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Influence of Performance Indicators and Stakeholder Engagement on Policy Success in Urban Water Management in Indonesia

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ABSTRACT

This study investigates the effects of performance indicators and stakeholder involvement on the success of urban drinking water management policies in Indonesia. Using a quantitative approach with 110 samples, data were collected through a Likert scale questionnaire and analyzed using Structural Equation Modeling-Partial Least Squares (SEM-PLS). The results reveal that both performance indicators and stakeholder involvement have significant positive impacts on policy success. Stakeholder involvement exhibited a slightly stronger influence, emphasizing the importance of inclusive governance in achieving policy objectives. The model explained 62% of the variance in policy success, demonstrating its robustness and predictive relevance. These findings highlight the necessity of integrating measurable performance metrics with participatory stakeholder engagement to enhance the effectiveness of urban drinking water management policies in Indonesia.

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1. INTRODUCTION

Urban drinking water management in Indonesia faces significant challenges due to rapid urbanization, inadequate infrastructure, and fragmented regulatory frameworks. These issues are compounded by climate change and the increasing demand for water resources, making effective management crucial for ensuring public health, socio-economic development, and environmental sustainability. Southeast Asian cities, including those in Indonesia, struggle with fragmented water management systems and inadequate infrastructure, leading to uneven access and service delivery [1]. The rapid urbanization and climate change exacerbate water scarcity, necessitating adaptive and resilient water management strategies [2], [3]. Implementing smart water networks and recycling technologies can enhance water use efficiency and balance in urban areas, with systems that allow for real-time monitoring and optimization—crucial for addressing water scarcity [4]. Integrated Water Resources Management (IWRM), which involves multidisciplinary perspectives, offers a comprehensive approach to tackling urban water scarcity, infrastructure constraints, and environmental impacts by emphasizing inclusive policies and governance [3]. Furthermore, policies integrating climate scenarios into urban water planning can enhance system resilience through the development of climate-resilient infrastructure standards and the promotion of nature-based solutions [2].

The success of urban water management policies depends on two key elements: robust performance indicators and active stakeholder involvement. Performance indicators, such as water coverage, service quality, and operational efficiency, serve as measurable benchmarks to evaluate policy implementation, identify gaps, and optimize resources. These include environmental, operational, safety, waste management, and public safety indicators, which support effective execution [5]. Key Performance Indicators (KPIs) offer structured tools to ensure policies remain relevant and effective over time [6], while integrated modelling and scenario assessments provide evidence to prioritize multi-benefit schemes and anticipate negative impacts [7]. Stakeholder involvement ensures inclusive policy planning, fostering transparency, accountability, and shared ownership. In Indonesia, collaboration among agencies such as the Ministry of National Development Planning and the Ministry of Public Works and Housing is vital to achieving safe drinking water targets [8]A multi-level approach, like London's Sub-Regional Integrated Water Management Strategy, enhances stakeholder engagement [7], and incorporating community feedback further strengthens policy development [6].

Despite these theoretical frameworks, there is limited empirical research assessing the impact of performance indicators and stakeholder involvement on the success of urban drinking water management policies in Indonesia. Existing studies often focus on isolated aspects of water management, overlooking the interconnected roles of performance measurement and participatory governance. This research aims to bridge this gap by quantitatively analyzing the relationships between these variables and their influence on policy outcomes.

2. LITERATURE REVIEW

2.1 Urban Drinking Water Management Policies

Urban drinking water management in Indonesia faces major challenges due to rapid urbanization, climate change, and resource scarcity. Addressing these issues requires a multifaceted approach involving infrastructure development, efficient resource allocation, and strong governance. Although Peraturan Pemerintah No. 122/2015 provides a legal foundation, implementation remains weak due to limited monitoring, poor stakeholder coordination, and minimal public engagement. Sustainable infrastructure—such as climate-resilient standards, low-impact development, and nature-based solutions—is key to enhancing resilience [2]. Decentralized water management can help recover resources at the source, but its adoption is hindered by coordination gaps [9]. Integrated Water Resources Management (IWRM) offers an effective framework for optimizing water use and addressing infrastructure constraints [3], while isotope techniques improve source evaluation and resource planning [10]. Strengthening governance through climate-integrated policies, regional planning bodies, and dedicated adaptation funding is also essential [2]. Inclusive and flexible governance approaches further support long-term sustainability [3]. Addressing these gaps requires a comprehensive understanding of the factors influencing policy success, particularly performance indicators and stakeholder involvement.

2.2 *Performance Indicators in Water Management*

Performance indicators are essential for evaluating drinking water management policies, offering measurable benchmarks for coverage, quality, efficiency, and sustainability. They help identify areas for improvement and ensure systems meet standards, with studies linking strong metrics to better service quality and customer satisfaction. However, their application in Indonesia's urban water sector remains inconsistent, indicating a need for further research on their policy impact. In Smart Water Cities (SWCs), KPIs assess water supply, quality monitoring, disaster resilience, and ecosystem preservation, as seen in Busan Eco Delta City, South Korea [11]. In Romania, regional operators use indicators to track technical, financial, and organizational performance, though efficiency gains are limited despite economies of scale and rising water prices [12]. Small and medium-sized systems benefit from KPI frameworks like in the Okanagan Valley, where 39 indicators across six criteria were used to guide local improvements [13]. In Rwanda, data mining supports water quality monitoring through real-time dashboards for compliance and customer engagement [14]. Performance indicators also play a key role in leakage management, enhancing environmental and cost-efficiency outcomes, especially in smaller systems [15].

2.3 *Stakeholder Involvement in Urban Water Governance*

Stakeholder involvement is pivotal in urban water management, as it brings together diverse perspectives and expertise, enhancing transparency, trust, and service delivery. Collaborative governance models that emphasize shared decision-making and accountability are particularly effective in addressing context-specific challenges and fostering co-created solutions for more resilient water systems. However, conflicting interests, power imbalances, and limited capacity can hinder effective engagement. Stakeholder participation enhances the legitimacy of environmental policies by aligning them with stakeholders' perceptions and experiences, which is crucial for reducing enforcement costs and improving policy acceptance [16]. Notably, legitimacy is constructed through stakeholders' experiences and needs, which may not always align with normative standards [16]. In practice, collaborative governance in the Cidanau River Basin involves government, private sector, and NGOs, but still faces challenges such as limited government engagement and unresolved local issues, underscoring the need for better organizational management and expert support [17]. In Surabaya, systemic leadership has proven essential for aligning stakeholder interests and achieving sustainable urban green space management [18]. Similarly, in Tanzania, stakeholder engagement in WASH projects contributes to long-term success, though barriers like weak capacity-building and conflicting perspectives persist, making structured frameworks and inclusive decision-making vital [19]. This underscores the need for structured frameworks to facilitate meaningful collaboration among stakeholders.

2.4 Integration of Performance Indicators and Stakeholder Involvement

Integrating performance indicators with stakeholder involvement is essential for effective urban water management, as it combines quantitative decision-making tools with inclusive, context-sensitive approaches. Performance indicators offer a measurable foundation for assessing sustainability, efficiency, and equity, while stakeholder engagement ensures that policies reflect community needs and foster shared ownership. This integration enhances accountability, adaptive management, and long-term success. In Babati, Tanzania, active community participation aligned with local needs led to improved project outcomes, while engaging stakeholders in setting benchmarks ensured relevance and feasibility [19]. Performance indicators, such as those used in Las Vegas, help balance water conservation goals with equity considerations, highlighting trade-offs between economic efficiency and social fairness [20]. A multi-level model incorporating environmental, social, and governance (ESG) criteria also supports sustainable project evaluation and stakeholder collaboration [21]. Furthermore, combining performance measurement with engagement strategies can generate synergies between infrastructure and supporting initiatives, maximizing urban value creation [22]. Integrated Water Resources Management (IWRM) reinforces this approach by emphasizing inclusive governance and multidisciplinary perspectives to address challenges like climate change, infrastructure limitations, and social equity [3]. Despite these theoretical insights, there is limited empirical evidence on how these factors interact in Indonesia's urban water sector.

2.5 Research Gap and Contribution

Existing literature provides valuable insights into the roles of performance indicators and stakeholder involvement in urban water management. However, studies often focus on either one of these aspects in isolation, neglecting their interconnected nature. Additionally, research specific to Indonesia's context remains scarce, particularly in the quantitative evaluation of these factors using advanced analytical methods such as Structural Equation Modeling (SEM).

3. METHODS

3.1 Research Design

This study employs a quantitative research design to examine the relationship between performance indicators, stakeholder involvement, and the success of urban drinking water management policies in Indonesia. The research is explanatory in nature, aiming to identify and quantify the causal relationships among the variables under investigation.

3.2 Population and Sample

The population for this study includes stakeholders involved in urban drinking water management in Indonesia, such as policymakers, municipal water supply managers, community representatives, and private sector operators. A purposive sampling technique was employed to select respondents who have direct experience or involvement in the formulation, implementation, or evaluation of drinking water policies.

The sample size for this study consists of 110 respondents, deemed adequate for Structural Equation Modeling (SEM) analysis, as recommended by Hair et al. (2017). The sample size ensures sufficient statistical power to test the proposed relationships and achieve reliable results.

3.3 Data Collection

Data were collected using a structured questionnaire designed to measure the key variables in the study, featuring closed-ended questions based on a five-point Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"). Each variable was assessed through multiple indicators derived from established literature to ensure content validity. The questionnaire was distributed via online platforms and direct communication with respondents to obtain a diverse and representative sample. A pilot study involving 15 respondents was conducted beforehand to test the instrument's clarity, reliability, and validity, with necessary revisions made based on the feedback. The independent variable Performance Indicators was measured using indicators such as service coverage, water quality, operational efficiency, and infrastructure sustainability, adapted from Van den Berg & Danilenko (2017). Stakeholder Involvement, also an independent variable, was assessed through government participation, private sector involvement, community engagement, and inter-agency collaboration, adapted from Ansell & Gash (2008). The dependent variable, Policy Success, was measured using indicators like policy implementation effectiveness, user satisfaction, resource optimization, and sustainability outcomes, adapted from Rogers & Hall (2003).

3.4 Data Analysis

The collected data were analyzed using Structural Equation Modeling with Partial Least Squares (SEM-PLS) methodology, employing SmartPLS 3 software. SEM-PLS was chosen for its suitability in handling complex models with multiple relationships and its robustness in analyzing smaller sample sizes (Hair et al., 2017). The analysis followed several key steps. First, the measurement model assessment evaluated the reliability and validity of constructs using Cronbach's alpha, composite reliability, and average variance extracted (AVE), ensuring all indicator loadings exceeded the threshold of 0.70. Second, the structural model assessment examined path coefficients to determine the significance and strength of relationships among variables, with bootstrapping (5000 resamples) conducted to test the statistical significance of the hypothesized paths. Lastly, goodness-of-fit metrics were analyzed through R^2 values to assess the model's explanatory power, along with effect sizes (f^2) and predictive relevance (Q^2) to confirm the overall adequacy of the model.

4. RESULTS AND DISCUSSION

4.1 Descriptive Statistics

The descriptive statistics summarize the demographic and professional characteristics of the 110 respondents and provide an overview of their responses to the research variables. In terms of organization type, 65% (71 respondents) were from government agencies, 20% (22 respondents) from private sector operators, and 15% (17 respondents) from community organizations. Regarding experience in urban water management, 15% (17 respondents) had less than 3 years of experience, 25% (28 respondents) had 3–5 years, and 60% (65 respondents) had more than 5 years. The age distribution of respondents showed that 30% (33 respondents) were between 25–35 years old, 50% (55 respondents) between 36–45 years, and 20% (22 respondents) were above 45 years.

The study measured three main variables—performance indicators, stakeholder involvement, and policy success—using a five-point Likert scale. Performance indicators had a mean score of 4.20 (SD = 0.65), with service coverage rated highest (Mean = 4.30), while operational efficiency was rated slightly lower (Mean = 4.10), indicating potential for improvement. Stakeholder involvement averaged 4.10 (SD = 0.70), with government participation receiving the highest rating (Mean = 4.25), and community engagement the lowest (Mean = 4.00), suggesting a need for stronger community inclusion. Policy success scored a mean of 4.15 (SD = 0.68), with both sustainability outcomes and policy implementation effectiveness rated highly (Mean = 4.20), reflecting positive perceptions of long-term impacts and policy execution.

4.2 Measurement Model Assessment

The measurement model was evaluated for reliability and validity using loading factors, Composite Reliability (CR), Cronbach's Alpha (CA), and Average Variance Extracted (AVE). For the Performance Indicators construct, all item loadings exceeded the recommended threshold of 0.70, with service coverage at 0.851, water quality at 0.803, operational efficiency at 0.821, and infrastructure sustainability at 0.876. The construct demonstrated strong internal consistency and convergent validity, with a CR of 0.911, CA of 0.876, and AVE of 0.712. Similarly, Stakeholder Involvement showed satisfactory reliability and validity, with loadings ranging from 0.795 to 0.882. Government participation had the highest loading (0.882), followed by inter-agency collaboration (0.852), private sector involvement (0.811), and community engagement (0.795). This construct had a CR of 0.90, CA of 0.861, and AVE of 0.694.

The Policy Success construct also met the criteria for reliability and validity, with indicator loadings ranging from 0.821 to 0.882. Specifically, sustainability outcomes had the highest loading (0.882), followed by resource optimization (0.862), policy implementation effectiveness (0.844), and user satisfaction (0.826). The construct achieved a CR of 0.921, CA of 0.892, and AVE of 0.734, indicating excellent internal consistency and convergent validity. These results confirm that all three constructs—performance indicators, stakeholder involvement, and policy success—are reliably measured and suitable for further analysis in the structural model.

Discriminant validity was assessed to ensure that each construct in the model is distinct from the others. The square root of the AVE for each construct is compared to the correlations between that construct and others. A construct exhibits discriminant validity if the square root of the AVE is greater than the correlations with other constructs.

Table 1. Discriminant Validity

Construct	Performance Indicators	Stakeholder Involvement	Policy Success
Performance Indicators	0.843		
Stakeholder Involvement	0.606	0.836	
Policy Success	0.551	0.583	0.852

The interpretation of the discriminant validity results shows that the diagonal values (in bold) represent the square root of the Average Variance Extracted (AVE) for each construct, while the off-diagonal values indicate the correlations between constructs. Since all diagonal values are greater than the corresponding off-diagonal correlations, this confirms that each construct shares more variance with its own indicators than with other constructs, thereby demonstrating satisfactory discriminant validity.

4.3 Structural Model Assessment

The structural model was evaluated to examine the relationships between constructs, including path coefficients, t-statistics, p-values, and R2R^2R2 values. Bootstrapping with 5,000 resamples was conducted in SEM-PLS to assess the significance of the hypothesized relationships.

Table 2. Hypothesis Testing

Hypothesis	Path Coefficient (β)	t-Statistic	p-Value	Result
H1: Performance Indicators → Policy Success	0.452	6.234	< 0.001	Supported
H2: Stakeholder Involvement → Policy Success	0.505	7.151	< 0.001	Supported

The interpretation of the structural model results shows that the path coefficients (β) reflect the strength of the relationships between constructs. Both stakeholder involvement ($\beta = 0.50$) and performance indicators ($\beta = 0.45$) have statistically significant effects on policy success, with t-statistics exceeding the critical value of 1.96 at a 95% confidence level and p-values below the 0.05 threshold. This indicates that both hypotheses (H1 and H2) are supported, and stakeholder involvement has a slightly stronger influence on policy success compared to performance indicators.

The coefficient of determination (R^2) for the dependent variable, policy success, is 0.62, which suggests that 62% of the variance in policy success is explained by the combined effects of performance indicators and stakeholder involvement. This value indicates moderate to high explanatory power and confirms that the model fits well in explaining the outcome variable.

The effect size (f^2) further highlights the impact of each independent variable, with stakeholder involvement showing a medium to large effect ($f^2 = 0.28$) and performance indicators showing a medium effect ($f^2 = 0.20$). Additionally, the Stone-Geisser predictive relevance value (Q^2) for policy success is 0.48, which is well above zero, demonstrating that the model has strong predictive relevance and can reliably forecast outcomes related to policy success.

Discussion

The findings of this study provide significant insights into the factors influencing the success of urban drinking water management policies in Indonesia. The analysis highlights the importance of performance indicators and stakeholder involvement as key determinants of policy success.

1. **Performance Indicators and Policy Success**

The results indicate a significant positive relationship between performance indicators and policy success. This finding underscores the critical role of clearly defined and measurable performance indicators in achieving policy objectives. Performance indicators serve as benchmarks for evaluating progress and effectiveness, enabling policymakers to identify areas requiring improvement. This aligns with previous studies emphasizing the importance of performance metrics in public sector management. Effective monitoring and evaluation mechanisms based on these indicators are essential for ensuring accountability and transparency in urban water management. The development of Composite Indicators (CI) and the use of key performance indicators (KPIs) across dimensions support comprehensive evaluations and sustainability [23]. Integrating big and open data through methods like data envelopment analysis further strengthens data-driven decision-making and addresses quality issues [24], while multi-criteria methods ensure benchmarking reflects contextual factors like population and climate [23]. Transparency and accountability in financial management are also critical, enhancing efficiency, public trust, and ensuring fair performance reporting through mechanisms like audits [25], [26].

2. **Stakeholder Involvement and Policy Success**

Stakeholder involvement demonstrated a slightly stronger influence on policy success compared to performance indicators. This finding underscores the necessity of active participation from all stakeholders, including government agencies, non-governmental organizations, community members, and private sector actors. Collaborative decision-making processes foster a sense of ownership and commitment, which are critical for the successful implementation of policies. This result is consistent with prior research that highlights the value of inclusive governance in addressing complex public policy challenges, particularly in resource management sectors such as water.

Inclusive governance empowers communities and promotes social justice by involving them directly, as seen in efforts to include Indigenous knowledge and sovereignty in water governance [27], [28]. In frameworks such as the water–food–energy–environment nexus (WFEEN), inclusive governance is essential for aligning environmental, economic, and social goals through cross-sectoral participation [29]. However, challenges such as entrenched hegemonies and colonial legacies in water management can impede equitable participation, requiring governance reforms to promote stakeholder involvement and power-sharing [30].

3. **Explanatory Power of the Model**

The structural model explains 62% of the variance in policy success, indicating moderate to high explanatory power. This suggests that the combined effects of performance indicators and stakeholder involvement substantially contribute to the success of urban drinking water management policies. Additionally, the predictive relevance further supports the model's robustness, highlighting its capacity to predict policy outcomes effectively.

4. **Practical Implications**

From a practical perspective, the findings suggest that policymakers should prioritize the establishment of robust performance indicators while fostering active stakeholder engagement. The integration of these elements into policy frameworks can enhance implementation effectiveness and ensure that urban drinking water management systems address both efficiency and equity concerns.

Furthermore, the slightly stronger influence of stakeholder involvement highlights the importance of participatory approaches in policy development and execution. Government authorities should actively seek input from diverse stakeholders and provide platforms for meaningful engagement to ensure that policies reflect the needs and priorities of all affected groups.

5. **Theoretical Contributions**

This study contributes to the literature by providing empirical evidence of the combined influence of performance indicators and stakeholder involvement on policy success in the context of urban water management. It bridges a critical gap in understanding how governance practices and measurement frameworks can jointly enhance policy outcomes.

6. **Limitations and Future Research**

While the study provides valuable insights, it is not without limitations. First, the sample size of 110 may limit the generalizability of the findings. Future research could expand the sample size and include case studies from diverse geographic regions to validate the results further. Second, qualitative methods could complement the quantitative analysis to provide deeper insights into the dynamics of stakeholder involvement and its nuances in different contexts.

5. CONCLUSION

This study highlights the critical role of This study highlights the critical roles of performance indicators and stakeholder involvement in determining the success of urban drinking water management policies in Indonesia. The findings reveal that performance indicators serve as essential benchmarks for monitoring and evaluating policy implementation, facilitating continuous improvement and accountability. Simultaneously, stakeholder involvement ensures policy inclusivity and sustainability, as participatory decision-making fosters greater commitment and effectiveness. The structural model confirms that these two factors collectively explain 62% of the variance in policy success, with stakeholder involvement having a slightly stronger impact. This emphasizes the value of collaborative governance and the integration of measurable performance metrics within policy frameworks.

For policymakers, these insights point to the need for balancing technical efficiency with inclusive, participatory approaches to achieve sustainable and equitable outcomes. Future research should expand upon these findings by examining additional variables that influence policy success and by broadening the geographic and demographic scope of the analysis. Ultimately, integrating these practices can significantly enhance the effectiveness, fairness, and sustainability of urban drinking water management, ensuring reliable access to this essential resource for all segments of society.

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