Engineering and Technology Journal e-ISSN: 2456-3358

Volume 10 Issue 06 June-2025, Page No.- 5432-5437

DOI: 10.47191/etj/v10i06.15, I.F. – 8.482

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Analysis of the Influence of Priority Scale Criteria on Improving Drainage Function in Serang City with DPUPR Performance as an Intervening Variable

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ABSTRACT: The rapid population growth and urban development in Serang City have significantly increased the incidence of flooding, highlighting the importance of improving urban drainage systems. This research analyzes the influence of priority scale criteria—technical, economic, inundation, socio-cultural, and environmental—on the enhancement of drainage functions in Serang City, with the performance of the Public Works and Housing Agency (DPUPR) as an intervening variable. The study uses a quantitative approach with data collected through expert validation and public surveys, analyzed using Structural Equation Modeling-Partial Least Square (SEM-PLS) and multiple linear regression. The findings reveal that the technical and inundation criteria have the most significant direct influence on drainage function improvement. Moreover, the performance of DPUPR mediates the relationship between priority criteria and the success of drainage improvements. The study proposes alternative strategies based on dominant influencing factors, providing a practical reference for urban infrastructure planning and flood mitigation efforts in Serang City.

KEYWORDS: Drainage, Priority Criteria, DPUPR Performance, Flood Mitigation, SEM-PLS

INTRODUCTION

Urban development often brings with it a multitude of environmental challenges, one of which is effective stormwater drainage. Serang City, the capital of Banten Province, Indonesia, has experienced rapid population growth and spatial development in recent years. These changes have led to significant alterations in land use, including the conversion of open and wetland areas into built-up zones, resulting in reduced capacity for water absorption and increased surface runoff. Consequently, urban flooding has become a recurring issue, especially during the rainy season (Saktyanu, 2016).

Drainage infrastructure plays a pivotal role in mitigating the risk of flooding in urban areas. However, despite the continuous annual efforts by the Department of Public Works and Public Housing (DPUPR) of Serang City to enhance and expand drainage systems, the existing programs have not fully addressed the problem. Various constraints, including limited budget allocation in the Regional Revenue and Expenditure Budget (APBD), have hindered the full implementation of comprehensive drainage projects

Recent data indicate a growing number of inundation points across the city, highlighting the need for more strategic and effective planning. Between 2020 and 2023, the number of flood-affected locations increased from 12 to 28, with most flood events lasting 2–4 hours. Although the DPUPR has prepared a significant number of drainage development plans, the realization of these plans into physical infrastructure remains limited, pointing to the need for better prioritization mechanisms.

Table 1 Point & Average duration of inundation

Year	Number of flood points	Average duration of waterlogging
2020	12	2-4 Hours
2021	16	2-4 Hours
2022	24	2-4 Hours
2023	28	2-4 Hours

This research aims to analyze the impact of various priority scale criteria on the improvement of drainage functionality in Serang City. The study also evaluates the performance of DPUPR as an intervening variable, with the goal of identifying the most influential criteria that can guide the allocation of limited resources to maximize drainage performance.

By investigating technical, economic, environmental, and socio-cultural criteria, this study seeks to support evidence-based decision-making for urban infrastructure planning. The findings are expected to contribute to more sustainable and resilient urban water management in Serang and serve as a reference for similar cities facing flooding challenges.

LITERATURE REVIEW

A. DRAINAGE

The term "drainage" referring to a system for removing excess water or waste. In civil engineering, drainage is defined as a technical measure aimed at removing excess water from an area, enabling it to function properly. This water may originate from rainfall, seepage, or irrigation overflow and is discharged via surface or subsurface channels (Asmorowati et al., 2021)

Urban drainage planning is intricately linked with land use, drainage system blueprints, and sociocultural factors. While often perceived as a straightforward task, urban drainage design is complex, requiring significant investment in time, resources, and community involvement.

B. URBAN DRAINAGE SYSTEM IN INDONESIA

According to the Ministry of Public Works Regulation No. 12/PRT/M/2014, Indonesia's urban drainage system must be environmentally sustainable, aiming for flood-free residential areas and conservation of water resources (Peraturan Menteri PU RI No12/PRT/M/ 2014, 2014).

This older model focuses on discharging excess water quickly into rivers and oceans. It treats flooding and environmental damage as isolated local issues without systemic watershed-level consideration. Eco-drainage, or environmentally friendly drainage, retains rainwater using retention basins, infiltration wells, or natural waterways. It promotes sustainable groundwater recharge and local ecosystem support. Eco-drainage model addresses climate change impacts (e.g., rising sea levels, altered rainfall) by integrating hydraulic-ecological concepts. Methods include conservation ponds, infiltration wells, riverside polders, and groundwater protection zones.

C. PRIORITY SCALE FOR DRAINAGE IMPROVEMENT

Determining priorities for drainage improvement is a decision-making process aimed at achieving specific goals. This process is complex due to the involvement of multiple stakeholders and limited resources. Budget constraints, particularly the limited availability of regional funds (APBD), make it essential to establish clear strategies based on relevant criteria (Putra, 2020).

Effective prioritization requires measurable and problem-focused criteria that can serve as a basis for ranking alternatives. According to literature, previous studies, and the Ministry of Public Works Regulation No. 12/PRT/M/2014, five key criteria are identified for drainage improvement prioritization in Serang City: technical (Saktyanu, 2016), economic, inundation-related, socio-cultural, and environmental aspects (Suliyati, 2016) .

D. DPUPR (DEPARTMENT OF PUBLIC WORKS AND PUBLIC HOUSING)

Based on the Regulation of the Ministry of Public Works and Public Housing No. 12/PRT/M/2014 on Urban Drainage Systems, the Department of Public Works and Public Housing (DPUPR) is responsible for planning and developing integrated and sustainable urban drainage systems. This includes preparing a drainage master plan that accounts for urban growth and climate change.

DPUPR also manages financial resources for drainage development and maintenance, funded by the national and regional budgets or other legal sources. It ensures all construction follows technical standards and conducts supervision to maintain project quality and timelines.

Additionally, DPUPR coordinates with local governments, communities, and the private sector to ensure efficient system implementation and encourages public participation in planning and monitoring. It also provides technical guidelines and oversight to support the system's effectiveness and sustainability, ultimately reducing flood risks and improving urban environmental quality (Peraturan Menteri PU RI No12/PRT/M/ 2014, 2014).

E. STRUCTURAL EQUATION MODELING – PARTIAL LEAST SQUARE (SEM-PLS)

Structural Equation Modeling (SEM) is an advanced statistical method that evolved from path analysis and multiple regression, offering a more comprehensive approach to analyzing relationships between variables (Fahr, 2008). SEM estimates the strength of hypothesized relationships, including both direct and indirect effects through intervening or moderating variables. It is capable of testing complex models involving multiple variables simultaneously.

Commonly used SEM software in Indonesia includes AMOS, LISREL, TETRAD, PLS, and GCSA. Choosing the appropriate software is essential, as each has specific requirements and features that must align with the characteristics of the model being developed.

RESEARCH METHODS

This study employs a descriptive quantitative method, where the quantitative approach is used to identify existing facts and phenomena as well as to gather factual information. The data collected will serve as research variables. Furthermore, this process involves measuring the relationships or correlations and the effects between two or more variables. This method also includes evaluating and comparing actions that have been taken in response to similar situations and problems, with the results being used to develop plans or solutions for future decision-making.

Data collection in this study was carried out through interviews and the distribution of questionnaires to respondents using pre-prepared documents. Respondents provided answers and completed the questionnaires based on explanations and illustrations given by the researcher. The questionnaire in this study consists of three (3) sections. The first section is intended to assess the relevance of variables identified through the literature review and will be validated by experts with relevant expertise in this research field. The second section aims to obtain more focused and in-depth results regarding the issue. The third section addresses alternative solutions based on the most dominant variable.

Hypothesis testing is conducted using Structural Equation Modeling Partial Least Squares (SEM-PLS), which is a statistical method used to test hypotheses in research. SEM-PLS is employed to build structural equation models that connect several variables, including both latent variables and observed variables. SEM is a statistical methodology that encompasses a series of linear equation models, allowing for the simultaneous estimation of multiple relationships involving one or more dependent and independent variables.

PLS (Partial Least Squares) is a methodology that encompasses confirmatory factor analysis, principal component analysis, path analysis, and structural modeling. PLS stands out as a more complex method compared to SEM (Structural Equation Modeling), given its application to both reflective and formative models, whereas SEM is exclusively limited to reflective models. This characteristic makes PLS a more adaptable choice in data analysis, especially in scenarios that require the depiction of complex relationships among variables. The identification of latent variables in PLS involves three different metrics.

RESULT AND DISCUSSION

The purpose of this study is to identify and analyze the criteria that influence the improvement of drainage function in Serang City. Based on the SEM-PLS analysis, several important findings were found that answer the research questions, as well as develop existing theories on scale criteria on improving drainage function.

A. OUTER SEM-PLS ANALYSIS / MEASUREMENT MODEL

The outer model is a part of Structural Equation Modeling (SEM) that focuses on evaluating latent variables and their relationships with indicators to assess the credibility and consistency of the model. The outer model setting plays an important role in describing the characteristics of indicators related to latent variables, such as whether they are reflective or formative, depending on the operational definition of the variable. The outer model is also known as the measurement model or outer relationship, which describes the relationship between latent variables and indicators or manifest variables (Fahr, 2008).

Construct validity can also be assessed by looking at the AVE (Average Variance Extracted) value where the AVE value is able to show the ability of the latent variable value to represent the original data score (Sarstedt et al., 2021). The greater the AVE value indicates the higher its ability to explain the values of the indicators that measure the latent variables. The cut-off value of AVE used is 0.50 where the AVE value of at least 0.50 indicates a good measure of convergent validity, meaning the probability of an indicator in a construct entering another variable is lower (less than 0.50) so that the probability of the indicator converging and entering the construct whose value in the block is greater than 50%.

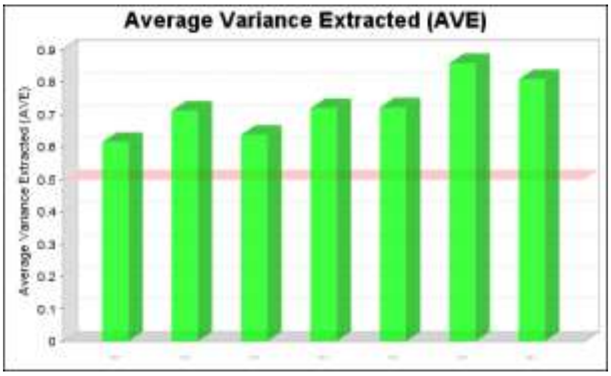

Figure 1 Average Variance Extracted (AVE) Value Diagram

Composite Reliability Test as a better method compared to Cronbach's alpha value in testing reliability in the SEM model. Composite reliability that measures a construct can be evaluated with two types of measures, namely internal consistency and Cronbach's alpha Cronbach's alpha tends to be a lower bound estimate in measuring reliability, while composite reliability does not assume reliability, while composite reliability is a closer approximation with the assumption that parameter estimates are more accurate. The interpretation of composite reliability is the same as Cronbach's alpha where a limit value of 0.7 and above is acceptable. The following are the results of composite reliability and Cronbach's alpha from SEM-PLS data processing:

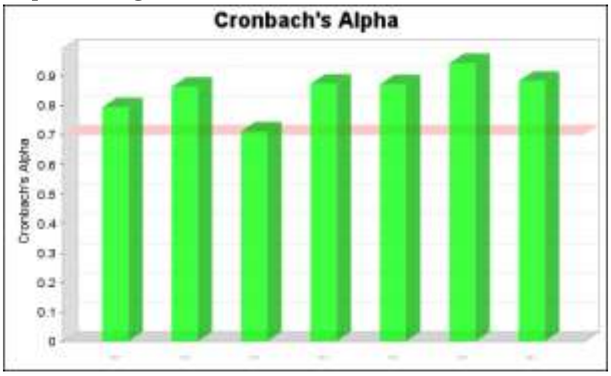

Figure 2 Cronbach's Alpha Value Diagram

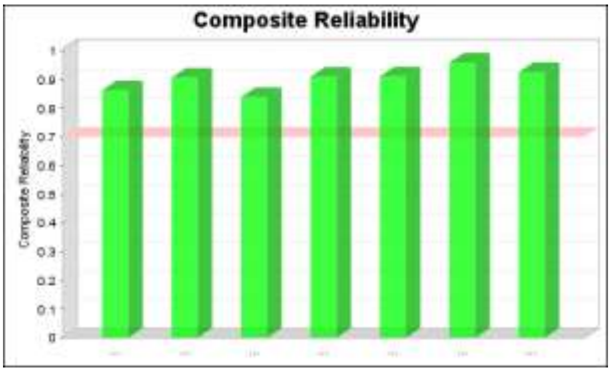

Figure 3 Composite Reliability Value Diagram

From the diagram above, it can be seen that the research model is considered reliable because the value of each construct shows a Cronbach's alpha value and composite reliability that is equal to or greater than 0.7. This indicates that the established criteria have been met, thus ensuring the reliability of each construct (Wong, 2014). The diagram shown visualizes the results of data analysis using Partial Least Squares Structural Equation Modeling (PLS-SEM) to evaluate reliability,

B. SEM-PLS INNER LOADING ANALYSIS / STRUCTURAL MODEL

The evaluation stage of the structural model aims to predict the relationship between latent constructs. There are several stages in evaluating the relationship between constructs. This can be seen from the path coefficient which describes the strength of the relationship between constructs. The sign in the path coefficient must be in accordance with the hypothesized theory, to assess the significance of the path coefficient can be seen from the t-test (critical ratio) obtained from the bootstrapping process (resampling method).

In viewing the predictive power of the structural model, the R^2 value of each endogenous construct can be used. According to (Sarstedt et al., 2021) where the R square value is 0.67 (high), 0.33 (moderate), 0.19 (weak); meaning the substantive influence (high), moderate and weak, so it can be used to measure the variation of changes in exogenous constructs to endogenous constructs.

Table 2 R Square Value

Main Factor	**R Square**	**R Square Adjusted**
DPUPR Performance (Y)	0.878	0.872
Drainage Function Improvement (Z)	0.740	0.737

The test results shown in the table above reveal that the R value for DPUPR Performance (Y) is 0.879, which is greater than 0.67, indicating that its influence is quite high. This result explains that 87.9% of DPUPR performance is influenced by the priority scale criteria. Meanwhile, the R value for Drainage Function Improvement (Z) is 0.740, which is also greater than 0.67, indicating a high influence. This means that 74% of drainage function improvement is influenced by the priority scale criteria.

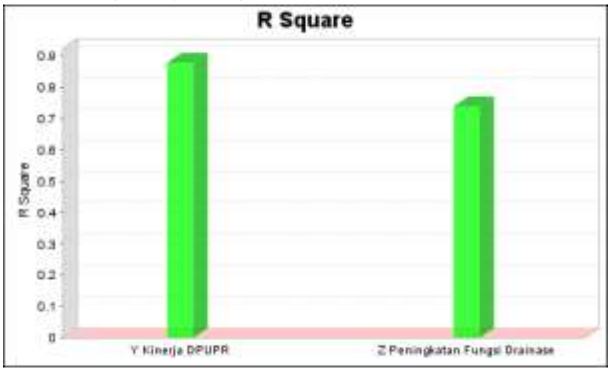

Figure 4 R Square Value

C. HYPOTHESIS TEST

At this stage of hypothesis testing, it will be analyzed whether there is a significant influence between the independent and dependent variables. Hypothesis testing is done by examining the path coefficients that indicate the parameters and the significance of the T-statistics. The significance of the calculated parameters will provide information about the relationship between the variables in the study. The limit for accepting or rejecting the hypothesis is determined with a probability of 0.05. Decisions are made based on the T-statistic value with a significance level of 0.05 (Hair & Ringle, 2022).

Table 3 Direct Effect Test

	T-Statistics	**P Values**
X1 Technical Criteria -> Y DPUPR Performance	6.884	0
X2 Economic Criteria -> Y DPUPR Performance	2.322	0
X3 Environmental Criteria -> Y DPUPR Performance	2.0567	0
X4 Socio-Cultural Criteria -> Y DPUPR Performance	2.423	0
X5 Inundation Criteria -> Y DPUPR Performance	3.658	0
Y DPUPR Performance -> Z Drainage Function Improvement	34.03	0

The results of the research and model analysis show that X1 Technical criteria, X2 Economic criteria, X3 Environmental criteria, X4 Socio-Cultural criteria, X5 Inundation criteria, Y DPUPR Performance has a significant direct influence on Z improving drainage function. with a T-Statistic value greater than 1.98 and a P value of 0. Then the hypothesis stating that all criteria have a significant direct influence on improving drainage function can be accepted.

In SEM PLS (Partial Least Squares Structural Equation Modeling) with bootstrapping, specific indirect effects refer to the indirect effects of the independent variable on the dependent variable through one or more specific mediating variables. The results of the Calculate PLS Bootstrapping command in the Smart-PLS program produce T Statistic and P Value outputs:

Table 4 Indirect Effect Test

	T-Statistics	**P Values**
X1 Technical Criteria -> Y DPUPR Performance -> Z Drainage Function Improvement	6.912	0
X2 Economic Criteria -> Y DPUPR Performance -> Z Drainage Function Improvement	2.296	0
X3 Environmental Criteria -> Y DPUPR Performance -> Z Drainage Function Improvement	2.074	0
X4 Socio-Cultural Criteria -> Y DPUPR Performance -> Z Improving Drainage Function	2.403	0
X5 Inundation Criteria -> Y DPUPR Performance -> Z Drainage Function Improvement	3.656	0

The results of the research and model analysis show that Technical Criteria X1, Economic Criteria X2, Environmental Criteria X3, Socio-Cultural Criteria X4, and Inundation Criteria X5 have a significant influence on Z improving drainage function through the Y Performance of DPUPR. With a T-Statistic value greater than 1.98 and a P value of 0. So that the hypothesis that all criteria have a significant influence on increasing drainage function through DPUPR performance can be accepted.

D. DOMINANT VARIABLE TEST

Table 5 Dominant Variable

	Standardized Coefficients	**Zero Order**	**(Standardized Coefficients x Zero Order) x 100**
X1 Technical Criteria	0.30	0.84	25,73
X2 Economic Criteria	0.13	0.77	10,24
X3 Environmental Criteria	0.11	0.62	7,41
X4 Socio-Cultural Criteria	0.16	0.78	12,82
X5 Inundation Criteria	0.34	0.88	**30,42**

Based on the analysis of the research that has been conducted, it can be concluded that the environmental criteria variable (X5) is the dominant factor in influencing the increase in drainage function by 30.42%.

The research that has been conducted states that all research variables, namely technical criteria (X1), economic criteria (X2), inundation criteria (X3), socio-cultural criteria (X4), environmental criteria (X5) can affect the improvement of drainage function in Serang City. This is almost in line with previous research by (Putra, 2020) entitled "Selection of Priority Areas for Handling Waterlogging Using the Analytic Hierarchy Process (AHP) Method in Dumai City" which observed the priority scale criteria in handling inundation problems in Dumai City. The difference between this study and the research that this study adds inundation criteria (X5) and DPUPR performance (Y) which have been proven to affect the improvement of drainage function in Serang City.

Economic criteria are criteria that have a significant influence on improving drainage functions in Serang City. This finding is consistent with research from (Savitri et al., 2022) which emphasizes that economic factors are very important in determining priorities for handling inundation and flooding. However, this study adds economic benefits (X2.4) and has a significant effect on improving drainage functions in Serang City.

The inundation criteria were the criteria that had the most significant influence on improving drainage function in Serang City, supporting the findings of (Suprapto et al., 2016), that inundation factors or criteria influenced the priority of drainage channel repair. This study provides additional findings that the duration of inundation (X5.3) has a significant influence on improving drainage function in Serang City.

This study provides a unique contribution by focusing on the problems of inundation and drainage in Serang City. In this context, the performance of DPUPR as an intervening variable provides a new perspective in improving the drainage function in Serang City which has not been widely discussed in previous literature, thus enriching the perspective of theory and practice.

CONCLUSIONS

Based on the results of the research that has been carried out, there are several things that can be concluded. The results of the Path Coefficient analysis show that technical criteria (X1), economic criteria (X2), environmental criteria (X3), socio-cultural criteria (X4) and inundation criteria (X5) have a significant direct influence on improving drainage function in Serang City and have a significant influence on improving drainage function in Serang City through the performance of DPUPR. The inundation criterion

(X5) is the dominant criterion in influencing the increase in drainage function in Serang City, namely 30.424%.

The difference between this study and previous studies is that this study adds inundation criteria (X5) and DPUPR performance (Y) which have been proven to have an effect on improving drainage function in Serang City.

Alternative solutions to improve drainage function in Serang City are carried out on the criteria of inundation (X5) as the dominant criteria. Alternative solutions that can be carried out include conducting water runoff analysis by calculating surface flow (runoff), integrated Geographic Information System (GIS) approach with Hec-Ras and Arcgis, infiltration well planning, upstream flood control and tidal flood control.

This study still has shortcomings that can be developed in the future. The addition of other variables that may be relevant and are expected to have an impact on improving drainage functions. The use of other methods and expansion of sample coverage.

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