

Development of a Risk-Based Planning, Construction, and Control System for Sidewalks in the DKI Jakarta Area to Improve Time Performance

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ABSTRACT : Sidewalk development as part of urban infrastructure plays an important role in supporting safe and comfortable pedestrian mobility. In DKI Jakarta, sidewalk construction and rehabilitation projects continue to be implemented to improve urban environmental quality. However, project implementation still frequently experiences delays due to planning, execution, and control processes that remain less optimal and do not comprehensively consider project risks. This study aims to develop a risk-based planning, implementation, and control system to improve the time performance of sidewalk projects based on the PMBOK 6th Edition. Data were collected through expert surveys and questionnaires distributed to 40 respondents from government institutions serving as project owners with experience in the planning, construction, and control of sidewalk projects in DKI Jakarta. Data analysis was conducted using IBM SPSS Statistics version 27 through homogeneity, validity, reliability, correlation, factor, and stepwise regression analyses. The results show that construction and control variables have a significant influence on project time performance, while planning and guideline variables have relatively smaller effects. In addition, 18 high-level risks were identified out of 126 project risks. The findings of this study serve as the basis for developing a risk-based SOP to improve the effectiveness of planning, implementation, and control processes in sidewalk projects in order to achieve better project time performance.

KEYWORDS - construction, controlling, high level risks, planning, sidewalk projects.

I. INTRODUCTION

Sidewalks are pedestrian pathways generally constructed parallel to the roadway and positioned at a higher elevation than the road pavement to ensure pedestrian safety [1]. In supporting the development of a more organized and pedestrian-friendly urban environment, the Department of Highways of the Special Capital Region of Jakarta has established sidewalk development targets as outlined in the 2023–2026 Regional Development Strategic Plan (Renstra RPD). The targets include the construction of 20 km of sidewalks in 2023, 40 km in 2024, and 50 km in 2025 [2]. Achieving these targets requires successful project implementation. A project itself is defined as a temporary endeavor undertaken to create a unique product, service, or result. In practice, project success is commonly measured by the ability to complete the work according to the predetermined schedule [3].

Project delay is officially identified when the work cannot be completed within the timeframe agreed upon in the contract between the Owner and the Contractor. This condition indicates that the project has exceeded the contractual deadline without achieving completion according to the

specified scope of work. Such delays serve as the basis for implementing corrective and administrative actions, including the imposition of delay penalties, schedule adjustments, and acceleration measures to ensure that the project objectives can still be achieved in accordance with the contract provisions [4].

Previous studies concerning project planning, construction, and control processes have predominantly focused on building projects, highways, and other construction sectors, while studies specifically related to sidewalk construction projects remain very limited [5,6,7,8]. In addition, research related to risk-based development of planning, construction, and control processes to improve project time performance has not identified the development of guidelines or Standard Operating Procedures (SOPs) specifically designed for sidewalk construction project management.

Based on these conditions, this study aims to strengthen and develop the planning, construction, and control processes of sidewalk projects through a risk-based approach, particularly by addressing dominant risks that have contributed to project delays in Jakarta. The proposed

development is intended to enable potential problems to be identified at an early stage so that mitigation actions can be implemented before they significantly affect project execution and cause delays in the field.

II. LITERATURE REVIEW

2.1 Existing Planning, Construction, and Control Processes of Sidewalk Projects

The primary focus of transportation is to accommodate human movement (moving people), or more specifically, to support the mobility of mass public transportation systems. One of the work programs implemented by the Department of Highways to support this objective is the development and improvement of pedestrian pathways/sidewalks. The construction of pedestrian facilities is aligned with transit-oriented development programs aimed at enhancing the connectivity and mobility of mass public transportation systems [2]. Currently, sidewalk management in Jakarta adopts the Complete Street approach. These pedestrian facilities are expected not only to function as mobility infrastructure, but also to create a more sustainable, safe, and comfortable urban environment through the implementation of an ideal and comprehensive Complete Street sidewalk concept [2].

A Complete Street is defined as a roadway whose spatial allocation and design are capable of accommodating the mobility and activity needs of all road users in an inclusive and user-friendly manner, including pedestrians, cyclists, public transport users, women, and people with disabilities. Furthermore, its development is integrated with other public infrastructure, facilities, and utilities, while also being adapted to the characteristics and contextual requirements of the surrounding urban area [9].



Figure 1. Complete Street Concept and Road Space Allocation

Source: Pedestrian Facility Design Guidelines (2017–2022)

In the planning stage of Complete Street sidewalk development, implementation is carried out through the preparation of activity plans. These plans are developed by considering technical

recommendations from Regional Apparatus Organizations/Work Units within Regional Apparatus Organizations and by accommodating the principles of Complete Street planning and development. The activity plans are then translated into detailed engineering design documents and other supporting technical documents. The implementation plan for sidewalk construction activities also refers to the information map provided by the Department of Human Settlements, Spatial Planning, and Land of the Special Capital Region of Jakarta Province [9].

During the implementation stage of Complete Street sidewalk construction in Jakarta, all construction activities are carried out in accordance with the approved technical planning documents. The construction process must consider the availability of temporary pedestrian pathways, occupational safety and security within the work area, cleanliness of the construction site, as well as traffic management and traffic engineering arrangements surrounding the sidewalk project location [9].

Project control is defined as a series of activities aimed at ensuring that the project remains on track by identifying deviations and implementing corrective actions when necessary [10].

2.2 Time Performance Concept

Project time performance is influenced by three main aspects, namely planning, implementation, and control. During the planning stage, scheduling is developed using time management methods to determine the sequence of activities and identify the project's critical path. In the implementation stage, time performance is highly influenced by the availability of resources, labor productivity, coordination among stakeholders, and external factors such as weather and site conditions. Meanwhile, during the control stage, periodic monitoring is required to compare planned progress with actual progress so that any deviations can be identified at an early stage [3].

2.3 Planning Process Based on PMBOK 6th Edition

The Planning Process Group is a set of processes carried out to establish the overall scope of work, define project objectives, and formulate the actions required to achieve those objectives. In this study, the planning process focuses on 24 planning components based on the PMBOK 6th Edition standard published in 2017 [3].

2.4 Project Construction Process Based on PMBOK 6th Edition

In the construction process group, the risk-based development system focuses on implementing plans flexibly while maintaining continuous risk monitoring [3]. Each construction activity is carried out by considering potential technical and managerial risks, thereby minimizing disruptions to project time, cost, and quality performance. This approach enables the project team to respond quickly to changes and emerging issues, while also ensuring clear communication among all stakeholders so that project implementation remains aligned with the established plans [10].

2.5 Project Construction Process Based on PMBOK 6th Edition

In the control process group, the risk-based development system emphasizes continuous monitoring and adjustment of action plans to ensure that the project proceeds according to the established plan [3]. Through this process, the project team is able to detect deviations at an early stage and implement appropriate corrective actions. This approach not only maintains alignment between planning and implementation, but also supports organizational learning from project experience, enabling emerging risks to become valuable lessons for improving future projects [11].

2.6 Risk Categories in the Planning, Construction, and Control Processes of Sidewalk Projects

Risk categories are used to classify individual project risks based on their sources or the areas affected by those risks. This classification is intended to ensure that the processes of risk identification, analysis, and response planning can be carried out in a more systematic and comprehensive manner. In the PMBOK 6th Edition, risk categorization is generally structured using a Risk Breakdown Structure (RBS), which is a hierarchical representation describing various potential sources of risk within a project. This structure assists the project team in considering all possible risk sources that may affect project success. Project risk categories may include technical, project management, organizational, and external aspects. Technical risks are related to design, technology, performance, and the quality of work outcomes. Project management risks are associated with time estimation, budgeting, resource allocation, and project control.

Organizational risks involve organizational structure, culture, and the distribution of responsibilities within the organization, while external risks originate from factors beyond the project’s control, such as regulatory changes, economic conditions, or political dynamics. Through this classification, the project team can more easily trace the sources of risk and ensure that no critical area is overlooked in the risk management process [3].

Risk management is critical in sidewalk construction projects due to the involvement of multiple stakeholders and the dynamic conditions of public spaces. Risks occurring during the planning, construction, and control phases can significantly affect project time and quality performance. Therefore, identifying key risks is essential for implementing effective mitigation measures, in line with the PMBOK framework, which advocates integrating risk management throughout the project life cycle to achieve project objectives efficiently [3].

Probability and Impact Matrix is a qualitative risk analysis tool used to evaluate and prioritize project risks by assessing the likelihood of a risk occurring and the magnitude of its impact on project objectives. By combining probability and impact ratings, risks can be classified into different levels, such as low, moderate, or high risk, enabling project teams to focus their attention and resources on the most critical risks requiring response and mitigation actions [3].

The probability and impact rankings for all variables are illustrated in the risk probability and impact matrix shown below.

Threats \ Probability	0.05 Very Low	0.10 Low	0.20 Moderate	0.40 High	0.80 Very High
0.90 Very High	0.05	0.09	0.18	0.36	0.72
0.70 High	0.04	0.07	0.14	0.28	0.56
0.50 Medium	0.03	0.05	0.10	0.20	0.40
0.30 Low	0.02	0.03	0.06	0.12	0.24
0.10 Very Low	0.01	0.01	0.02	0.04	0.08

Fig 2. Probability and impact matrix

2.7 Concept of Guidelines for Sidewalk Planning, Construction, and Control

The implementation of planning, construction, and control activities for sidewalk development projects refers to the Standard Operating Procedures (SOPs) issued by the Department of Highways of the Special Capital Region of Jakarta Province in 2019. Standard Operating Procedures are standardized written instructions that regulate various organizational

activity processes, including how and when activities should be carried out, where they should take place, and by whom they should be performed [12].

The main difference between the SOP currently being developed and the previous SOP lies in its approach and underlying framework. While the previous SOP primarily focused on administrative aspects and general procedures, the SOP examined in this study is designed based on the PMBOK 6th Edition guidelines, integrating the planning, construction, and control processes with a risk-based approach. This approach enables each stage of the project, such as sidewalk construction projects in Jakarta, to incorporate risk identification and mitigation mechanisms from the initial planning stage through project implementation, thereby minimizing the potential for delays and cost overruns. Consequently, this new SOP functions not only as an operational guideline but also as a project management tool that is more responsive to project dynamics and uncertainties encountered in the field [3].

2.8 Relationship between Planning, Construction, and Control Risks and Time Performance

Risks arising during the planning, construction, and control stages have a direct relationship with project time performance. In the planning stage, risks significantly influence project timeliness because this stage serves as the foundation for scheduling and resource allocation. Risk identification and analysis are conducted to minimize the possibility of unrealistic duration estimates, labor shortages, or scope changes. If these risks are not properly anticipated, the project may experience delays from the outset [3].

The planning, construction, and control stages are interrelated and have a direct impact on project time performance. Consistent risk management throughout the planning, construction, and control processes is therefore essential to ensure that the project remains aligned with its intended schedule and performance targets [13].

2.9 Conceptual Framework

The conceptual framework of this study focuses on risk management in sidewalk construction projects in Jakarta, which is closely related to the planning, construction, and control processes. Risk factors affecting the time performance of construction projects are identified by examining a number of variables derived from various indicators. These indicators are obtained from the knowledge areas contained in the PMBOK 6th Edition, particularly those related to

the planning, construction implementation, and control stages [3].

III. METHODS

3.1 Research Design

The method employed in this study was a quantitative approach. The questionnaire was administered to 40 respondents from government agencies serving as project owners, all of whom had direct experience and involvement in the planning, construction, and control of sidewalk projects in the Special Capital Region of Jakarta (DKI Jakarta). Data collection was conducted through a literature review, questionnaires, and expert validation to achieve the research objectives. The questionnaire data were analyzed through several stages, including archival analysis, descriptive analysis, homogeneity testing, data adequacy testing, validity testing, reliability testing, risk level analysis, correlation analysis, factor analysis, regression analysis, and expert judgment. The research findings were subsequently validated by experts to obtain recommendations in the form of procedures and proposed Standard Operating Procedures (SOPs) for sidewalk projects based on the PMBOK 6th Edition framework, presented as a process diagram/framework.

3.2 Data Collection

The respondents data used in this study were categorized based on educational background, organizational position, and work experience. In terms of educational attainment, 10% of the respondents held an Diploma, 50% held a Bachelor's Degree, and 40% held a Master's Degree. Based on their organizational positions, 37% of the respondents were staff members, 53% served as Heads of Implementation Units, and 10% held managerial positions such as Section Heads, Heads of Sub-Groups, or Heads of Sub-Divisions. Furthermore, respondents were classified into five categories according to their work experience: 28% had 5–10 years of experience, 12% had 10–15 years, 46% had 15–20 years, 12% had 20–25 years, and 2% had more than 25 years of experience. This composition indicates that the majority of respondents possessed undergraduate and postgraduate educational qualifications, held positions directly related to project implementation, and had substantial professional experience, thereby enabling them to provide relevant and

representative information to support the objectives of the study.

3.3 Variables

Variables are the primary elements that serve as the focus of observation and analysis in a research study. They are used to explain the phenomena under investigation and provide the basis for testing hypotheses or examining relationships among concepts within the research framework [14]. In this study, four independent variables and one dependent variable were identified. The independent variables consist of X1 (Risk-Based Planning Process), X2 (Risk-Based Implementation Process), X3 (Risk-Based Control Process), and X4 (Guidelines for Planning, Implementation, and Control), while the dependent variable is Y (Project Time Performance).

3.4 Data Analysis Methods

The collected data were analyzed using SPSS version 27 through a series of statistical procedures as follows:

1. Homogeneity Test
The Kruskal–Wallis H test was employed to assess whether respondents grouped by educational background, organizational position, and work experience differed significantly in their perceptions. Data were considered homogeneous when the significance value exceeded 0.05 for all groups.
2. Data Sufficiency Test
A data sufficiency assessment was conducted to ensure that the sample size was adequate for subsequent statistical analyses.
3. Validity Test
Instrument validity was evaluated using the item–total correlation method. Questionnaire items were considered valid when the calculated correlation coefficient (r -calculated) was greater than the critical value (r -table) at a significance level of 0.05 and $df = 30$.
4. Reliability Test
The internal consistency of the research instrument was examined using Cronbach's Alpha coefficient. A value greater than 0.60 indicated acceptable reliability.
5. Risk Analysis
Risk analysis was performed to identify the most critical risk factors by assessing the probability and impact ratings of each indicator. The overall risk level was

determined through a probability–impact matrix and risk weighting approach.

6. Correlation Analysis
Kendall's Tau correlation analysis was applied to evaluate the strength and direction of the relationships between the independent variables and the dependent variable.
7. Factor Analysis
Principal Component Analysis (PCA) was conducted to examine the underlying structure of the risk variables. Sampling adequacy was assessed using the Kaiser–Meyer–Olkin (KMO) measure, with values greater than 0.50 considered acceptable.
8. Regression Analysis
Simple linear regression analysis was used to examine the extent to which the planning, construction, control, and guideline processes influence time performance in sidewalk construction projects. Each of these variables was represented by a composite score derived from the average values of all risk indicators, which had previously been confirmed as valid through factor analysis.
9. Expert Validation
To ensure the practical applicability, relevance, and feasibility of implementation in sidewalk construction projects, the proposed model and research findings were reviewed and validated by seven domain experts.

IV.RESULT

4.1 Statistical Validity and Reliability

The validity test results indicated that most indicators of the risk impact variable had Corrected Item–Total Correlation values exceeding the minimum threshold of 0.312. This finding suggests that each indicator exhibited a sufficiently strong relationship with the overall variable score, confirming its validity and its ability to adequately measure the intended risk impact construct. Furthermore, the Cronbach's Alpha if Item Deleted values ranged from 0.733 to 0.738, indicating that the removal of any individual indicator would not result in a substantial improvement in the instrument's reliability. Therefore, all indicators that met the validity criteria were retained, as they contributed positively to the internal consistency of the research instrument.

4.2 Risk Analysis

Based on the analysis of questionnaire data collected from 40 respondents, several indicators were identified as having high-risk levels

across the planning, construction, and control processes, as well as within the guidelines governing these project phases. These findings indicate that the identified risk factors have the potential to significantly affect the implementation and performance of sidewalk construction projects.

The results of the risk ranking analysis obtained in this study are summarized in the table below.

Table 1. Risk Ranking

No.	Code	Risk Factor	Risk Ranking	Risk Level
Planning Process				
1	X1.6.2	Adverse weather conditions, natural disasters, utility relocation, delays in resource procurement, change orders, lack of coordination, and external disruptions.	1	High
2	X1.3.1	Inaccurate data, restricted site access, and utility interferences (water supply, electricity, fiber-optic networks, etc.).	2	High
3	X1.1.3	Repeated revisions resulting in slow and inefficient document preparation processes.	3	High
4	X1.12.1	Human error, inaccurate surveys, and design revisions.	4	High
Construction Process				
5	X2.7.1	Delayed or inaccurate progress reporting.	1	High
6	X2.10.3	Slow coordination with external stakeholders causing project delays.	2	High
7	X2.2.1	Failure to document lessons learned, leading to recurring mistakes in future projects.	3	High
8	X2.7.3	Ineffective management of communication media and channels.	4	High
9	X2.4.3	Suppliers failing to meet quality requirements and delivery schedules.	5	High

No.	Code	Risk Factor	Risk Ranking	Risk Level
10	X2.6.2	Conflicts among project team members.	6	High
Control Process				
11	X3.5.3	Sudden schedule changes, resource constraints, and ineffective inter-team coordination.	1	High
12	X3.12.1	Miscommunication and delays in coordination.	2	High
13	X3.6.2	Inaccurate initial cost estimates and work modifications through Construction Change Orders (CCOs).	3	High
14	X3.3.2	Incomplete partial documentation.	4	High
15	X3.9.2	Lost or poorly organized communication records and documents.	5	High
Planning, Construction, and Control Guidelines				
16	X4.3.3	Cost overruns, delays due to work modifications, and the occurrence of Construction Change Orders (CCOs).	1	High
17	X4.3.1	Work results failing to meet standards, irregular inspections, and repeated rework.	2	High
18	X4.2.1	Poor work quality and delays in project progress.	3	High

Source : Processed Data, 2026

4.3 Correlation Analysis

Based on the results of the Kendall's Tau-b correlation test presented in the table, it can be concluded that several significant relationships exist between the research variables and project time performance. The construction variable shows a strong and significant negative relationship with time performance, indicating that higher risk in the construction phase leads to a decrease in project time performance. Similarly, the control variable also exhibits a significant negative relationship with time performance, although the strength of the relationship is lower compared to the construction variable. In contrast, the planning and guideline variables do not show significant relationships with time performance, as their significance values exceed 0.05.

Furthermore, a significant positive relationship is found between the control and guideline variables), indicating that better implementation of guidelines is associated with improved project control processes. Overall, the findings suggest that risk factors in the construction and control phases are the most influential variables affecting the time performance of sidewalk construction projects. Therefore, these two aspects should be prioritized in risk management efforts to improve project scheduling and ensure timely project completion.

4.4 Factor Analysis

Based on the results of the KMO and Bartlett's test, a value of 0.734 (> 0.5) and a significance level of < 0.001 were obtained. These results indicate that the dataset meets the adequacy requirements and is suitable for further analysis using factor analysis.

All variables :planning (0.626), construction (0.691), control (0.795), and guideline (0.665), exhibit loading factor values above 0.5 on Component 1. This indicates that all variables are valid and contribute sufficiently to forming a single underlying factor. The control variable has the highest loading value, suggesting that it is the most dominant variable in forming this factor, followed by construction, while guideline and planning contribute relatively equally. Therefore, these results indicate that all variables can be grouped into a single component representing one main dimension in the study.

4.5 Regression Analysis

Based on the Model Summary results, an R value of 0.533 was obtained, indicating a moderately strong relationship between the planning, construction, control, and guideline variables and project time performance. The R Square value of 0.581 indicates that 58.1% of the variation in time performance can be explained by these four variables, while the remaining 41.9% is influenced by other factors outside the research model. After adjustment, the Adjusted R Square value of 0.533 suggests that the model still has a reasonably good explanatory power.

In addition, the results of the simultaneous test through F Change ($F = 12.122$; $p < 0.001$) indicate that the regression model is statistically significant. This confirms that the independent variables collectively have a significant effect on project time performance.

Based on the ANOVA test results, an F-value of 12.122 with a significance level of < 0.001 was obtained, indicating that the regression model is statistically appropriate and that the planning, construction, control, and guideline variables jointly have a significant effect on project time performance. Partially, the coefficient test results show that the construction and control variables have a negative and significant effect on time performance. This indicates that the higher the level of issues in the construction and control phases, the lower the project time performance tends to be. Meanwhile, the planning and guideline variables do not show a significant effect, as their significance values exceed 0.05.

The results of this study also indicate that the success of project time performance in sidewalk construction is more strongly influenced by the effectiveness of implementation and direct field control than by administrative aspects only. Accordingly, planning remains a fundamental basis in construction projects; however, the effectiveness of construction execution and control processes plays a more decisive role in achieving project time performance targets.

4.6 Expert Validation

The addition of activities in the risk-based SOP developed in this study is not intended to increase administrative procedures, but rather to strengthen control processes and decision-making from the early stages of the project. Activities such as the development of an active risk register and early design evaluation are formulated based on dominant risks that have been identified as major causes of delays in sidewalk construction projects in DKI Jakarta. Accordingly, these additional activities are designed to ensure that potential problems can be identified at an early stage, enabling mitigation measures to be implemented before they lead to delays in field execution.

ensure that these additional activities do not create new inefficiencies, their effectiveness can be assessed through post-implementation project performance evaluation. This may include comparing project completion timeliness, the number of work delays, response time in problem resolution, and the effectiveness of stakeholder coordination before and after SOP implementation. In addition, evaluation can also be conducted on administrative processing time and coordination activities to determine whether the additional procedures remain proportional to the benefits generated.

In this study, the development of Standard Operating Procedures (SOPs) is primarily focused on simplifying the monitoring process and strengthening coordination so that corrective actions can be implemented more quickly and in a

more targeted manner. Accordingly, the proposed additional activities are expected not to create a new administrative burden, but rather to help minimize delays caused by weak control and late problem handling during project implementation.

The developed SOPs in this study were subsequently re-validated by experts to ensure that the procedures are in accordance with the actual conditions of sidewalk construction project implementation in DKI Jakarta and can be effectively applied in field operations. The validation process was carried out by obtaining expert feedback and input regarding the suitability of workflow sequences, completeness of stages, clarity of task allocation, and the effectiveness of control mechanisms in each process. Furthermore, the experts were asked to evaluate the flowcharts of the Planning SOP, Construction SOP, and Control SOP that had been developed. The feedback obtained was then used as a basis for refining the SOPs to make them more applicable, systematic, and aligned with the operational requirements of project implementation in the field.

The following figure presents the flowchart for the development of the Standard Operating Procedure (SOP) for sidewalk construction project planning.

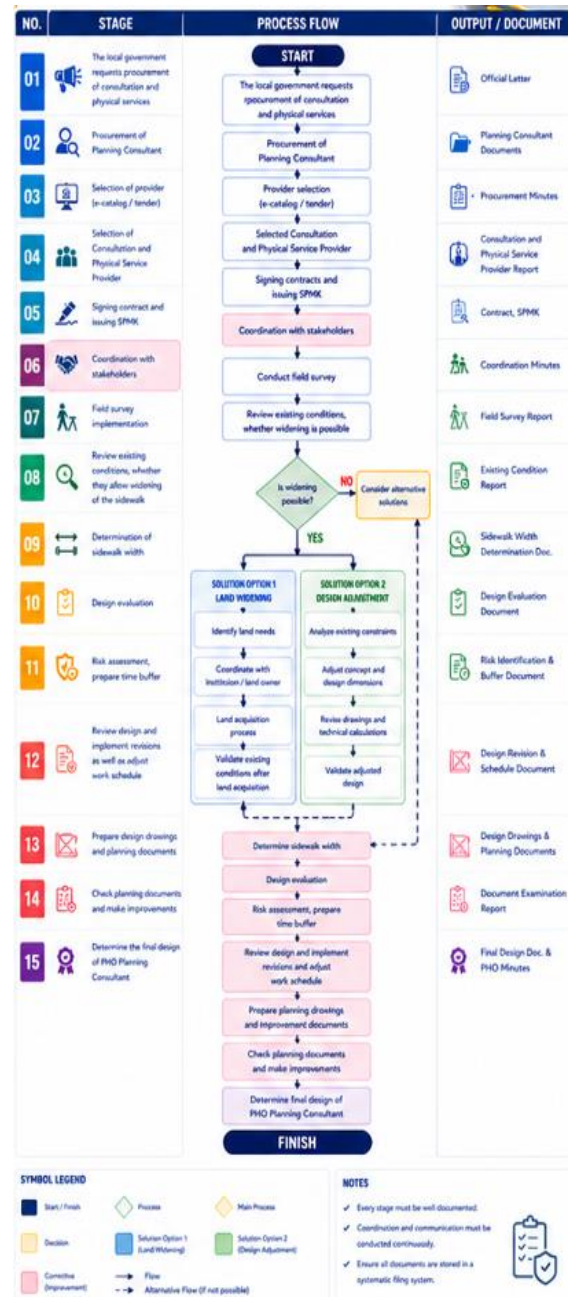


Fig. 3 Planning Flowchart SOP For Sidewalk Projects

Figure below illustrates the flowchart depicting the development process of the Standard Operating Procedure (SOP) for sidewalk construction projects.



Fig. 4 Construction Flowchart SOP For Sidewalk Projects

The figure below illustrates the flowchart for developing the Standard Operating Procedure (SOP) for the control of sidewalk construction projects.

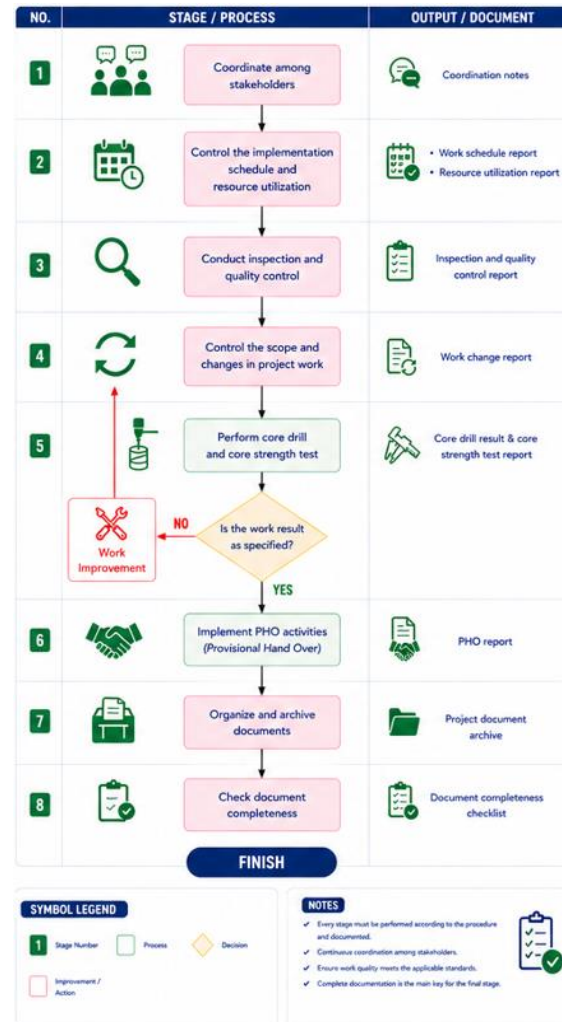


Fig. 5 Controlling Flowchart SOP For Sidewalk Projects

V.CONCLUSION

This study examines the influence of planning, construction, control, and guideline processes on time performance in sidewalk construction projects in DKI Jakarta. Overall, the processes implemented are found to be in accordance with relevant standards and have been validated by experts. The time performance indicators used are also considered relevant to project conditions, although further improvement is required to enhance accuracy and consistency in their application. Statistical analysis indicates that the four variables—planning, construction, control, and guidelines—have a moderately strong relationship with project time performance, explaining 58.1%

of its variation, and are jointly significant. Risk analysis identifies several high-risk activities across all project phases, which should serve as a basis for process improvement to minimize delays.

Partially, construction and control variables have a significant negative effect on time performance, indicating that increased issues in these phases lead to greater project delay risk. In contrast, planning and guidelines do not show a significant effect, as these aspects are relatively standardized, while field conditions play a more dominant role in influencing delays.

In conclusion, project time performance is primarily driven by field implementation factors, particularly construction and control phases. Therefore, the development of Standard Operating Procedures (SOPs) in this study focuses on strengthening these two aspects through improved monitoring, stakeholder coordination, corrective actions, and risk-based schedule adjustments to enhance overall project efficiency and timeliness.

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