

Digital Literacy and ICT-Based Supervision: Antecedents of Work Discipline in Coastal Public Sector Organizations

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Abstract

This study aimed to examine the effect of ICT-based supervision on employee work discipline and analyze the moderating role of digital literacy in public sector organizations in coastal areas. A quantitative approach was employed using survey data collected from 217 public-sector employees. The data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) with SmartPLS 4 and purposive sampling from five coastal regencies. The results showed that ICT-based supervision positively and significantly affected work discipline. Digital literacy also had a strong and significant influence, emerging as the most dominant factor. However, the moderating effect of digital literacy was not significant. The findings indicate that human capability mediates technology effectiveness, and digital literacy plays a more critical role than technological systems in shaping employee discipline. This study was limited by its cross-sectional design and focus on a specific regional context, which may have affected its generalizability. This study contributes to the digital governance literature by highlighting the dominant role of digital literacy and providing empirical evidence from coastal regions.

Keywords: Digital Literacy, ICT-Based Supervision, North Kalimantan, Public Administration, Socio-Technical Theory

1. INTRODUCTION

As an archipelagic country with more than 17,000 islands, Indonesia faces significant challenges in ensuring equitable public service delivery and developing digital infrastructure. Government initiatives, such as e-government systems and digital performance, have been implemented to improve public sector performance. However, disparities in digital access and literacy across regions, particularly in coastal and remote areas, remain major concerns. Recent studies have highlighted that disparities in digital infrastructure and human resource capacity significantly affect governance quality and employee behavior in public institutions ([Hossain et al., 2025](#)); Ly, 2025). This issue is particularly relevant in Indonesia, where regional inequality continues to influence public service delivery and bureaucratic performance.

In response to these challenges, the adoption of Information and Communication Technology (ICT)-based supervision has emerged as a strategic approach to enhance transparency, accountability, and real-time monitoring of employee performance. ICT-enabled systems, such as digital attendance platforms and integrated performance management applications, allow organizations to systematically track employee activities and enforce discipline more effectively ([Febriyanti, Widianingsih, Sumaryana, & Buchari, 2023](#); [Munir & Hamid, 2026](#)). Empirical evidence suggests that digital governance mechanisms can strengthen oversight functions and reduce inefficiencies in public administration by improving data accuracy and managerial responsiveness ([Adil, Marhani, & Rosa, 2025](#); [Fleischer & Wanckel, 2024](#); [Juknevičienė et al., 2025](#)).

However, the effectiveness of ICT-based supervision is not solely determined by the availability of technological systems. A growing body of literature emphasizes that individual capabilities, particularly digital literacy, play a crucial role in shaping employees interactions with and responses to digital systems ([Cetindamar Kozanoglu & Abedin, 2021](#); [Duan & Dong, 2025](#); [Lei, Tang, Zhao, & Chen, 2024](#)). Digital literacy encompasses the ability to access, evaluate, and utilize digital information effectively, as well as to engage ethically in digital environments. In the context of public sector organizations, employees with higher levels of digital literacy are more likely to adapt to digital work systems, comply with organizational rules, and exhibit disciplined work behavior ([Amankona, Yi, Tackie, Tweneboaa Kodua, & Odai, 2025](#); [Ndone, 2025](#)).

Previous studies have consistently demonstrated a positive relationship between supervision and employee discipline and between digital competence and performance outcomes. Nevertheless, empirical findings remain fragmented regarding how technological and human factors interact to influence work discipline. While some studies focus on the direct effects of ICT adoption or digital competence, limited attention has been given to the moderating role of digital literacy in strengthening or weakening the relationship between ICT-based supervision and employee discipline, particularly in the public sector context ([Al-Hawamleh, 2024](#); [Dogbe, Alhassan, Adomako, & Davies, 2024](#)).

Moreover, existing research has largely been conducted in urban or technologically advanced settings, leaving a significant gap in understanding how digital governance mechanisms operate in geographically constrained areas, such as coastal regions ([Bhimasta, Surya, & Pramudita, 2025](#); [Ichdan, 2024](#)). These areas present unique challenges, including limited digital infrastructure, lower levels of technological readiness, and socioeconomic constraints that may influence employee behavior differently than urban environments. Consequently, findings from prior studies may not be fully generalizable to these contexts or populations.

Based on these gaps, this study aims to examine the effect of ICT-based supervision on employee work discipline and analyze the moderating role of digital literacy in this relationship within the context of public sector employees in coastal areas of North Kalimantan Province, focusing on civil servants (ASN) at echelon III-IV levels. By integrating technological and human capability perspectives, this study contributes to the literature on digital governance and public sector management, particularly by providing empirical evidence from under-researched regions characterized by infrastructural and digital disparity. Based on the identified research gaps, this study aims to address the following objectives:

RO₁: Examine the effect of ICT-based supervision on employee work discipline.

RO₂: To analyze the effect of digital literacy on employee work discipline.

RO₃: To investigate the moderating role of digital literacy in the relationship between ICT-based supervision and discipline.

2. LITERATURE REVIEW

2.1 Theoretical Framework: Socio-Technical Systems Theory

This study is grounded in the socio-technical systems theory, which emphasizes the interdependence between technological systems and human factors in organizational performance. According to this perspective, the effectiveness of technology implementation depends not only on technological infrastructure but also on the capabilities and readiness of its users. In the context of this study, ICT-based supervision represents the technical system, and digital literacy reflects the human system. The interaction between these two dimensions determines the effectiveness of work discipline in public sector organizations. This framework provides a theoretical basis for understanding why digital literacy may play a more dominant role than technology.

2.2 ICT-Based Supervision and Work Discipline

Supervision is a fundamental managerial function aimed at ensuring that organizational activities are aligned with predetermined standards and objectives. In public sector organizations, supervision plays a crucial role in maintaining employee discipline, accountability, and performance. With the advancement of digital technologies, traditional supervision mechanisms have evolved into ICT-based supervision systems that enable real-time monitoring, data-driven evaluations, and transparent reporting processes.

Recent studies suggest that ICT-based supervision enhances organizational control by reducing information asymmetry and improving managerial decision-making processes ([Febriyanti et al., 2023](#); [Niu, Ozdemir, & Kim, 2025](#)). From the perspective of principal-agent theory, digital supervision systems help minimize opportunistic behavior by increasing visibility and traceability of employee actions ([Medina, Baudet, & Lebraty, 2024](#); [Sakita, Helgheim, & Bråthen, 2024](#)). Furthermore, the integration of ICT into public administration has been shown to strengthen governance quality and improve compliance with organizational rules ([Juknevičienė et al., 2025](#)).

The development of ICT-based systems in organizational management has become increasingly important in the era of Industry 4.0, enabling more efficient monitoring and decision-making processes ([Banding & Padliansyah, 2022](#)).

Empirical evidence also indicates that digital monitoring tools, such as electronic attendance systems and performance dashboards, contribute to higher levels of employee discipline by enforcing consistency and accountability ([Fleischer & Wanckel, 2024](#)). However, the effectiveness of such systems may vary depending on contextual factors, including infrastructure readiness and employee adaptability. Employee performance and discipline are influenced by effective human resource practices, including recruitment, selection, and proper job placement ([Nugraha & Indiyati, 2025](#); [Shalahuddin, Werang, Suaib, Huriati, & Kamase, 2022](#)).

2.3 Digital Literacy and Employee Behavior

Digital literacy has emerged as a critical competency in the digital transformation era, particularly within public sector organizations. It encompasses not only technical skills but also the cognitive and ethical dimensions related to the use of digital technologies. According to [Lei et al. \(2024\)](#), digital literacy significantly influences employees' ability to adapt to digital environments and perform tasks efficiently and effectively.

In organizational settings, digital literacy has been linked to various positive outcomes, including improved performance, enhanced collaboration, and increased compliance with organizational procedures ([Amankona et al., 2025](#); [Nikou, De Reuver, & Mahboob Kanafi, 2022](#)). Employees with higher digital literacy are more capable of understanding digital systems, interpreting data, and responding to digital feedback mechanisms, which ultimately fosters disciplined work behavior ([Duan & Dong, 2025](#)). Moreover, digital literacy plays a strategic role in supporting digital transformation initiatives in the public sector. Studies indicate that without adequate digital competencies, the implementation of ICT systems may fail to achieve the desired outcomes, as employees may resist or misuse technological tools ([Hossain et al., 2025](#); [Valtonen & Holopainen, 2025](#)). Therefore, digital literacy is a foundational element for the successful adoption of digital governance practices.

2.4 Moderating Role of Digital Literacy

Although ICT-based supervision and digital literacy have been widely studied as independent predictors of employee performance and discipline, their interaction remains underexplored. Recent research highlights the importance of examining moderating variables to better understand complex relationships within digital organizational environments ([Chatterjee, Chaudhuri, Vrontis, & Giovando, 2023](#); [Hoang, 2024](#)). Digital literacy is expected to function as a moderating variable that strengthens the effectiveness of ICT-based supervision. Employees with higher levels of digital literacy are more likely to fully utilize digital supervision systems, interpret performance indicators accurately, and adjust their behavior accordingly ([Ndone, 2025](#); [Oberländer, Beinicke, & Bipp, 2020](#)).

Conversely, employees with lower digital literacy may experience difficulties in using digital systems, which can weaken the impact of ICT-based supervision on employee performance. Employee behavior and performance are also shaped by organizational culture and work motivation, which play crucial roles in supporting discipline in the workplace ([Shalahuddin, 2022](#)). This moderating perspective is supported by studies on digital governance and organizational behavior, which emphasize that human capital readiness significantly influences the outcomes of technological implementation ([Al-Hawamleh, 2024](#)). In this regard, digital literacy acts not only as an individual competency but also as a contextual factor that determines the effectiveness of organizational control mechanisms.

2.5 Research Gap and Hypothesis Development

Although previous studies have established the positive effects of supervision and digital competence on employee outcomes, several gaps still remain. First, most studies have examined these variables independently rather than exploring their interaction effects. Second, limited research has

focused on the moderating role of digital literacy in the relationship between ICT-based supervision and discipline. Third, empirical evidence from geographically constrained regions such as coastal areas remains scarce. To address these gaps, this study proposes an integrated framework that examines both direct and moderating effects within the context of public sector organizations in coastal regions. Based on the theoretical and empirical arguments discussed above, the following hypotheses are formulated.

H₁: ICT-based supervision positively affects employee work discipline.

H₂: Digital literacy positively affects employee work discipline.

H₃: Digital literacy moderates the relationship between ICT-based supervision and employee discipline.

3. METHODOLOGY

3.1 Research Design

This study employed a quantitative approach with an explanatory research design to examine the causal relationships between ICT-based supervision, digital literacy, and work discipline. Quantitative methods are appropriate for testing theoretical models and hypotheses involving latent variables, particularly in public sector research contexts, where behavioral constructs are measured using perception-based indicators ([Sohail & Chen, 2022](#)). The explanatory design allows for the identification of both direct and moderating effects among variables within a structured analytical framework.

3.2 Population and Sample

The study population consisted of public sector employees working in the coastal areas of North Kalimantan Province, Indonesia. These regions are characterized by geographical constraints and varying levels of digital infrastructure, making them relevant for examining the effectiveness of ICT-based supervision. A purposive sampling technique was employed to ensure that respondents met specific criteria, namely, (1) active public sector employees and (2) individuals who have experience using digital systems in their work environment. This approach is widely used in structural equation modeling (SEM) studies to ensure contextual relevance and data quality ([Tariq, Batool, Liaqat, & Khan, 2025](#)).

The final sample comprised 217 respondents. The sample size satisfied the requirements for Partial Least Squares Structural Equation Modeling (PLS-SEM), which is suitable for studies with moderate sample sizes and complex models. According to [Sarstedt, Ringle, and Hair \(2021\)](#), the minimum sample size in PLS-SEM should be at least five to ten times the number of indicators or based on the inverse square root method. With 18 indicators used in this study, the sample size exceeded the recommended threshold, indicating adequate statistical power.

3.3 Data Collection

Data were collected using a structured questionnaire distributed to respondents across five administrative regions: Tarakan City, Bulungan Regency, Malinau Regency, Nunukan Regency, and Tana Tidung Regency in North Kalimantan Province. The questionnaire employed a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), which is commonly used to measure perceptions and attitudes in behavioral studies. The measurement items were adapted from the established literature on supervision, work discipline, and digital literacy to ensure content validity. Prior to data collection, the questionnaire was reviewed to ensure clarity and relevance to the public sector context.

3.4 Variables and Measurement

This study included three main constructs: ICT-based supervision (independent variable), work discipline (dependent variable), and digital literacy (moderating variable). Each construct was operationalized using multiple indicators derived from previous studies. ICT-based supervision was measured using four dimensions: setting standards, performance measurement, performance comparison, and corrective actions. Work discipline was measured using indicators such as

attendance, compliance with rules, adherence to work standards, vigilance, and ethical behavior. Digital literacy was measured through competencies, including information literacy, digital communication, content creation, digital security, problem-solving, and ethical use of technology. All constructs were modeled as reflective variables, consistent with prior research in public administration and information systems (Radzi, Rahman, & Almutairi, 2022).

3.5 Data Analysis Technique

Data analysis was conducted using Partial Least Squares Structural Equation Modeling (PLS-SEM) with SmartPLS 4 software. PLS-SEM was selected because of its suitability for predictive and exploratory research, particularly when dealing with complex models, non-normal data distributions, and relatively small to medium sample sizes (Chinnaraju, 2025; Sarstedt et al., 2021). Compared to covariance-based SEM (CB-SEM), PLS-SEM focuses on maximizing the explained variance (R²) and is more appropriate for theory development and prediction-oriented studies (Sukhov, Olsson, & Friman, 2022). Additionally, PLS-SEM can simultaneously test measurement models (outer model) and structural relationships (inner model), including moderating effects.

The analysis procedure consisted of two main stages. First, the measurement model was evaluated to assess reliability and validity using loading factors, Cronbach’s alpha, composite reliability, average variance extracted (AVE), and HTMT. Second, the structural model was assessed by examining the path coefficients, t-statistics, p-values, effect sizes (f²), and Q² with blindfolding, as well as the moderating effect of digital literacy using interaction terms. Bootstrapping with 5,000 resamples was applied to test the statistical significance of the hypothesized relationships, as recommended in SEM analysis to obtain robust standard errors and confidence intervals (Legate, Ringle, & Hair Jr, 2024).

3.6 Common Method Variance (CMV)

As the data were collected using self-reported questionnaires, common method variance (CMV) was assessed to ensure that the results were not biased. Harman’s single-factor test was conducted, in which all measurement items were loaded into an exploratory factor analysis. The results showed that the first factor accounted for less than 50% of the total variance, indicating that CMV was not a serious concern in this study. Therefore, the validity of the findings was not significantly affected by common method bias.

4. RESULTS AND DISCUSSIONS

This section presents the results of the data analysis and discusses the findings in relation to the proposed hypotheses and existing literature. The analysis was conducted using Partial Least Squares Structural Equation Modeling (PLS-SEM), which includes the evaluation of the measurement and structural models. The results provide empirical evidence regarding the relationships between ICT-based supervision, digital literacy, and employee work discipline, particularly in public sector organizations in coastal regions.

4.1 Respondent Characteristics

Table 1. Respondent characteristics

Characteristic	Category	Frequency (n)	Percentage (%)
Gender	Male	128	59.0
	Female	89	41.0
Age	< 30 years	37	17.1
	30–35 years	58	26.7
	36–40 years	64	29.5
	> 40 years	58	26.7
Education Level	High School (SMA)	31	14.3
	Diploma (D3)	43	19.8
	Bachelor (S1)	112	51.6
	Master (S2)	31	14.3



Work Experience	< 5 years	48	22.1
	5–10 years	79	36.4
	> 10 years	90	41.5

The majority of respondents were male (59%), aged between 36 and 40 years (29.5%), and held a bachelor’s degree (51.6%). Most respondents had more than 10 years of work experience (41.5%), indicating that the sample was dominated by experienced public sector employees.

4.2 Variables and Measurement Indicators

Table 2. Variables and measurement indicators

Variable	Indicators	Measurement Items
ICT-Based Supervision	Setting Standards	Performance standards are clearly established through digital systems
	Performance Measurement	Employee performance is regularly monitored through digital applications
	Performance Comparison	Work outcomes are compared with standards through digital reports or dashboards
	Corrective Action	Supervisors provide corrective actions based on digital performance data
Work Discipline	Attendance	Employees arrive and leave work on time according to regulations
	Compliance with Rules	Employees comply with all organizational rules and procedures
	Adherence to Work Standards	Employees perform tasks in accordance with established standards
	Vigilance	Employees work carefully, accurately, and efficiently
	Ethical Behavior	Employees demonstrate professional and responsible work behavior
Digital Literacy	Information & Data Literacy	Employees are able to search and evaluate digital information effectively
	Communication & Collaboration	Employees are able to communicate and collaborate using digital platforms
	Digital Content Creation	Employees are able to create and manage digital content for work purposes
	Digital Security	Employees understand data security and digital privacy
	Problem Solving	Employees are able to use digital tools to solve work-related problems
	Digital Ethics	Employees use digital technology responsibly and ethically

4.3 Convergent Validity

The measurement model was evaluated to assess the reliability and validity of the constructs before proceeding to structural model analysis. In Partial Least Squares Structural Equation Modeling (PLS-SEM), the evaluation of the outer model is essential to ensure that the indicators accurately measure their respective latent variables. This study assessed indicator reliability by examining outer loadings, where values above 0.70 indicate a strong correlation between the indicators and their constructs. Internal consistency reliability was evaluated using Cronbach’s alpha and composite reliability (CR), with threshold values greater than 0.70 indicating satisfactory reliability ([Sarstedt et al., 2021](#)). Furthermore, convergent validity was assessed using the Average Variance Extracted



(AVE), where values exceeding 0.50 indicate that the construct explains more than half of the variance of its indicators. The results of the measurement model evaluation are shown in Table 3.

Table 3. Measurement model evaluation

Variable	Indicator	Loading	Cronbach Alpha	Composite Reliability (CR)	AVE
Digital Literacy	DL1	0.834	0.910	0.930	0.690
	DL2	0.805			
	DL3	0.834			
	DL4	0.862			
	DL5	0.839			
	DL6	0.809			
ICT-Based Supervision	ICT1	0.865	0.887	0.922	0.746
	ICT2	0.850			
	ICT3	0.863			
	ICT4	0.876			
Work Discipline	WD1	0.871	0.916	0.937	0.749
	WD2	0.881			
	WD3	0.860			
	WD4	0.871			
	WD5	0.843			

As shown in Table 3, all indicator loadings exceeded the recommended threshold of 0.70, indicating satisfactory indicator reliability. The Cronbach’s alpha and composite reliability values for all constructs were above 0.70, demonstrating strong internal consistency reliability. In addition, the AVE values for all constructs were greater than 0.50, confirming that convergent validity was achieved. These results indicate that the measurement model is reliable and valid, and therefore suitable for further analysis of the structural model.

4.4 Discriminant Validity

Discriminant validity was assessed to ensure that each construct was empirically distinct from the other constructs in the model. This study employed two commonly used approaches in PLS-SEM: the Fornell–Larcker criterion and the Heterotrait–Monotrait ratio (HTMT). The Fornell–Larcker criterion requires that the square root of the Average Variance Extracted (AVE) for each construct should be greater than its correlations with other constructs. HTMT values below 0.90 indicate adequate discriminant validity (Sarstedt et al., 2021). The results of the discriminant validity testing are presented in Table 4.

Table 4. Discriminant validity (Fornell-Larcker Criterion and HTMT)

Fornell-Larcker Criterion			
Variable	Digital Literacy	ICT-Based Supervision	Work Discipline
Digital Literacy	0.831		
ICT-Based Supervision	0.276	0.864	
Work Discipline	0.741	0.383	0.865

HTMT Ratio	
Relationship	HTMT Value
ICT-Based Supervision ↔ Digital Literacy	0.304
Work Discipline ↔ Digital Literacy	0.810
Work Discipline ↔ ICT-Based Supervision	0.421

As shown in Table 4, the square root of the AVE for each construct is greater than the correlations with the other constructs, satisfying the Fornell–Larcker criterion. This indicates that each construct has adequate discriminant validity. Furthermore, all HTMT values were below the threshold of 0.90, confirming that the constructs were empirically distinct from one another. Therefore, the discriminant validity of the measurement model was established.

4.5 Structural Model Evaluation

After confirming the reliability and validity of the measurement model, the structural model was evaluated to test the proposed hypotheses using AMOS. The assessment included the examination of path coefficients, t-statistics, p-values, and effect sizes (f^2). In addition, the coefficient of determination (R^2) and predictive relevance (Q^2) were evaluated to assess the explanatory and predictive power of the model. The results of the structural model evaluation are shown in Table 5.

Table 5. Structural model results

Hypothesis	Relationship	Coefficient (β)	T-Statistic	P-Value	f^2	Result
H_1	ICT-Based Supervision → Work Discipline	0.203	4.205	0.000	0.088	Supported
H_2	Digital Literacy → Work Discipline	0.705	13.071	0.000	0.983	Supported
H_3	ICT-Based Supervision × Digital Literacy → Work Discipline	0.033	0.907	0.364	0.005	Not Supported

Model Fit:

- R^2 (Work Discipline) = 0.585
- Adjusted R^2 = 0.579
- Q^2 = 0.434

As shown in Table 5, ICT-based supervision positively and significantly affected work discipline ($\beta = 0.203$, $p < 0.05$), supporting H_1 . Digital literacy has a strong positive and significant effect on work discipline ($\beta = 0.705$, $p < 0.05$), supporting H_2 . However, the moderating effect of digital literacy on the relationship between ICT-based supervision and work discipline was not significant ($\beta = 0.033$, $p > 0.05$), indicating that H_3 is not supported. The R^2 value of 0.585 indicates that 58.5% of the variance in work discipline is explained by the model, which can be considered to be moderate. Furthermore, the Q^2 value of 0.434 suggests that the model has a strong predictive relevance.

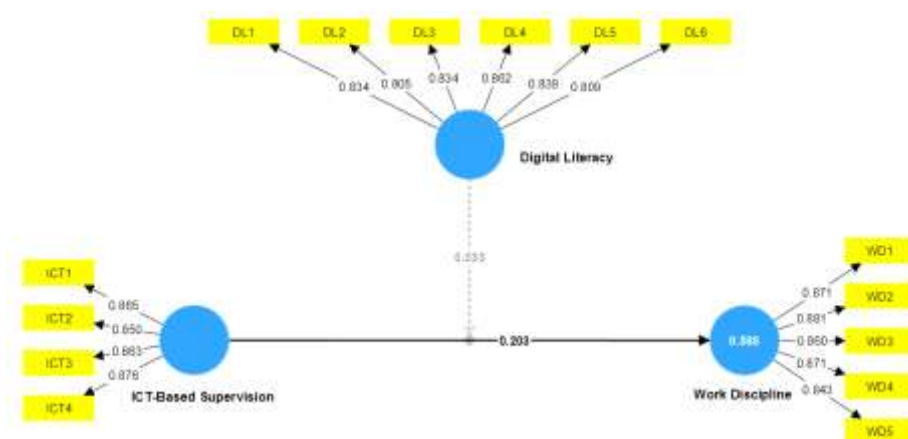


Figure 1. Structural model

Figure 1 illustrates the structural model analyzed using PLS-SEM, including the relationships between ICT-based supervision, digital literacy and work discipline. The model presents the path coefficients and coefficient of determination (R^2) for the dependent variable. The results show that digital literacy has the strongest positive effect on work discipline ($\beta = 0.705$), followed by ICT-based supervision ($\beta = 0.203$). Meanwhile, the interaction effect between ICT-based supervision and digital literacy was relatively weak and not statistically significant ($\beta = 0.033$). The R^2 value of 0.585 indicates that the model explains 58.5% of the variance in the students' work discipline. Overall, the figure demonstrates that digital literacy plays a dominant role in influencing employee discipline, whereas ICT-based supervision contributes as a supporting factor. This finding highlights the importance of human capability in maximizing the effectiveness of digital governance.

4.6 Discussions

The relatively moderate coefficient suggests that while ICT-based supervision plays an important role in shaping employee work discipline, its influence is not as dominant as other factors. This indicates that the presence of digital monitoring systems alone is insufficient to fully control or predict employees' behavior. This finding is consistent with prior studies emphasizing that digital supervision enhances transparency, traceability, and accountability in organizational processes but may not fully determine behavioral outcomes due to the complex nature of human factors ([Fleischer & Wanckel, 2024](#); [Juknevičienė et al., 2025](#)). Therefore, ICT-based supervision should be viewed as a facilitating mechanism rather than the sole determinant of discipline.

In the context of coastal regions, this result can be further explained by infrastructural limitations, uneven digital access, and disparities in technological readiness among workers. These constraints may reduce the effectiveness of ICT-based monitoring systems, as not all employees can fully engage with or benefit from digital tools. Consequently, the implementation of technology in such environments may face practical challenges that limit its effectiveness. This suggests that technology serves more as a supporting mechanism rather than a primary driver of discipline, particularly in geographically constrained regions.

This finding aligns with previous research highlighting that digital competence enhances adaptability, compliance, and performance in digital work environments ([Amankona et al., 2025](#); [Lei et al., 2024](#)). Employees with high digital literacy are more capable of interpreting digital systems, responding effectively to monitoring mechanisms, and aligning their behavior with the organization's expectations. In this sense, digital literacy functions as an enabling capability that allows employees to maximize the benefits of technology.

Importantly, this study reveals that human capability is more influential than technological systems in driving employee discipline than technological systems. This finding reinforces the socio-technical perspective, which emphasizes that successful digital transformation depends not only on the availability of technology but also on the readiness and competence of its users ([Duan & Dong, 2025](#); [Hossain et al., 2025](#)). Without adequate human capacity, even advanced technological systems may fail to produce desired organizational outcomes.

This finding provides an important contribution to the literature because it challenges the common assumption that individual competencies always strengthen the effectiveness of technological systems. Instead, the results suggest that digital literacy functions primarily as an independent predictor rather than a moderating variable. This implies that its influence on employee behavior operates directly rather than through interaction effects with the supervision systems.

One possible explanation is that employees with high digital literacy tend to exhibit self-regulated behavior, reducing their dependence on external supervision mechanisms. These individuals are more likely to internalize organizational rules and proactively adapt to digital work environments. Conversely, employees with low digital literacy may struggle to use ICT-based systems effectively, thereby limiting the potential interaction effect between technology and supervision. This asymmetry may explain the nonsignificant moderating effect observed in this study.

The non-significant moderating effect of digital literacy suggests that its role does not depend on the presence of ICT-based supervision but operates independently as a direct determinant of discipline. This finding challenges the common assumption that individual competencies always

enhance the effectiveness of technological systems. Several explanations can be proposed for this. First, the absence of moderation may be attributed to the relatively homogeneous digital literacy levels among respondents, which limits variability and reduces interaction effects. Second, the relationship between ICT-based supervision and work discipline may be linear rather than conditional, meaning that supervision affects discipline regardless of the digital literacy level.

Third, from a theoretical perspective, this result indicates that digital literacy functions as a primary antecedent rather than a boundary condition. Employees with high digital literacy tend to exhibit self-regulated behavior and reduce their reliance on external monitoring systems. Conversely, employees with low digital literacy may not effectively utilize ICT systems, thereby weakening this interaction effect.

This finding suggests the need to reconsider the role of human capability in digital governance models, where digital literacy may substitute rather than moderate technological control mechanisms. Thus, digital literacy is a direct determinant of work discipline rather than a reinforcing factor in supervision systems. Its role is fundamental in shaping employee behavior, particularly in environments where digital systems are increasingly integrated into organizational processes.

These results suggest that the combination of ICT-based supervision and digital literacy provides a meaningful and comprehensive explanation of employee discipline in the public sector, particularly in geographically constrained regions. The integration of technological and human factors offers a more holistic understanding of how disciplines are formed and maintained.

This study contributes to the literature in three key areas. First, it extends principal-agent theory by incorporating ICT-based supervision as a modern digital control mechanism in public organizations, thereby updating traditional supervision concepts in the context of the digital governance. Second, it reinforces human capital theory by demonstrating that digital literacy is a critical resource that influences employee behavior and organizational outcomes. Third, the findings support the socio-technical perspective, emphasizing that human capability is more critical than technological systems in achieving effective digital governance outcomes. This highlights the need to consider both the technological and human dimensions in organizational research and practice.

From a practical standpoint, the findings suggest that policymakers and public sector managers should prioritize the development of digital literacy among employees. While investments in ICT infrastructure remain important, they should be complemented by continuous training programs and capacity-building initiatives to enhance employees' digital competencies. In coastal and remote areas, where infrastructural challenges persist, strengthening human capacity may yield greater benefits than relying solely on technological solutions alone. Therefore, a balanced approach that integrates technology with human resource development is essential to ensure the effectiveness of digital transformation initiatives in the health sector.

This study provides empirical evidence from coastal regions that are often underrepresented in digital governance research. The findings highlight that geographical constraints significantly influence the effectiveness of digital systems and employee behavior, thereby underscoring the importance of contextual factors. By focusing on North Kalimantan, this study demonstrates that the regional context plays a crucial role in shaping the outcomes of digital transformation initiatives in the public sector. This insight is particularly relevant for policymakers in developing regions, where disparities in infrastructure and digital readiness remain significant challenges to be addressed.

5. CONCLUSIONS

5.1 Conclusion

This study aimed to examine the effect of ICT-based supervision on employee work discipline and analyze the moderating role of digital literacy in public sector organizations in coastal areas. The findings reveal that ICT-based supervision has a positive and significant effect on work discipline, indicating that digital monitoring systems contribute to improving employee compliance and accountability. Furthermore, digital literacy has a stronger and more significant effect on work discipline, suggesting that employees' ability to understand and utilize digital technologies plays a dominant role in shaping disciplined behavior. However, the moderating effect of digital literacy was not significant, indicating that it does not strengthen the relationship between ICT-based supervision

and work discipline. Overall, this study highlights that human capability, particularly digital literacy, is more influential than technological systems in enhancing employees' discipline. These findings contribute to the literature on digital governance by emphasizing the importance of integrating technological systems into human resource development.

5.2 Research Limitations

This study had several limitations. First, the research was conducted using a cross-sectional design, which limits the ability to capture changes in behavior over time. Second, the study focused only on public sector employees in the coastal areas of North Kalimantan, which may limit the generalizability of the findings to other regions or sectors. Third, the model only included ICT-based supervision and digital literacy as predictors of work discipline, while other potential factors such as organizational culture, leadership style, and motivation were not. These limitations suggest that the findings should be interpreted in the specific context of this study.

5.3 Suggestions and Directions for Future Research

Based on the findings and limitations, several recommendations for future research are proposed. Future studies should use longitudinal designs to better understand changes in employee behavior over time. Expanding research to include different regions or sectors would enhance the generalizability of the findings. Additionally, future research should consider incorporating other variables, such as leadership, organizational culture, and employee motivation, to provide a more comprehensive understanding of the factors influencing work discipline. Researchers should explore alternative analytical approaches or mixed-method designs to gain deeper insights into the interaction between technology and human capability in digital governance contexts.

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REFERENCES

- Adil, A., Marhani, M., & Rosa, I. (2025). The influence of individual characteristics and work discipline on the performance of PT employees Bank Syariah Indonesia Palopo Branch. *Dirham: Journal of Sharia Finance and Economics*, 1(1), 15-25. doi:<https://doi.org/10.35912/josfe.v1i1.3330>
- Al-Hawamleh, A. M. (2024). Investigating the multifaceted dynamics of cybersecurity practices and their impact on the quality of e-government services: evidence from the KSA. *Digital policy, regulation and governance*, 26(3), 317-336. doi:<https://doi.org/10.1108/DPRG-11-2023-0168>
- Amankona, D., Yi, K., Tackie, E. A., Tweneboa Kodua, L., & Odai, L. A. (2025). Responsible digital innovation and innovation performance in Ghana's high-tech industry: The mediating roles of digital organizational culture and strategy, and the moderating role of digital literacy. *Sage Open*, 15(2), 21582440251341256. doi:<https://doi.org/10.1177/21582440251341256>
- Banding, M. P., & Padliansyah, R. (2022). *Sistem Informasi Manajemen: Dalam Perspektif Revolusi Industri 4.0*: Syiah Kuala University Press.
- Bhimasta, R. A., Surya, R. A., & Pramudita, D. P. D. (2025). Integrating Marketing, HRM, and Accounting Systems for Customer Value Sustainability. *Jurnal Relevansi: Ekonomi, Manajemen dan Bisnis*, 9(2), 149-162. doi:<https://doi.org/10.61401/relevansi.v9i2.307>
- Cetindamar Kozanoglu, D., & Abedin, B. (2021). Understanding the role of employees in digital transformation: conceptualization of digital literacy of employees as a multi-dimensional organizational affordance. *Journal of enterprise information management*, 34(6), 1649-1672. doi:<https://doi.org/10.1108/JEIM-01-2020-0010>

- Chatterjee, S., Chaudhuri, R., Vrontis, D., & Giovando, G. (2023). Digital workplace and organization performance: Moderating role of digital leadership capability. *Journal of Innovation & Knowledge*, 8(1), 100334. doi:<https://doi.org/10.1016/j.jik.2023.100334>
- Chinnaraju, A. (2025). Partial least squares structural equation modeling (PLS-SEM) in the AI Era: Innovative methodological guide and framework for business research. *Magna Scientia Advanced Research and Reviews*, 13(02), 062-108. doi:<https://doi.org/10.30574/msarr.2025.13.2.0048>
- Dogbe, F., Alhassan, M. D., Adomako, R. B., & Davies, E. (2024). The mediating role of government ICT use on the nexus between ICT access and public sector performance. *Transforming Government: People, Process and Policy*, 18(3), 434-450. doi:<https://doi.org/10.1108/TG-02-2024-0039>
- Duan, Y., & Dong, X. (2025). Does Digital Literacy Matter for E-Government Usage Behavior? An Empirical Analysis Based on Data from Rural Women in China. *Sage Open*, 15(3), 21582440251376118. doi:<https://doi.org/10.1177/21582440251376118>
- Febriyanti, D., Widianingsih, I., Sumaryana, A., & Buchari, R. A. (2023). Information Communication Technology (ICT) on Palembang city government, Indonesia: Performance measurement for great digital governance. *Cogent Social Sciences*, 9(2), 2269710. doi:<https://doi.org/10.1080/23311886.2023.2269710>
- Fleischer, J., & Wanckel, C. (2024). Job satisfaction and the digital transformation of the public sector: The mediating role of job autonomy. *Review of Public Personnel Administration*, 44(3), 431-452. doi:<https://doi.org/10.1177/0734371X221148403>
- Hoang, H. (2024). Navigating the digital landscape: an exploration of the relationship between technology-organization-environment factors and digital transformation adoption in SMEs. *Sage Open*, 14(4), 21582440241276198. doi:<https://doi.org/10.1177/21582440241276198>
- Hossain, M. A., Akter, S., Dwivedi, Y. K., Maier, C., Janssen, M., Rana, N. P., & Currie, W. (2025). Digital Transformation Empowerment Capabilities in Public Service Systems. *Journal of Computer Information Systems*, 1-23. doi:<https://doi.org/10.1080/08874417.2025.2527293>
- Ichdan, D. A. (2024). Analysis of employee performance through productivity: The role of kaizen culture, motivation, and work discipline in the manufacturing industry. *Annals of Human Resource Management Research*, 4(1), 13-28. doi:<https://doi.org/10.35912/ahrmr.v4i1.2158>
- Juknevičienė, V., Leach, N., Toleikienė, R., Balčiūnas, S., Razumė, G., Rybnikova, I., & Ābolaņa, I. (2025). E-Leadership within public sector organisations: a systematic literature review. *Sustainability*, 17(10), 4474. doi:<https://doi.org/10.3390/su17104474>
- Legate, A. E., Ringle, C. M., & Hair Jr, J. F. (2024). PLS-SEM: a method demonstration in the R statistical environment. *Human Resource Development Quarterly*, 35(4), 501-529. doi:<https://doi.org/10.1002/hrdq.21517>
- Lei, H., Tang, S., Zhao, Y., & Chen, S. (2024). Enterprise digitalization, employee digital literacy and R&D cooperation: the moderating role of organizational inertia. *Chinese Management Studies*, 18(2), 479-505. doi:<https://doi.org/10.1108/CMS-10-2021-0456>
- Medina, M. J., Baudet, C., & Lebraty, J.-F. (2024). Blockchain and agency theory in supply chain management: A question of trust. *International journal of information management*, 75, 102747. doi:<https://doi.org/10.1016/j.ijinfomgt.2023.102747>
- Munir, S., & Hamid, M. (2026). E-Government & the Concept of Evidence Based Monitoring for Effective Governance: A Case of Punjab, Pakistan. *Public Organization Review*, 26, 1-42. doi:<https://doi.org/10.1007/s11115-026-00984-8>
- Ndone, J. (2025). Public relations in the age of AI: the moderating effects of authentic leadership and supervisors' digital literacy on AI-induced uncertainty among Kenyan public relations practitioners. *Corporate communications: An international journal*, 1-22. doi:<https://doi.org/10.1108/CCIJ-03-2025-0057>
- Nikou, S., De Reuver, M., & Mahboob Kanafi, M. (2022). Workplace literacy skills—how information and digital literacy affect adoption of digital technology. *Journal of Documentation*, 78(7), 371-391. doi:<https://doi.org/10.1108/JD-12-2021-0241>

- Niu, J., Ozdemir, S. Z., & Kim, Y. U. (2025). Taking action to reduce board-level information asymmetry: the adoption of enterprise information systems. *Industrial management & data systems*, 125(1), 1-29. doi:<https://doi.org/10.1108/IMDS-03-2024-0172>
- Nugraha, A., & Indiyati, D. (2025). Effect of recruitment, job placement and compensation on the performance of health workers. *American Journal of Economic and Management Business (AJEMB)*, 4(5), 580-593. doi:<https://doi.org/10.58631/ajemb.v4i5.221>
- Oberländer, M., Beinicke, A., & Bipp, T. (2020). Digital competencies: A review of the literature and applications in the workplace. *Computers & Education*, 146, 103752. doi:<https://doi.org/10.1016/j.compedu.2019.103752>
- Radzi, A. R., Rahman, R. A., & Almutairi, S. (2022). Modeling COVID-19 impacts and response strategies in the construction industry: PLS-SEM approach. *International Journal of Environmental Research and Public Health*, 19(9), 5326. doi:<https://doi.org/10.3390/ijerph19095326>
- Sakita, B. M., Helgheim, B. I., & Bråthen, S. (2024). The principal-agent theoretical ramifications on digital transformation of ports in emerging economies. *Logistics*, 8(2), 51. doi:<https://doi.org/10.3390/logistics8020051>
- Sarstedt, M., Ringle, C. M., & Hair, J. F. (2021). Partial least squares structural equation modeling *Handbook of market research* (pp. 587-632): Springer.
- Shalahuddin, S. (2022). Improving employee performance through good organizational culture and work motivation. *Advances in Human Resource Management Research*, 1(1), 45-54. doi:<https://doi.org/10.60079/ahrmr.v1i1.26>
- Shalahuddin, S., Werang, N. L., Suaib, S., Huriati, H., & Kamase, J. (2022). Peran rekrutmen, seleksi, dan penempatan: analisis kinerja karyawan. *Inovasi: Jurnal Ekonomi, Keuangan, Dan Manajemen*, 18(1), 167-175. doi:<https://doi.org/10.30872/jinv.v18i1.10524>
- Sohail, M. T., & Chen, S. (2022). Public perceptions About Foreign Investment, A PLS-SEM Analysis toward republic sustainable infrastructure. *PLoS One*, 17(11), e0277673. doi:<https://doi.org/10.1371/journal.pone.0277673>
- Sukhov, A., Olsson, L. E., & Friman, M. (2022). Necessary and sufficient conditions for attractive public Transport: Combined use of PLS-SEM and NCA. *Transportation Research Part A: Policy and Practice*, 158, 239-250. doi:<https://doi.org/10.1016/j.tra.2022.03.012>
- Tariq, A., Batool, A., Liaqat, S., & Khan, I. H. (2025). Institutions, Corruption and Economic Development: PLS-SEM Analysis. *Journal of Political Stability Archive*, 3(3), 1351-1374. doi:<https://doi.org/10.63468/jpsa.3.3.90>
- Valtonen, A., & Holopainen, M. (2025). Mitigating employee resistance and achieving well-being in digital transformation. *Information Technology & People*, 38(8), 42-72. doi:<https://doi.org/10.1108/ITP-05-2024-0701>