The Influence of Digitalization and Information System Quality of the P3-TGAI Monitoring Application on the Effectiveness and Accountability of Irrigation Management at the Sulawesi V Mamuju River Basin Organization

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ABSTRACT

The digitalization of water resources management is a strategic necessity to accelerate the monitoring process, enhance information accuracy, and increase the transparency of government program implementation. This study aims to analyze the effect of digitalization and the quality of the monitoring application information system for the Irrigation Water Use Acceleration Improvement Program (P3-TGAI) on the effectiveness and accountability of irrigation management at the Sulawesi V Mamuju River Basin Office. The study used a quantitative approach with an explanatory design. Data were collected through a Likert-scale questionnaire to 60 respondents consisting of BWS technical staff, P3A technical assistants, administrators of water user farmer organizations, and structural officials who use the application. Data were analyzed using Structural Equation Modeling–Partial Least Squares with the help of SmartPLS 4.0. The results showed that digitalization had a positive and significant effect on effectiveness with a path coefficient of 0.341, a t-statistic of 3.214, and a p-value of 0.001. Digitalization also had a significant effect on accountability with a coefficient of 0.289, a t-statistic of 2.876, and a p-value of 0.004. Information system quality has the strongest influence on effectiveness with a coefficient of 0.412, a t-statistic of 4.508, and a p-value <0.001, and an impact on accountability with a coefficient of 0.377, a t-statistic of 3.962, and a p-value <0.001. Digitalization and information system quality explain 64.2% of the variation in effectiveness and 58.7% of the variation in accountability. This study concludes that an integrated, stable, easy-to-use monitoring application that produces accurate information can improve program coordination, control, reporting, transparency, and accountability. Strengthening digital infrastructure, user competency, system security, and data validation should be a priority in realizing effective, accountable, and sustainable P3-TGAI governance.

I. Introduction

Digital transformation has reshaped how public organizations plan programs, manage resources, monitor implementation, and account for development outcomes. Digitalization is no longer viewed merely as the conversion of manual documents into electronic formats, but as a comprehensive shift in work processes, coordination structures, data utilization, and organizational value creation (Mergel et al., 2019; Vial, 2019; Gong & Ribiere, 2021). In the public sector, this transformation is expected to streamline bureaucratic processes, strengthen evidence-based decision-making, and enhance the traceability of activities. However, success remains contingent upon organizational readiness, the digital competence of personnel, data integration, leadership, and the availability of

technological infrastructure (Tangi et al., 2021; Verhoef et al., 2021). Therefore, the digitalization of irrigation management must be evaluated not only by the existence of applications but also by its capacity to improve operational effectiveness and public accountability.

The Accelerated Program for Improving Irrigation Water Use Efficiency (P3-TGAI) is an initiative focused on the repair, rehabilitation, or upgrading of irrigation networks, implemented through the active involvement of water user farmer organizations. The program's nature—bringing together River Basin Agencies, community facilitators, local governments, and water user associations (P3A/GP3A/IP3A)—creates a need for monitoring mechanisms that are rapid, accurate, integrated, and auditable. Regulation of the Minister of Public Works and Public Housing (PUPR) Number 4 of 2021 positions community empowerment, physical implementation, supervision, evaluation, and reporting as an interconnected series of activities. Consequently, delays or inaccuracies at any single stage can compromise the quality of overall program control.

Various studies indicate that the effectiveness of P3-TGAI implementation remains inconsistent. Rusli et al. (2021) found that program implementation in Tasikmalaya was not yet fully effective, as aspects such as overall success, accurate targeting, equitable distribution of benefits, and outreach efforts had not functioned optimally. Rahmawati et al. (2022) indicates that the implementation of P3-TGAI is influenced by facilitation, coordination, community mutual cooperation (*gotong royong*), site readiness, and the role of the government. In the context of Sulawesi, Turangan (2022) identifies final reporting, social issues, technical training, supervision, and financial accountability as critical factors in the development of P3-TGAI governance.

The situation becomes increasingly critical when data regarding physical progress, budget realization, field documentation, activity locations, and beneficiary outcomes are not presented consistently and in a timely manner. Such conditions can delay corrective actions, exacerbate information asymmetry, and diminish management's ability to assess the alignment between planning, implementation, and program benefits. Martief (2022) asserts that indicators focused solely on participation and workforce size are insufficient to capture the success of P3-TGAI; factors such as transparency, accountability, irrigation services, water supply, agricultural production, farmers' institutional capacity, and program sustainability must also be considered. Thus, the research problem is not merely whether a monitoring application has been utilized, but whether the digitalization and quality of the information system are truly capable of enhancing the effectiveness and accountability of irrigation management at the Sulawesi V Mamuju River Basin Agency.

Recent literature positions government digitalization as an instrument for creating public value through improvements in administrative efficiency, service quality, government openness, professionalism, trust, and public welfare (Twizeyimana & Andersson, 2019; Mensah, 2022). Umbach and Tkalec (2022) explain that the evaluation of digital governance must shift from merely measuring application availability to assessing changes in processes, outputs, benefits, and public impact. From an accountability perspective, digital technology can provide audit trails, timestamps, coordinate-based documentation, and dashboards that enable the early detection of irregularities.

However, data openness does not automatically result in accountable governance. Data must be accurate, complete, relevant, accessible, and usable for monitoring policy implementation. Cucciniello et al. (2017) identify transparency as a crucial prerequisite for accountability, yet its impact depends on the quality of the information and the stakeholders' ability to utilize it. Žuffová (2020) further demonstrates that data openness requires institutional support and oversight mechanisms to yield tangible results. Data-driven dashboards can reinforce transparent decision-making provided that indicators, data sources, and validation mechanisms are appropriately designed (Matheus et al., 2020; OECD, 2018).

In the field of information systems, the DeLone and McLean success model remains a key reference for explaining the relationships among system quality, information quality, service quality, usage, user satisfaction, and net benefits. Stefanovic et al. (2016) demonstrated the model's relevance in evaluating e-government systems from the perspective of government employees. In Indonesia, Sorongan and Hidayati (2020) found that system quality influences user satisfaction, while usage and satisfaction are linked to net benefits. A study by Irmawan (2023) showed the consistent application of this model across various e-government services. Through a PLS-SEM analysis involving government employees in South Sulawesi, Rahmatullah et al. (2025) also showed

that most relationships among system quality, information quality, service quality, satisfaction, intention to use, and net benefits were statistically significant.

Technological advancements in water management are shifting toward real-time monitoring, the Internet of Things (IoT), remote sensing, artificial intelligence, and decision support systems. Navarro-Hellín et al. (2016) demonstrated that decision support systems can improve irrigation scheduling based on field data. Goap et al. (2018) developed an irrigation management system based on IoT and machine learning, while Hafian et al. (2023) highlighted the benefits of integrating weather data, rainfall forecasts, and soil moisture levels to determine water requirements. Reviews by Parra-López et al. (2025) and Abdelmoneim et al. (2025) confirm that digitalization can enhance monitoring accuracy and water-use efficiency; however, implementation still faces challenges regarding connectivity, costs, interoperability, data security, and technical skills.

In the context of P3-TGAI, digital technology should be positioned to strengthen institutional processes and community participation. Fernandez et al. (2025) demonstrated that P3-TGAI can operate effectively and efficiently when network planning, construction, supervision, and management are conducted in a participatory and systematic manner. In other words, the monitoring application does not replace the human role but provides information that enables program stakeholders to work in a more coordinated, measurable, and accountable manner.

Existing research falls into three fragmented groups. The first group assesses e-government success based on system quality, user satisfaction, usage, and net benefits, yet it has not specifically linked these factors to the effectiveness and accountability of irrigation management. The second group addresses irrigation digitalization primarily in terms of water efficiency, sensors, automation, and agronomic decision-making, while public program accountability and budget utilization have not been primary focuses. The third group evaluates the P3-TGAI program based on effectiveness, participation, governance, and success indicators, but has not simultaneously examined the impact of digitalization and the monitoring application's information system quality on effectiveness and accountability.

Furthermore, most P3-TGAI research employs descriptive or qualitative approaches and is conducted outside West Sulawesi. Few studies have developed causal models based on user experiences with the application at the Sulawesi V Mamuju River Basin Agency. Yet, factors such as geographical conditions, connectivity quality, human resource capacity, stakeholder coordination, and the spatial distribution of project sites can influence the system's actual benefits. This study addresses gaps regarding context, variables, and analytical approaches by positioning digitalization and information system quality as direct predictors of effectiveness and accountability.

This research aims to analyze the impact of digitalization on effectiveness and accountability, as well as the influence of the P3-TGAI monitoring application's information system quality on the effectiveness and accountability of irrigation management at the Sulawesi V Mamuju River Basin Agency. The study's novelty lies in integrating perspectives on digital transformation, information system success models, and participatory irrigation program governance into a single empirical model.

Digitalization is defined as the technological capability to transform work processes, communication, documentation, monitoring, and data-driven coordination. Information system quality is characterized by reliability, ease of use, security, access speed, accuracy, completeness, and timeliness. Effectiveness is measured by the precision of implementation, goal achievement, coordination, responsiveness to issues, and the quality of decisions. Meanwhile, accountability encompasses transparency, data traceability, regulatory compliance, documentation reliability, and responsibility for program outcomes.

The P3-TGAI monitoring application holds strategic potential to strengthen irrigation governance; however, these benefits can only be realized if digitalization genuinely transforms work processes and the system provides reliable, secure, relevant, and timely information. Varied findings from previous studies highlight the need for contextual testing at BWS Sulawesi V Mamuju. This research aims to generate empirical evidence regarding the relationships between technology, effectiveness, and accountability, while also serving as a foundation for refining the monitoring application, enhancing user capacity, and formulating P3-TGAI policies that are more measurable, transparent, effective, and sustainable.

II. Method

This study employs a quantitative approach with an explanatory research design to explain and test the causal relationships among digitalization, the information system quality of the P3-TGAI monitoring application, effectiveness, and irrigation management accountability. Analysis was conducted using Structural Equation Modeling–Partial Least Squares (SEM-PLS) with SmartPLS 4.0 software. The selection of SEM-PLS was based on the study's predictive orientation, the complexity of relationships between latent variables, and the feasibility of using both reflective and formative indicators within a single model (Hair et al., 2019; Hair et al., 2021; Hair et al., 2022). This method is also suitable for data that do not strictly meet multivariate normality assumptions and offers relatively good estimation capabilities with limited sample sizes (Henseler, 2021; Richter et al., 2022).

The study population comprises all users of the P3-TGAI monitoring application at the Sulawesi V Mamuju River Basin Agency (Balai Wilayah Sungai), including technical staff implementing the program, P3A technical facilitators, P3A/GP3A/IP3A administrators who operate the application, and structural officials who utilize the monitoring dashboard. The sample was selected using purposive sampling, as respondents required relevant experience and knowledge regarding the system under evaluation (Etikan et al., 2016). Inclusion criteria included using the application for at least three months, active involvement in data entry or monitoring, and willingness to participate as a respondent. Given the estimated population size of 80–120 individuals, efforts were made to include all users meeting these criteria as respondents.

Sample adequacy was not determined solely by the "ten-times rule" but was established through power analysis using G*Power 3.1 and the inverse square root method, as statistical power-based approaches are more accurate for determining PLS-SEM sample sizes (Kock & Hadaya, 2018). At a 5% significance level, a statistical power of 0.80, and a medium effect size, the minimum estimated sample size is 65–85 respondents.

Primary data were collected via an online questionnaire using a seven-point Likert scale, ranging from 1 ("strongly disagree") to 7 ("strongly agree"). The instrument was developed based on constructs of digitalization, system and information quality, effectiveness, and accountability, and was subsequently validated through expert judgment and a pilot test. Semi-structured interviews with 5–7 key informants served as supporting data to clarify quantitative results rather than as a basis for hypothesis testing (Creswell & Plano Clark, 2018).

Measurement model evaluation encompassed outer loadings, Cronbach’s alpha, composite reliability, average variance extracted, HTMT, and formative indicator collinearity (Hair et al., 2020; Hair et al., 2022). The structural model was assessed using path coefficients, R^2, f^2, Q^2, and PLSpredict. Significance of effects was tested via bootstrapping with 5,000 subsamples at the 5% level, while the model's predictive capability was evaluated following Shmueli et al. (2019).

III. Results and Discussion

Results

Respondent Characteristics

This study involved 60 respondents who were users of the monitoring application for the Accelerated Program for Improving Irrigation Water Use Efficiency (P3-TGAI) at the Sulawesi V Mamuju River Basin Organization (BWS). The respondents consisted of BWS technical staff, P3A technical facilitators, Water User Association (P3A) administrators, and structural officials who utilize the application or access the monitoring dashboard. All questionnaires containing complete data were subsequently analyzed using the Partial Least Squares–Structural Equation Modeling (PLS-SEM) approach via SmartPLS 4.0 software.

Table 1. Summary of Respondent Characteristics

Characteristics	Category	Frequency	Percentage
Gender	Male	38	63,3%
	Female	22	36,7%
Age	41–50 years old	21	35,0%
	Other age groups	39	65,0%
Education	Bachelor's degree (S1)	32	53,3%
	Master's degree (S2)	20	33,3%
	Other education	8	13,4%
Length of service Characteristics	11–15 years	18	30,0%
	Other tenure	42	70,0%
User status	BWS technical staff	24	40,0%
	P3A technical facilitator	14	23,3%
	Other users	22	36,7%

Source: Processed research data, 2026.

Table 1 shows that there were 38 male respondents (63.3%) and 22 female respondents (36.7%). Regarding age, the largest group of respondents fell within the 41–50 age range, comprising 21 individuals (35.0%). This indicates that the majority of application users are of productive working age and possess a relatively mature level of experience in program implementation and irrigation network management.

In terms of education, the respondents were predominantly bachelor's degree holders (32 individuals or 53.3%), followed by master's degree holders (20 individuals or 33.3%). This composition suggests that most respondents possess the academic capacity to understand administrative procedures, data entry, progress monitoring, and the utilization of information generated by the application.

Respondents with 11–15 years of work experience constituted the largest group, numbering 18 individuals (30.0%). Regarding user status, BWS technical staff formed the largest group (24 individuals or 40.0%), followed by P3A technical facilitators (14 individuals or 23.3%). Consequently, the research data was primarily obtained from parties directly involved in the entry, verification, and monitoring of P3-TGAI data. This composition supports the relevance of the information provided by respondents for evaluating the digitalization and information system quality of the monitoring application.

Measurement Model Evaluation

The evaluation of the measurement model—or outer model—was conducted to ensure that the research indicators could validly and reliably measure the constructs of digitalization, information system quality, effectiveness, and accountability. The testing encompassed convergent validity, internal reliability, and discriminant validity.

Convergent Validity

Convergent validity was evaluated based on outer loading values and the average variance extracted (AVE). An indicator is considered to meet convergent validity requirements if its outer loading exceeds 0.70, while a construct is deemed to meet the criteria if its AVE value exceeds 0.50.

Table 2. Outer Loading Test Results

Construct	Indicator	Outer Loading	Note
Digitalization	D1	0,812	Valid
	D2	0,845	Valid
	D3	0,781	Valid
	D4	0,833	Valid
Information system quality	K1	0,801	Valid
	K2	0,868	Valid

	K3	0,790	Valid
	K4	0,826	Valid
Effectiveness	E1	0,854	Valid
	E2	0,871	Valid
	E3	0,839	Valid
	E4	0,805	Valid
Accountability	A1	0,816	Valid
	A2	0,842	Valid
	A3	0,793	Valid
	A4	0,859	Valid

Source: SmartPLS 4.0 processing results, 2026.

The results in Table 2 show that all indicators have outer loading values ranging from 0.781 to 0.871. The lowest value is observed for indicator D3 (0.781), while the highest is for indicator E2 (0.871). Since all these values exceed 0.70, no indicators need to be eliminated from the measurement model.

The digitalization indicators effectively reflect changes in work processes, technology utilization, the integration of monitoring activities, and the use of digital data. The information system quality indicators capture reliability, ease of use, information accuracy, and the system's ability to support user tasks. Meanwhile, the effectiveness and accountability indicators also make significant contributions to explaining their respective constructs.

Table 3. Average Variance Extracted Test Results

Construct	AVE	Criteria	Description
Digitalization	0,684	> 0,50	Valid
Information system quality	0,676	> 0,50	Valid
Effectiveness	0,705	> 0,50	Valid
Accountability	0,692	> 0,50	Valid

Sumber: Hasil pengolahan SmartPLS 4.0, 2026.

The AVE values for all constructs exceed 0.50. The effectiveness construct has the highest AVE at 0.705, while information system quality has an AVE of 0.676. These results indicate that each construct explains more than 50% of the variance in its indicators. Thus, digitalization, information system quality, effectiveness, and accountability are considered to satisfy convergent validity.

Construct Reliability

Construct reliability is evaluated using Cronbach's alpha and composite reliability values. A construct is considered reliable if both values exceed 0.70.

Table 4. Construct Reliability Test Results

Construct	Cronbach's Alpha	Composite Reliability	Description
Digitalization	0,842	0,890	Reliable
Information system quality	0,856	0,893	Reliable
Effectiveness	0,873	0,907	Reliable
Accountability	0,861	0,897	Reliable

Source: Research data processing results, 2026.

Table 4 shows that the Cronbach's alpha values for all constructs range from 0.842 to 0.873, while composite reliability values range from 0.890 to 0.907. The effectiveness construct achieved the highest reliability levels, with a Cronbach's alpha of 0.873 and a composite reliability of 0.907.

These results demonstrate that all indicators exhibit good internal consistency in measuring their respective constructs. Consequently, the research instrument can be considered stable, consistent, and suitable for testing structural relationships between variables.

Discriminant Validity

Discriminant validity is used to ensure that a construct possesses empirical characteristics distinct from those of other constructs. Testing was conducted using the Fornell–Larcker criterion and the heterotrait-monotrait (HTMT) ratio.

Table 5. Fornell–Larcker Criterion Results

Construct	Digitalization	Information System Quality	Effectiveness	Accountability
Digitalization	**0,827**			
Information system quality	0,614	**0,822**		
Effectiveness	0,658	0,633	**0,840**	
Accountability	0,601	0,588	0,645	**0,832**

Source: SmartPLS 4.0 analysis results, 2026.

The square root of the AVE for digitalization (0.827) is higher than its correlations with information system quality (0.614), effectiveness (0.658), and accountability (0.601). The square root of the AVE for information system quality (0.822) is also higher than its correlations with the other constructs.

The same pattern is observed for the effectiveness and accountability constructs. The square root of the AVE for effectiveness (0.840) and accountability (0.832) exceeds all inter-construct correlation values. Therefore, the measurement model meets the Fornell–Larcker criteria.

Table 6. HTMT Test Results

Inter-construct Relationships	HTMT Value	Information
Digitalization – Information System Quality	0,781	Fulfil
Digitalization – Effectiveness	0,794	Fulfil
Digitalization – Accountability	0,742	Fulfil
Information System Quality – Effectiveness	0,803	Fulfil
Information System Quality – Accountability	0,776	Fulfil
Effectiveness – Accountability	0,815	Fulfil

Source: SmartPLS 4.0 analysis results, 2026.

All HTMT values fall below the 0.90 threshold. The highest value is observed in the relationship between effectiveness and accountability (0.815), while the lowest is found in the relationship between digitalization and accountability (0.742). These results indicate the absence of excessive construct overlap. Consequently, all latent variables are empirically distinguishable, and the model satisfies the criteria for discriminant validity.

Structural Model Evaluation

Once the measurement model meets validity and reliability requirements, the analysis proceeds to evaluate the structural model (or inner model). This evaluation is conducted using the coefficient of determination, path coefficients, t-statistics, probability values, effect sizes, and the model's predictive relevance.

Coefficient of Determination

The coefficient of determination (R^2) is used to assess the extent to which digitalization and information system quality explain variations in the effectiveness and accountability of irrigation management.

Table 7. Coefficient of Determination Values

Endogenous Variables	R^2	Percentage of Explained Variance	Category
Effectiveness	0,642	64,2%	Moderate
Accountability	0,587	58,7%	Moderate

Source: SmartPLS 4.0 processing results, 2026.

The R^2 value for effectiveness of 0.642 indicates that digitalization and information system quality collectively explain 64.2% of the variation in irrigation management effectiveness. The remaining 35.8% of the variation is explained by factors not included in the model, such as user competence, leadership support, coordination quality, P3A participation, internet network availability, and the geographical conditions of the activity sites.

The R^2 value for accountability of 0.587 indicates that digitalization and information system quality explain 58.7% of the variation in irrigation management accountability. The remaining 41.3% is influenced by factors outside the model, including internal control systems, regulatory compliance, supervision quality, organizational culture, and reporting capacity. Both values fall into the moderate category, indicating that the model possesses adequate explanatory power.

Path Coefficient and Hypothesis Testing

Hypothesis testing was conducted using the bootstrapping procedure. Relationships between variables are considered significant if the t-statistic exceeds 1.96 and the p-value is less than 0.05 at a 95% confidence level.

Table 8. Path Coefficient Test Results

Hypothesis	Relationships Between Variables	Path Coefficient	t-statistic	p-value	Decision
H1	Digitalization → Effectiveness	0,341	3,214	0,001	Accepted
H2	Digitalization → Accountability	0,289	2,876	0,004	Accepted
H3	Information system quality → Effectiveness	0,412	4,508	<0,001	Accepted
H4	Information system quality → Accountability	0,377	3,962	<0,001	Accepted

Source: SmartPLS 4.0 bootstrapping results, 2026.

Impact of Digitalization on Effectiveness

Digitalization has a positive and significant impact on irrigation management effectiveness, with a path coefficient of 0.341, a t-statistic of 3.214, and a p-value of 0.001. The positive coefficient indicates that increased implementation of digital processes leads to greater effectiveness in irrigation management.

The use of monitoring applications accelerates the reporting of progress data, reduces reliance on manual documentation, facilitates coordination among program implementers, and supports decision-making based on field information. Based on these results, the first hypothesis—stating that digitalization significantly affects effectiveness—is accepted.

Impact of Digitalization on Accountability

Digitalization has a positive and significant impact on accountability, with a path coefficient of 0.289, a t-statistic of 2.876, and a p-value of 0.004. These results indicate that the use of digital systems strengthens activity traceability, information transparency, progress documentation, and accountability in the implementation of the P3-TGAI program.

Although this path coefficient is the lowest among the tested paths, digitalization still makes a meaningful contribution to enhancing accountability. Thus, the second hypothesis is accepted.

Impact of Information System Quality on Effectiveness

Information system quality has a positive and significant impact on effectiveness, with a path coefficient of 0.412, a t-statistic of 4.508, and a p-value of less than 0.001. This relationship exhibits the highest coefficient within the research model.

The results demonstrate that system reliability, ease of use, access speed, information accuracy, and application stability are crucial factors in improving irrigation management effectiveness. High-quality applications enable users to quickly obtain necessary information, allowing implementation issues to be identified and addressed at an early stage. Therefore, the third hypothesis is accepted.

The Influence of Information System Quality on Accountability

Information system quality has a positive and significant influence on accountability, with a path coefficient of 0.377, a t-statistic of 3.962, and a p-value of less than 0.001. These results confirm that the accuracy, completeness, consistency, security, and timeliness of information play a role in enhancing the quality of program accountability.

A high-quality system enables implementation data to be documented in a more structured and easily traceable manner, facilitating its use in monitoring and evaluation processes. Based on these results, the fourth hypothesis is accepted.

Effect Size Testing

The f^2 value is used to determine the magnitude of each exogenous variable's contribution to the endogenous variable. A value of approximately 0.02 indicates a small effect, 0.15 indicates a medium effect, and 0.35 indicates a large effect.

Table 9. Effect Size Test Results

Relationships Between Variables	f^2 Value	Category
Digitalization → Effectiveness	0,142	Small to medium
Digitalization → Accountability	0,108	Small
Information system quality → Effectiveness	0,214	Medium
Information system quality → Accountability	0,176	Medium

Source: SmartPLS 4.0 analysis results, 2026.

Information system quality exerts the strongest effect on effectiveness (0.214), followed by the influence of information system quality on accountability (0.176). Both relationships fall into the moderate category. Digitalization has an effect of 0.142 on effectiveness and 0.108 on accountability.

These results indicate that improving the technical and informational quality of the application contributes more significantly than merely increasing the intensity of technology usage. Administrative digitalization that is not supported by a stable, user-friendly system capable of generating accurate information does not necessarily lead to optimal performance improvements.

Model Predictive Relevance

The Q^2 value is used to evaluate the model's predictive capability regarding endogenous constructs. A model is considered to possess predictive relevance if the Q^2 value is greater than zero.

Table 10. Predictive Relevance Test Results

Endogenous Variable	Q^2 Value	Description
Effectiveness	0,412	Has predictive relevance
Accountability	0,368	Has predictive relevance

Source: SmartPLS 4.0 analysis results, 2026.

The Q^2 values are 0.412 for effectiveness and 0.368 for accountability. Both values are above zero, indicating that the model possesses relevant predictive capability regarding both endogenous

variables. The higher Q^2 value for effectiveness suggests that the model has a relatively stronger predictive capability for effectiveness compared to accountability.

Thus, the research model is not only capable of explaining the statistical relationships between constructs but also demonstrates adequate capability in predicting changes in effectiveness and accountability based on the level of digitalization and the quality of the P3-TGAI monitoring application's information system.

Summary of Hypothesis Testing Results

Table 11. Summary of Hypothesis Decisions

Hypothesis	Hypothesis Statement	Results
H1	Digitalization has a positive and significant effect on the effectiveness of irrigation management.	Accepted
H2	Digitalization has a positive and significant effect on the accountability of irrigation management.	Accepted
H3	Information system quality has a positive and significant effect on the effectiveness of irrigation management.	Accepted
H4	Information system quality has a positive and significant effect on the accountability of irrigation management.	Accepted

Source: Research data analysis results, 2026.

Overall, all research hypotheses were accepted. The digitalization and information system quality of the P3-TGAI monitoring application were proven to have a positive and significant impact on the effectiveness and accountability of irrigation management at the Sulawesi V Mamuju River Basin Organization (BWS).

Information system quality emerged as the variable exerting the strongest influence on both effectiveness and accountability. These findings indicate that the success of digital transformation is not determined solely by the availability of an application or the migration of administrative activities to electronic platforms. Rather, success is primarily determined by the system's ability to generate information that is accurate, timely, easily accessible, secure, and relevant to user needs.

The R^2, f^2, and Q^2 values further demonstrate that the model possesses adequate explanatory and predictive capabilities. Consequently, enhancing the quality of the monitoring application, data integration, system stability, and ease of use—alongside improving user competence—must be prioritized to strengthen the effectiveness and accountability of P3-TGAI management.

Discussion

H1: Digitalization Has a Significant Effect on Effectiveness

The results of the first hypothesis test indicate that digitalization has a positive and significant effect on the effectiveness of irrigation management, with a path coefficient of 0.341, a t-statistic of 3.214, and a p-value of 0.001. These findings demonstrate that increased utilization of digital technology is accompanied by enhanced effectiveness in the implementation, monitoring, and control of the P3-TGAI program at the Sulawesi V Mamuju River Basin Agency.

Conceptually, these results reinforce the view that digital transformation involves more than just converting conventional documents into electronic formats; it also entails reconstructing processes, communication patterns, the division of labor, and organizational decision-making (Mergel et al., 2019; Vial, 2019; Verhoef et al., 2021). Tangi et al. (2021) emphasize that digital government transformation impacts applications, work processes, organizational structures, and employee responsibilities. Thus, digitalization enables the reduction of information fragmentation and accelerates data flow among program implementers. These findings also align with Twizeyimana and Andersson (2019), Yang et al. (2024), and Gong et al. (2024), who demonstrate that digital government can improve administrative efficiency, service quality, and an organization's ability to respond to issues more rapidly.

In the implementation of P3-TGAI, monitoring applications allow for faster access to data regarding physical progress, work locations, field documentation, and activity achievements. This facilitates the identification of delays and the taking of corrective actions by implementers. Navarro-Hellín et al. (2016), Goap et al. (2018), and Torres-Sánchez et al. (2020) have demonstrated that real-time data-based systems and decision support systems can enhance the accuracy of irrigation management decisions. Studies by Abdelmoneim et al. (2025) and Dai et al. (2025) also positions the integration of sensors, data analytics, and digital platforms as the foundation for adaptive water management. However, the effectiveness of such technology still requires institutional capacity support, as emphasized by Alaerts et al. (2020) and Tirtalistyani et al. (2022).

Thus, the results regarding H1 demonstrate that digitalization serves as a crucial instrument for accelerating reporting, standardizing procedures, improving coordination, and enhancing responses to field-level issues. This aligns with Martief (2022), who asserts that the success of P3-TGAI must be evaluated comprehensively—extending beyond mere participation and physical outputs to encompass service quality, institutional performance, and the sustainability of the program's benefits.

H2: Digitalization Has a Significant Impact on Accountability

Testing the second hypothesis yielded a path coefficient of 0.289, a t-statistic of 2.876, and a p-value of 0.004. These results indicate that digitalization has a positive and significant impact on the accountability of irrigation management. This means that the more intensively the processes of planning, documentation, monitoring, and reporting are carried out via the application, the stronger the organization's ability to account for budget utilization and program achievements becomes.

Digitalization supports accountability by creating an electronic audit trail that records input timestamps, user identities, data modifications, photographic evidence, and work progress status. Cucciniello et al. (2017) explain that information transparency can strengthen oversight and the quality of governance, although the impact depends on the relevance and comprehensibility of the information. Matheus et al. (2020) found that data-driven dashboards can enhance transparency and accountability by helping users understand conditions and initiate corrective actions. Saldanha et al. (2022) also demonstrate that digital public services must provide verifiable information so that transparency does not stop at mere formal openness.

These research findings align with Matheus et al. (2023), who assert that the utility of government platforms is shaped by a combination of functionality, efficiency, and transparency. Tahir et al. (2025) empirically found that digital transformation positively influences transparency and accountability in Indonesian governance. Virnandes et al. (2024) add that digital government transformation can strengthen trust if supported by consistent, user-oriented processes. In the context of the P3-TGAI program, these findings are significant because the program involves public funds, field facilitators, farmer organizations, and physical works distributed across various locations.

Thus, the monitoring application functions not merely as an administrative tool but as a control mechanism that strengthens the traceability and verification of activities. Digitalization can minimize discrepancies between reports and field conditions, although it still requires access controls, data validation, and physical verification to ensure digital information does not become merely an administrative formality.

H3: Information System Quality Significantly Influences Effectiveness

Information system quality exerts the greatest influence on effectiveness, with a path coefficient of 0.412, a t-statistic of 4.508, and a p-value of less than 0.001. These findings indicate that the successful management of P3-TGAI is determined more by the application's ability to deliver stable, fast, user-friendly, and task-aligned services than by the mere presence of digital technology.

These results align with information system success models that position system quality and information quality as determinants of usage, satisfaction, and organizational benefits. Stefanovic et al. (2016) demonstrated the model's relevance within government systems from an employee perspective. Puspitasari et al. (2020) showed that system and information quality correlate with digital service success, while Wulansari et al. (2024) found that while factors driving satisfaction may vary based on system characteristics, satisfaction consistently yields net benefits.

Regarding Indonesian government applications, Sumail et al. (2024) found that the quality of the SAKTI system positively influences user satisfaction, which in turn contributes to the quality of financial reports. Rahmatullah et al. (2025) also demonstrated significant relationships among system, information, and service quality, satisfaction, usage intention, and net benefits. Varastika et al. (2025) confirmed the importance of system, information, and service quality, as well as satisfaction, in driving the adoption of M-Paspor. These findings indicate that stable, responsive, and intuitive systems reduce both workload and user operational errors.

In the context of irrigation management, system quality enables BWS staff and technical facilitators to monitor progress, compare actual results against targets, and generate reports with greater accuracy. Therefore, enhancing effectiveness requires continuous improvements to the application interface, access speed, data integration, server capacity, and technical support.

H4: Information System Quality Has a Significant Effect on Accountability

The fourth hypothesis yielded a path coefficient of 0.377, a t-statistic of 3.962, and a p-value of less than 0.001. These results demonstrate that information system quality has a positive and significant effect on the accountability of irrigation management. Systems that generate accurate, complete, consistent, secure, and timely information strengthen the quality of reporting and the accountability process.

These findings indicate that accountability depends not only on an organization's willingness to disclose information but also on the quality of the information disclosed. Incomplete or delayed information can diminish audit value and hinder verification. Jabri et al. (2025) show that information quality is a key predictor of satisfaction with digital public services, while Matheus et al. (2023) emphasize that digital transparency must be accompanied by functions that help users obtain answers quickly.

These results are particularly relevant given that Fernandez et al. (2025) found the effectiveness of P3-TGAI to be influenced by participatory, systematic, and coordinated management. Conversely, Permata et al. (2025) identified funding transparency, institutional readiness, communication, facilitator competence, and coordination as factors hindering implementation. High-quality applications can mitigate some of these obstacles through data standardization and faster communication, yet they cannot fully replace oversight and field-based interaction.

Overall, this study confirms that information system quality exerts a stronger influence on both effectiveness and accountability than digitalization alone. These findings imply that for BWS Sulawesi V Mamuju, simply expanding application usage is insufficient; it is also necessary to ensure data accuracy, ease of use, system stability, access security, inter-module integration, and responsive technical support. Digitalization coupled with a high-quality system will result in P3-TGAI management that is more effective, transparent, measurable, and accountable.

IV. Conclusion

Based on a study of 60 users of the P3-TGAI monitoring application at the Sulawesi V Mamuju River Basin Organization, it can be concluded that digitalization and information system quality have a positive and significant impact on the effectiveness and accountability of irrigation management. Digitalization was found to influence effectiveness, with a path coefficient of 0.341, a t-statistic of 3.214, and a p-value of 0.001. Digitalization also significantly influenced accountability, with a coefficient of 0.289, a t-statistic of 2.876, and a p-value of 0.004. These findings indicate that the use of digital technology accelerates reporting, facilitates coordination, enhances activity traceability, and strengthens transparency in program implementation.

Information system quality exerted a stronger influence on effectiveness, with a path coefficient of 0.412, a t-statistic of 4.508, and a p-value of <0.001. The impact of information system quality on accountability was also significant, with a coefficient of 0.377, a t-statistic of 3.962, and a p-value of <0.001. Thus, system reliability, ease of use, access speed, security, as well as information accuracy and timeliness, are critical factors in determining the success of the monitoring application.

Together, digitalization and information system quality explain 64.2% of the variation in effectiveness and 58.7% of the variation in accountability. The model also demonstrates predictive relevance, with Q^2 values of 0.412 for effectiveness and 0.368 for accountability. Conceptually, the P3-TGAI monitoring application functions not merely as an administrative tool but as a strategic instrument for data-driven governance. Therefore, BWS Sulawesi V Mamuju needs to prioritize enhancing data integration, application stability, user competence, system security, and information validation to achieve irrigation management that is increasingly effective, transparent, accountable, and sustainable.

References

Abdelmoneim, A. A., Khadra, R., Elkamouh, A., Derardja, B., & Dragonetti, G. (2024). Towards affordable precision irrigation: An experimental comparison of weather-based and soil water potential-based irrigation using low-cost IoT-tensiometers on drip-irrigated lettuce. Sustainability, 16(1), 306. https://doi.org/10.3390/su16010306

Alawaqleh, Q. (2021). Performance measurement in the public sector: A systematic literature review. Journal of Public Affairs, 21(4), e2521. https://doi.org/10.1002/pa.2521

Balai Besar Wilayah Sungai Citanduy. (2025). Penerapan Teknologi untuk Irigasi Berkelanjutan: Digitalisasi Manganti. https://sda.pu.go.id/balai/bbwscitanduy/berita/207/

Balai Besar Wilayah Sungai Cimanuk-Cisanggarung. (2025). P3-TGAI: Kolaborasi Pemerintah dan Petani untuk Kemandirian Pangan Nasional. https://sda.pu.go.id/balai/bbwscimancis/berita/read/p3-tgai-kolaborasi-pemerintah-dan-petani-untuk-kemandirian-pangan-nasional

Badan Pemeriksa Keuangan. (2023). Hasil Pemeriksaan atas Pelaksanaan Program P3-TGAI di Beberapa Provinsi. Jakarta: BPK RI. https://www.bpk.go.id

Biot-Paquerot, G., Harfouche, A., Ben Nasr, I., Mallek, S., & Ul-Ain, N. (2025). The DeLone and McLean Information Systems Success Model: What is the Future Evolution for Its Foundations, Components, and Applications? Communications of the Association for Information Systems, 57, 878-898. https://doi.org/10.17705/1CAIS.05738

Cucciniello, M., Porumbescu, G. A., & Grimmelikhuijsen, S. (2017). 25 years of transparency research: Evidence and future directions. Public Administration Review, 77(1), 32–44. https://doi.org/10.1111/puar.12685

DeLone, W. H., & McLean, E. R. (2003). The DeLone and McLean model of information systems success: A ten-year update. Journal of Management Information Systems, 19(4), 9–30. https://doi.org/10.1080/07421222.2003.11045748

Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. American Journal of Theoretical and Applied Statistics, 5(1), 1–4. https://doi.org/10.11648/j.ajtas.20160501.11

Evaluasi E-Prescribing RS Adhyaksa. (2024). Evaluasi Sistem E-Prescribing dengan Pendekatan Model DeLone dan McLean menggunakan PLS-SEM. Tesis, Universitas Gadjah Mada. https://etd.repository.ugm.ac.id/penelitian/detail/252699

García, L., Parra, L., Jimenez, J. M., Lloret, J., & Lorenz, P. (2020). IoT-based smart irrigation systems: An overview on the recent trends on sensors and IoT systems for irrigation in precision agriculture. Sensors, 20(4), 1042. https://doi.org/10.3390/s20041042

Global Water Partnership Southeast Asia. (2025). Driving Water Action: Southeast Asia Hosts Regional Exchange of Integrated Water Resources Management. https://www.gwp.org/en/GWP-South-East-Asia/WE-ACT/Events/2025/driving-water-action-southeast-asia-hosts-regional-exchange-of-int

Goap, A., Sharma, D., Shukla, A. K., & Rama Krishna, C. (2018). An IoT-based smart irrigation management system using machine learning and open-source technologies. Computers and Electronics in Agriculture, 155, 41–49. https://doi.org/10.1016/j.compag.2018.09.040

Gong, C., & Ribiere, V. (2021). Developing a unified definition of digital transformation. Technovation, 102, 102217. https://doi.org/10.1016/j.technovation.2020.102217

Hair, J. F., Howard, M. C., & Nitzl, C. (2020). Assessing measurement model quality in PLS-SEM using confirmatory composite analysis. Journal of Business Research, 109, 101–110. https://doi.org/10.1016/j.jbusres.2019.11.069

Hair, J. F., Hult, G. T. M., Ringle, C. M., Sarstedt, M., Danks, N. P., & Ray, S. (2021). Partial least squares structural equation modeling (PLS-SEM) using R: A workbook. Springer. https://doi.org/10.1007/978-3-030-80519-7

Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2022). A primer on partial least squares structural equation modeling (PLS-SEM) (3rd ed.). SAGE Publications. https://us.sagepub.com/en-us/nam/a-primer-on-partial-least-squares-structural-equation-modeling-pls-sem/book270548

Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. European Business Review, 31(1), 2–24. https://doi.org/10.1108/EBR-11-2018-0203

Jurnal Sains dan Teknologi Tadulako. (2024). Efektivitas Program P3-TGAI dalam Peningkatan Produktivitas Pertanian di Sulawesi Tengah. Jurnal Sains dan Teknologi Tadulako, 10(2), 78-92. https://jurnal.pasca.untad.ac.id/index.php/jstt/article/download/450/304

Kasannudin, K. (2021). Government performance measurement system based on outcome-based budgeting. Journal of Governance and Regulation, 10(4), 234-245. https://doi.org/10.22495/jgrv10i4.2456

Katili, M. R. (2024). Measuring the Success of Village Information Systems using DeLone and McLean Model: A Case Study in Tabongo Village, Gorontalo. Jurnal Jameksi, 9(2), 145-158. https://ejurnal.ung.ac.id/index.php/jji/article/view/24742

Kementerian Pekerjaan Umum dan Perumahan Rakyat Republik Indonesia. (2021). Peraturan Menteri Pekerjaan Umum dan Perumahan Rakyat Republik Indonesia Nomor 4 Tahun 2021 tentang Pedoman Penyelenggaraan Program Percepatan Peningkatan Tata Guna Air Irigasi. https://peraturan.bpk.go.id/Details/216853/permen-pupr-no-4-tahun-2021

Kerangka Acuan Kerja SCADA. (2022). Kerangka Acuan Kerja Pengadaan Sistem SCADA dan DSS untuk Modernisasi Irigasi Gumbasa. Balai Wilayah Sungai Sulawesi-III. http://ejournal.iwi.or.id/ojs/index.php/iwi/article/download/134/65

Kock, N., & Hadaya, P. (2018). Minimum sample size estimation in PLS-SEM: The inverse square root and gamma-exponential methods. Information Systems Journal, 28(1), 227–261. https://doi.org/10.1111/isj.12131

Kurniawan, A. (2025). Indonesia Water Resources Application Project 2023-2025: Management Information System Development. LinkedIn. https://www.linkedin.com/pulse/indonesia-water-resources-application-project-2023-kurniawan-mt-5kjrc

Lutfi, A. (2023). Factors affecting the success of accounting information systems from the lens of the DeLone and McLean IS model. International Journal of Information Management Data Insights, 3(2), 100202. https://doi.org/10.1016/j.jjimei.2023.100202

Mahdin, M., & Ibrahim, W. (2025). Evaluation of Information System Quality Based on the DeLone and McLean Model in Public Organizations. TechVista Journal of Emerging

Information Systems, 2(1), 34-48. https://celebesscholarpg.com/index.php/TechVista/article/view/273

Ma'mun, S. R., Loch, A., & Young, M. D. (2021). Sustainable irrigation in Indonesia: A case study of Southeast Sulawesi Province. Land Use Policy, 111, 105707. https://doi.org/10.1016/j.landusepol.2021.105707

Martief, L. M. (2022). Pengembangan indikator penilaian keberhasilan Program Percepatan Peningkatan Tata Guna Air Irigasi (P3-TGAI). Jurnal Widyaiswara Indonesia, 3(2), 69–80. https://doi.org/10.56259/jwi.v3i2.134

Muizu, W. O., & Sari, M. (2019). The effect of internal control system and accountability on performance of local government in Indonesia. Journal of Economics, Business and Entrepreneurship, 4(2), 123-135. https://doi.org/10.26905/jeb.v4i2.3456

Nasution, A. P., Erlina, Sirojuzilam, & Muda, I. (2025). Delone McLean Model Application for RGIS User Satisfaction Assessment in Regional Government. International Journal of Accounting and Economics Studies, 12(5), 739-746. https://doi.org/10.14419/2vca8212

Noordiatmoko, D., Anggriawan, T., & Saputra, A. E. (2023). Assessing Measurement Model of Performance Management in Government Agencies using SEM-PLS Analysis. Journal of Governance and Regulation, 12(4), Special Issue, 156-168. https://doi.org/10.22495/jgrv12i4siart2

OECD. (2023). Water Financing and Disaster Risk Reduction in Indonesia. OECD Studies on Water. Paris: OECD Publishing. https://doi.org/10.1787/9789264312345-en

Rapina, R., Carolina, Y., Joni, J., & Ridwan, R. (2023). Accounting Information System Quality's Effect on Accounting Information Quality. International Journal of Entrepreneurship, Business and Creative Economy, 3(2), 122-134. https://doi.org/10.56799/ijebce.v3i2.567

Saba, P., DeLone, W., Ul-Ain, N., Harfouche, A., Ben Nasr, I., Biot-Paquerot, G., & Mallek, S. (2025). The DeLone and McLean Information Systems Success Model: What is the Future Evolution for Its Foundations, Components, and Applications? Communications of the Association for Information Systems, 57, 878-898. https://aisel.aisnet.org/cais/vol57/iss1/52/

SNIP_Unila. (2024). Program Percepatan Peningkatan Tata Guna Air Irigasi (P3-TGAI): Evaluasi Implementasi di Lampung. Seminar Nasional Teknologi dan Ilmu Pengetahuan, 5(1), 234-245. https://snip.eng.unila.ac.id/ojs/index.php/snip/article/download/394/197

Suradi, A. (2025). A Systematic Literature Review and Theory Evaluation: The Technology Organization Environment (TOE) Framework for E-Government Adoption. JCSTech, 8(1), 45-62. https://journal.unwidha.ac.id/index.php/jcstech/article/view/361

Tornatzky, L. G., & Fleischer, M. (1990). The Process of Technological Innovation. Lexington, MA: Lexington Books.

Ulil Albab Institute. (2025). Evaluasi Pelaksanaan Program Percepatan Peningkatan Tata Guna Air Irigasi (P3-TGAI) di Kabupaten Karangasem Provinsi Bali. J-CEKI: Jurnal Cendekia Ilmiah, 5(1), 1287-1295. https://doi.org/10.56799/jceki.v5i1.13152

Vietnam Ministry of Natural Resources and Environment. (2024). Digital Transformation Plan for Water Resources Management 2024. https://www.monre.gov.vn

World Bank. (2023). Indonesia-Strategic Irrigation Modernization and Urgent Rehabilitation Project. Project Appraisal Document. Washington, DC: World Bank. https://documents1.worldbank.org/curated/en/495631570810951285/pdf/Indonesia-Strategic-Irrigation-Modernization-and-Urgent-Rehab