond PPJB limits, the maximum allowable time is often reached or exceeded, triggering late penalty clauses. To address these issues, an integrated master schedule monitoring approach is required—utilizing internet-based systems supported by dedicated cloud servers.

Despite extensive research on construction project management, few studies have specifically explored the integration of real-time, cloud-based monitoring systems for housing projects under PPJB constraints. Munir (2015) discussed software project management control processes but did not focus on real estate applications. Siswanto (2017) developed a monitoring system for multi-construction projects using the House of Quality method, although this approach lacked real-time capabilities and cloud integration. Fajri et al. (2020) created a web-based monitoring application for highway projects, but it did not address the unique

complexities of housing projects involving multiple stakeholders and stringent consumer handover deadlines. The novelty of this study lies in developing an integrated, cloud-based master schedule monitoring system specifically designed to minimize PPJB delay penalties in housing projects through real-time, multi-departmental coordination.

The background of this research is to address inefficiencies in real estate development companies in Serpong, Tangerang. It aims to reduce late delivery penalties, which can reach billions of rupiah, and to ensure timely unit handovers. This research focuses on developing an integrated, real-time master schedule monitoring system to prevent delays in construction progress. By implementing a new method involving all Personnel In Charge (PICs), the system aims to ensure work efficiency, minimize potential additional project costs, and enable coordinated monitoring by all stakeholders—from Marketing and Planning to Quantity Surveying and Project Management—thereby reducing potential losses and improving overall work effectiveness.

RESEARCH METHOD

The study employed a mixed-methods approach combining quantitative analysis of delay data with qualitative assessment through interviews and observations. Data collection involved reviewing 1,213 unit handover records, conducting structured interviews with 15 project managers and department heads, and observing daily project coordination processes over the four-year period.

Research Concepts and Models

The research methodology is carried out in several stages; the following is the framework that will be used in this study (Figure 1).

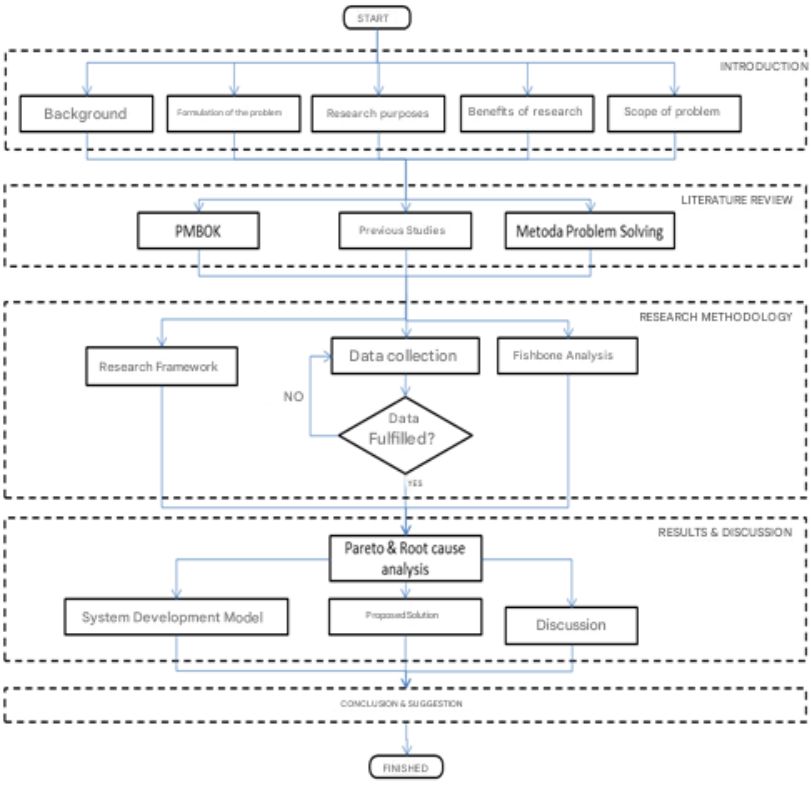

Figure 1. Research Framework

The study was conducted on real estate developer companies in seven housing development clusters in Serpong, Tangerang, Banten, from 2016 to 2019. The analysis model

was carried out using fishbone analysis, pareto diagrams and master schedule evaluations, as well as simple statistical analysis of variance.

The research followed a systematic problem-solving framework adapted from Freddy Liong (2016), which includes: (1) defining the problem through data analysis, (2) conducting causal analysis using brainstorming and fishbone methods, (3) identifying root problems through the 5 Why method, (4) identifying possible solutions, (5) selecting optimal solutions based on ranking criteria, (6) preparing action plans, and (7) implementing solutions with evaluations.

RESULTS AND DISCUSSION

Result

Through *the Fishbone* method, by grouping on two main factors of late handover to consumers: internal factors and external factors. The fishbone analysis revealed multiple contributing factors within each category. Internal factors included inadequate schedule control systems, delayed land handover, material handling issues, design changes, and coordination problems between departments. External factors encompassed contractor performance issues, weather disruptions, and regulatory delays. This systematic categorization enabled prioritization of factors based on their frequency and impact on project timelines.

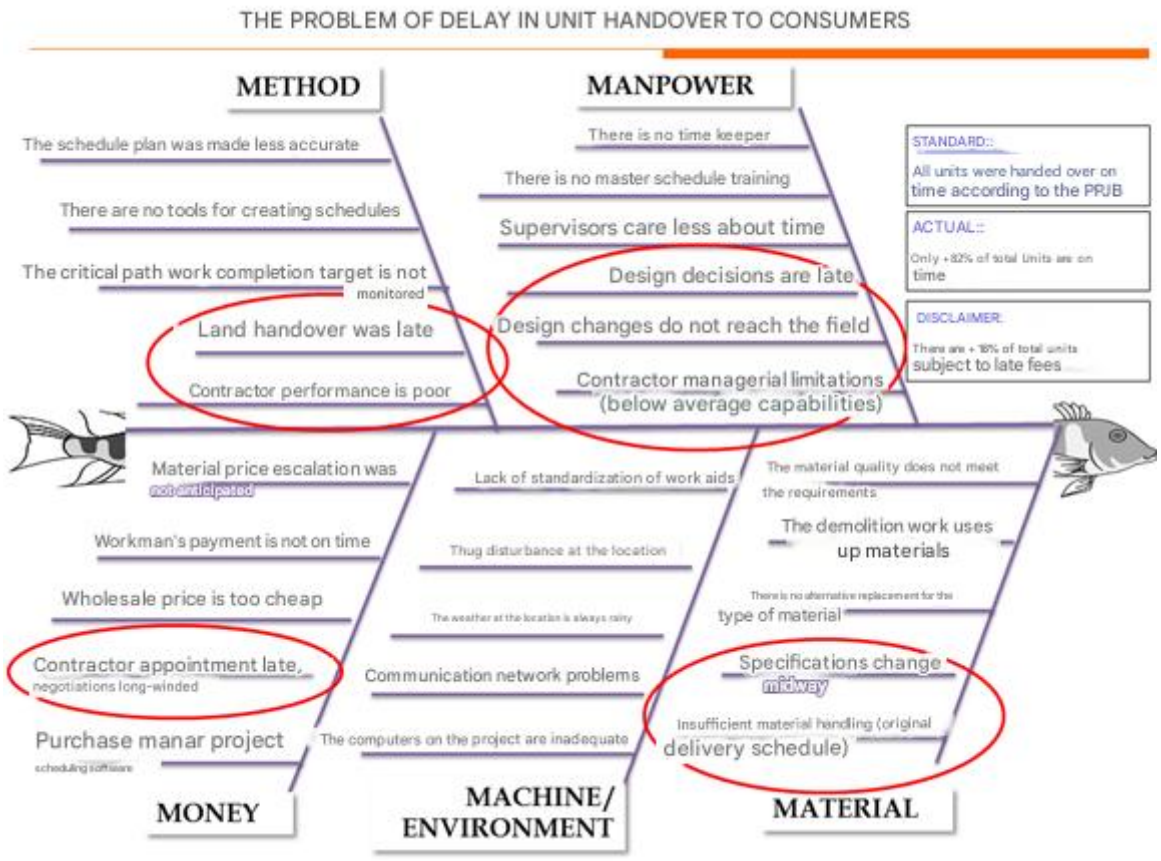

Figure 2. *Fishbone Diagram*

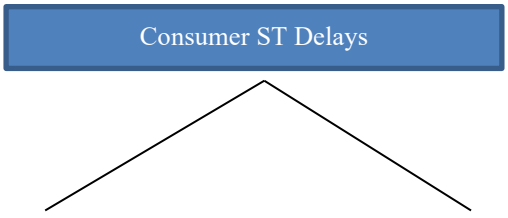

Figure 3. Two causative factors analyzed through Fishbone

From the fishbone analysis followed by the 5 Why method (root problem identification), two potential root problems were identified: a suboptimal system for monitoring project schedules and an insufficiently rigorous contractor selection system. The 5 Why analysis traced each delay instance to its fundamental cause. For example, delayed material delivery (Why 1) was caused by poor coordination (Why 2), which stemmed from inadequate communication systems (Why 3), rooted in the absence of real-time monitoring (Why 4), ultimately caused by reliance on manual, single-person schedule control (Why 5). This root cause analysis, supported by research from Kerzner (2017) on project management systems, validated the need for integrated monitoring approaches.

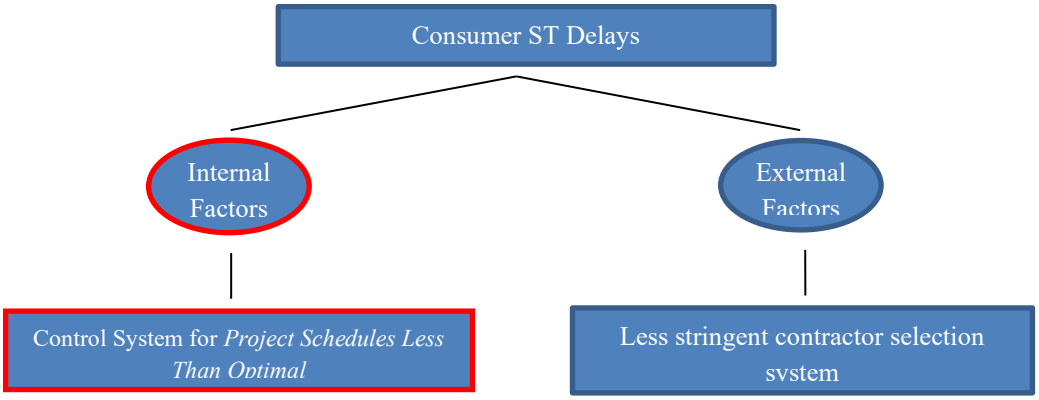

Figure 4. Summary of the results of the analysis of Fishbone with the Root of the Problem (red)

Then the cause is found below (after the less relevant cause is removed). With more dominant Pareto data, it is found in the 3 largest problems that cause 80% of the events as seen in figure 5 and figure 6. The Pareto analysis quantified the relative impact of each factor: (1) delayed land handover accounted for 35% of delays, (2) material handling issues contributed 28%, and (3) design changes represented 17% of delay incidents. This 80/20 distribution aligns with Pareto's principle, where approximately 80% of effects come from 20% of causes (Gaspersz, 1998). These findings directed the research focus toward addressing the most impactful factors.

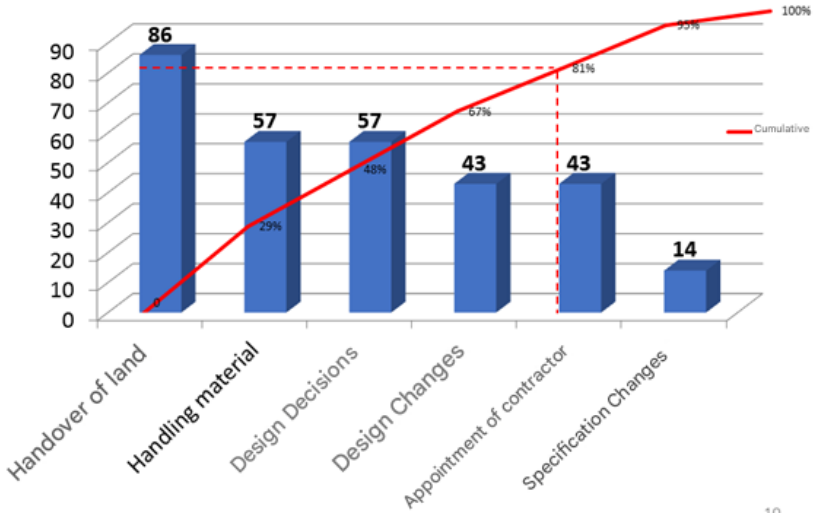

Figure 5. Internal Factors with the Dominant Cause of the Pareto number

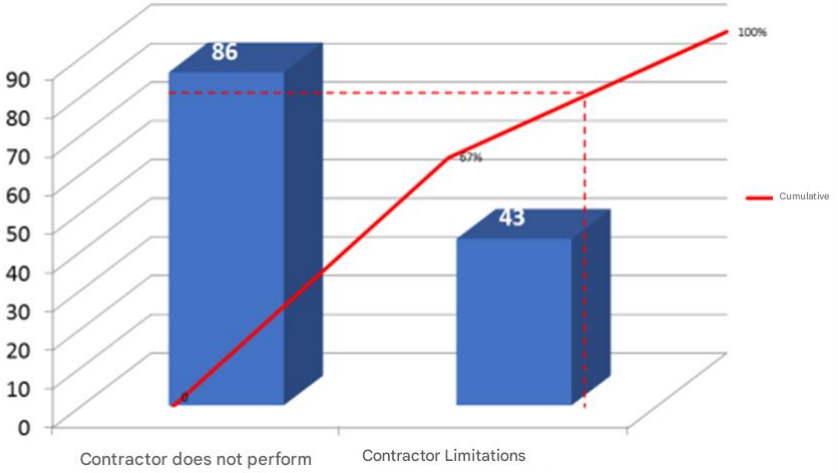

Figure 6. External Factors with the Dominant Cause of the Pareto number

In this case, the discussion of the research focuses on internal factors because it will have a very significant impact. As for the external factors in this discussion, no further discussion was carried out. Because the focus of the solution will be on the method and system in project management, the Control System for the schedule that is still considered to be less than optimal (red box) is the root of the problem in question, which will be found a solution. Supported from Pareto data with 3 (three) main causes: late land handover, material handling (from schedule problems and problematic materials in the field) to decisions and designs that change or are not applicable in the field and related to technical drawings for construction.

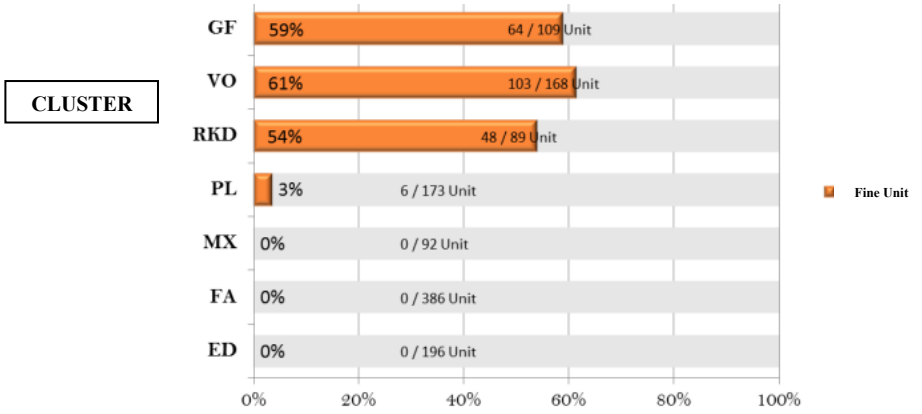

Figure 7. Amount of Delay in Fine Unit

Based on the results of the research that occurred, there was a delay between the handover and PPJB as shown in figure 7 and figure 8. The PPJB list consists of many dates according to their respective units, in contrast to figure 2 which presents SPK dates only. For the last 3 (three) clusters (MX, FA, ED) the handover is the same as PPJB, while the next 4 (four) clusters (GF, VO, RKD, PL) have a deviation between the handover and PPJB. Statistical analysis revealed that early-period clusters (GF, VO, RKD, PL) experienced significantly higher delay rates (25-61%) compared to later clusters (MX, FA, ED) with 0% delays, suggesting learning effects and system improvements over the project timeline.

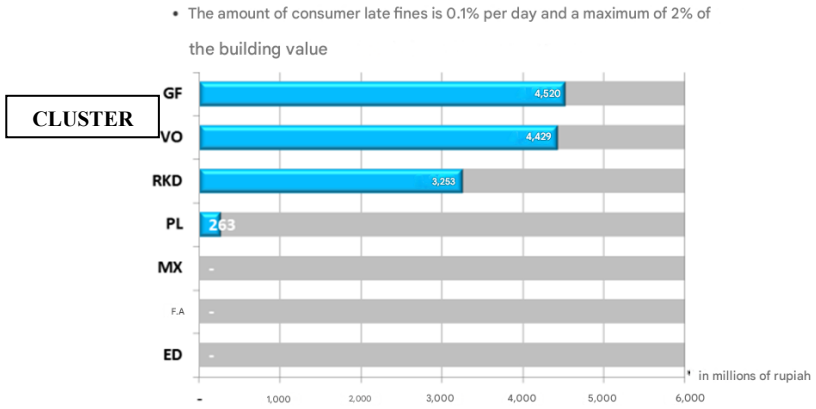

Figure 8. Amount of Delay in Rupiah

With the percentage of units experiencing the largest fines, which is 61% (VO cluster), and the highest number of fines of Rp.4,520,000,000 is in the GF cluster. For a recap of the situation of late fines in this paper experienced by Real Estate Developers in Serpong, as follows:

1) Total Units built : 1,213 units
2) Total Late Units : 221 units
3) Percentage : 18.22 %
4) Late Fines : Rp. 12.464.815.643,-

Discussion

After analysis and discussion, the author identified the following shortcomings or potential weaknesses through observations:

1. Schedule monitoring is performed by only one Time Control person
2. Heavy reliance on Time Control person's memory
3. Reactive approach—problems arise before joint action is taken
4. Personnel involved in the project are not engaged in real-time
5. Significant effort required to remind all Persons in Charge

6. Potential for substantial financial losses

These findings align with research by Dvir and Lechler (2004) on project management effectiveness, which emphasizes that centralized control by single individuals creates bottlenecks and information asymmetries. Similarly, Kerzner (2017) argues that successful project delivery requires distributed responsibility and real-time information sharing across all stakeholders. The identified weaknesses demonstrate a critical gap between traditional project control methods and the demands of complex, multi-departmental housing projects.

Based on observation results, analysis, and interviews, an integrated internet-based master schedule monitoring system is proposed to operate in real-time, involving all related departments: Marketing, Planning, Quantity Surveying, and Project teams. The proposed system architecture leverages cloud computing technology to enable simultaneous access and updates from multiple users across departments. This approach addresses the limitations of centralized control by distributing monitoring responsibilities while maintaining integrated visibility. Research by Azhar et al. (2012) on Building Information Modeling (BIM) and cloud-based project management demonstrates that integrated digital platforms can reduce project delays by 15-25% through improved coordination and early problem detection. The system flow diagram is presented in Figure 9.

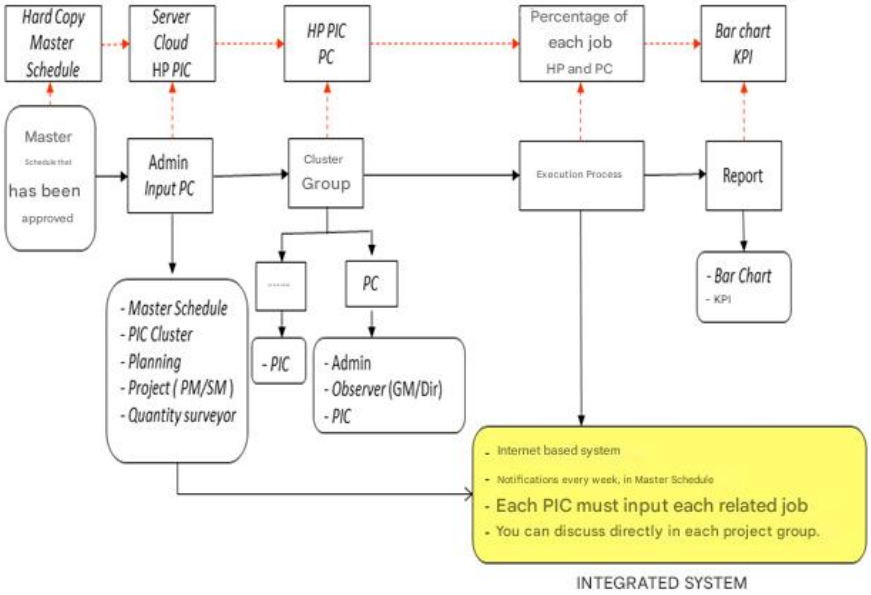

Figure 9. Flow Diagram of the Project Implementation Control Process

Note: Due to the requirement for real-time system operation, internet connectivity is mandatory. Cloud system computing is also proposed to ensure accessibility, data synchronization, and system reliability across all user locations.

Table 1 presents predicted outcomes and impacts of implementing the proposed solution to overcome late penalties to consumers. The comparative analysis demonstrates substantial improvements across multiple dimensions: shifting from single-person monitoring to collaborative oversight, transitioning from Excel-based tracking to integrated specialized programs, moving from reactive to proactive delay detection, and enabling real-time information retrieval. These improvements are expected to reduce the potential for substantial losses to minimal levels, though with additional software costs. The cost-benefit analysis suggests that software investment is justified by the elimination of multi-billion Rupiah penalty risks.

Table 1. Predicting Outcomes for Delay Solution Measurement

Description	Existing Conditions	Proposed Solutions
Situation	Monitoring is carried out by 1 time control person	Monitoring is carried out by 1 time control person and PIC involved
Work System	Monitoring using Excel program Relying on time control memory Delays are still frequent	Monitoring with integrated special programs Each PIC is programmed to input work progress Delays can be detected in advance Running project information can be retrieved in real time
Potential Loss	Big	Minimal
Cost	Employee Salary	Employee Salary + Program Software

CONCLUSION

Based on the research findings, this study successfully identified that delays in housing project handovers resulted in penalty costs of Rp. 12,464,815,643 across seven clusters in Serpong, Tangerang, affecting 18.22% of total units. The root cause analysis revealed that inadequate schedule control systems—characterized by single-person monitoring, reliance on memory, and lack of real-time coordination—were the primary internal factors driving these delays. The proposed internet-based integrated master schedule monitoring system addresses these deficiencies by enabling real-time, multi-departmental collaboration among Marketing, Planning, Quantity Surveying, and Project teams. Implementation of this cloud-based system is expected to significantly reduce late handovers through early delay detection, proactive problem-solving, and enhanced coordination efficiency. This research contributes to project management practice by demonstrating how digital transformation of schedule monitoring can protect developers' financial positions and improve project delivery performance. Future research should focus on developing specific software applications tailored to Indonesian housing project contexts, conducting longitudinal studies to measure actual penalty reduction rates post-implementation, and exploring integration with Building Information Modeling (BIM) systems for comprehensive project lifecycle management. Additionally, comparative studies across different regions and project scales would provide valuable insights into scalability and adaptability of the proposed system.

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