

BRIDGING DIGITAL LEADERSHIP AND TECHNOLOGY CAPABILITY WITH WATER UTILITY PERFORMANCE: THE MEDIATING ROLE OF ORGANIZATIONAL CULTURE

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ABSTRACT

Digital transformation is reshaping water utility management by increasing the need for effective leadership, technological capability, and organizational adaptability. This study examines the relationships between Digital Leadership (DL), Technology Capability (TC), and Water Utility Performance (WUP), with Organizational Culture (OC) as a mediating mechanism. Drawing on Dynamic Capabilities Theory (DCT) and the Technology–Organization–Environment (TOE) framework, the study positions DL and TC as organizational capabilities that can strengthen utility performance directly and through a supportive organizational culture. A quantitative cross-sectional design was employed among employees of Air Selangor, Malaysia, with 412 valid responses analyzed using Partial Least Squares Structural Equation Modelling (PLS-SEM). The study provides an integrated Industrial Management perspective for understanding how leadership, technology capability, and organizational culture interact within the water utility environment. The proposed relationships offer practical insights for strengthening digital transformation, operational efficiency, infrastructure reliability, asset performance, water-loss management, and service continuity within the water utility sector.

Keywords: Digital Leadership; Technology Capability; Organizational Culture; Water Utility Performance; Digital Transformation; PLS-SEM

INTRODUCTION

Digital transformation is increasingly reshaping infrastructure-intensive industries, including water utilities, through greater use of data analytics, digital monitoring, integrated information systems, and technology-supported decision-making. Daniel et al. (2023) highlight that digital transformation within water utilities is increasingly supported by interconnected digital technologies and data-driven operational practices. More recently, Grigg (2025) reinforces the growing strategic importance of digital transformation for modern water utility management. Nevertheless, technological investment alone cannot guarantee stronger performance, as its value depends on the integration of technological resources with organizational processes, infrastructure,

and human capabilities.

Within this transformation, Digital Leadership (DL) has become increasingly important. Digital leaders provide strategic direction, mobilize resources, encourage innovation, and support employees in adapting to technological change. Mollah et al. (2024) demonstrate that digital leadership can influence organizational outcomes through internal organizational mechanisms rather than operating solely through direct effects. In water utilities, this role is particularly relevant because digital transformation requires coordination among management, engineering, operations, maintenance, IT, data, and asset-management functions.

Alongside leadership, Technology Capability (TC) determines whether organizations can effectively integrate, utilize, and adapt their technological resources. Côte-Real et al. (2024) associate dynamic IT capabilities with an organization's capacity to respond to changing technological environments and develop broader organizational capabilities. For water utilities, strong technology capability can support operational monitoring, infrastructure management, data-driven decisions, and asset performance. However, Wu et al. (2024) indicate that the performance value of technological capability may also depend on intermediate organizational mechanisms.

One such mechanism is Organizational Culture (OC). A culture that encourages collaboration, learning, adaptability, information sharing, and innovation can facilitate the translation of leadership and technological resources into organizational outcomes. Ghafoori et al. (2024) emphasize the importance of organizational culture within data-driven digital transformation, particularly when technological resources must be integrated into existing organizational practices. This is highly relevant to water utilities, where effective performance depends on coordination across multiple technical and operational functions.

Despite growing interest in digital transformation, existing research has largely examined digital leadership, technology capability, organizational culture, and performance within manufacturing, services, education, or general organizational environments. Mollah et al. (2024) further reported that digital culture did not significantly mediate the relationship between digital leadership and competitive performance in their study, suggesting that the role of culture may differ across organizational contexts. Meanwhile, Sjöstrand et al. (2025) emphasize that organizational and cultural transformation remains a major challenge in water-sector digitalization. These findings provide a strong basis for examining culture as a mediating mechanism specifically within an infrastructure-intensive water utility environment.

Accordingly, this study examines the relationships between Digital Leadership, Technology Capability, Organizational Culture, and Water Utility Performance at Air Selangor, Malaysia. It further investigates whether Organizational Culture mediates the relationships between Digital Leadership and Water Utility Performance and between Technology Capability and Water Utility Performance. Drawing primarily on Dynamic Capabilities Theory (DCT) and complemented by the Technology–Organization–Environment (TOE) framework, the study explains how managerial and technological capabilities may be translated into operational performance through organizational culture.

The study contributes to the literature by integrating leadership, technology capability, organizational culture,

and utility performance within a single framework. More specifically, it extends digital transformation research into the relatively underexplored Malaysian water utility context and strengthens the Industrial Management perspective by linking digital transformation with operational efficiency, infrastructure reliability, asset performance, water-loss management, and service continuity. Rather than treating digital transformation merely as technology adoption, the study positions it as an organizational capability challenge involving the alignment of leadership, technology, culture, and operational performance.

2. LITERATURE REVIEW

2.1 Digital Leadership

Digital Leadership (DL) reflects the ability of leaders to align technological change with organizational strategy, employee capabilities, and operational priorities. Unlike conventional leadership, digital leadership requires managers to understand emerging technologies while simultaneously managing organizational adaptation and change. Mollah et al. (2024) found that digital leadership can influence organizational outcomes through internal organizational mechanisms, suggesting that leadership remains central to converting digital initiatives into organizational value. Within water utilities, this capability is particularly important because technological transformation requires coordination among engineering, operations, maintenance, IT, data, and asset-management functions.

Digital leaders may also influence the cultural environment in which technological transformation occurs. Through strategic direction, communication, learning, and support for innovation, leaders can encourage employees to collaborate and adapt to new digital practices. Consequently, this study proposes that Digital Leadership contributes directly to Water Utility Performance while also strengthening Organizational Culture.

H1: Digital Leadership has a positive and significant relationship with Water Utility Performance.

H3: Digital Leadership has a positive and significant relationship with Organizational Culture.

2.2 Technology Capability

Technology Capability (TC) refers to an organization's capacity to integrate, utilize, and adapt technological resources in support of organizational objectives. Côte-Real et al. (2024) explain that dynamic IT capabilities enable organizations to reconfigure technological resources and develop broader capabilities in response to environmental change. Within water utilities, these capabilities include digital infrastructure, system integration, data analytics, technical expertise, and technological adaptability.

Technology capability can support real-time operational monitoring, infrastructure management, asset planning, and data-driven decision-making. Nevertheless, technological resources do not automatically generate performance improvements. Wu et al. (2024) indicate that the performance contribution of IT capability may operate through intermediate organizational mechanisms. Technology capability may therefore contribute directly to utility performance while simultaneously influencing organizational practices and culture.

H2: Technology Capability has a positive and significant relationship with Water Utility Performance.

H4: Technology Capability has a positive and significant relationship with Organizational Culture.

2.3 Organizational Culture

Organizational Culture (OC) represents shared values, behaviours, and working practices that influence collaboration, learning, adaptability, information sharing, and innovation. These characteristics become particularly important during digital transformation because technology frequently changes established work

routines and requires greater coordination across organizational boundaries. Ghafoori et al. (2024) emphasize that organizational culture plays an important role in data-driven digital transformation by creating conditions that enable technological resources to be integrated into organizational practices.

Within water utilities, a supportive organizational culture can facilitate collaboration among managerial, engineering, technical, operational, and digital functions. This may strengthen the organization's ability to translate information and technological resources into operational improvements. Organizational Culture is therefore expected to contribute positively to Water Utility Performance.

H5: Organizational Culture has a positive and significant relationship with Water Utility Performance.

2.4 Mediating Role of Organizational Culture

The relationship between organizational capabilities and performance may extend beyond direct effects. Digital leaders can influence employee behaviour, communication, learning, and adaptability, while technology capability can reshape information sharing and organizational routines. Organizational Culture may therefore provide the mechanism through which these capabilities are converted into performance outcomes. Interestingly, Mollah et al. (2024) reported that digital culture did not significantly mediate the relationship between digital leadership and competitive performance in their particular context. This mixed evidence provides a useful basis for re-examining mediation within an infrastructure-intensive water utility setting.

The water utility context is particularly relevant because digital transformation involves the integration of people, technologies, physical assets, and operational processes. Sjöstrand et al. (2025) emphasize that organizational and cultural transformation remains an important challenge in water-sector digitalization. Accordingly, this study examines whether Organizational Culture provides the internal mechanism connecting Digital Leadership and Technology Capability with Water Utility Performance.

H6: Organizational Culture mediates the relationship between Digital Leadership and Water Utility Performance.

H7: Organizational Culture mediates the relationship between Technology Capability and Water Utility Performance.

2.5 Theoretical Foundation

This study is primarily grounded in Dynamic Capabilities Theory (DCT), which explains how organizations develop, integrate, and reconfigure capabilities in response to changing environments. From this perspective, Digital Leadership and Technology Capability represent strategic capabilities that enable an organization to sense technological opportunities, mobilize resources, and transform organizational practices. Organizational Culture provides the internal environment through which these capabilities can become embedded in everyday operations and subsequently contribute to Water Utility Performance.

The Technology–Organization–Environment (TOE) framework complements DCT by recognizing that technological transformation depends on both technological and organizational conditions. In this study, Technology Capability represents the technological dimension, while Digital Leadership and Organizational Culture capture important organizational conditions. Combining DCT and TOE therefore provides a suitable theoretical foundation for explaining the interaction between leadership, technology, culture, and performance in the water utility sector. Data were collected using a structured questionnaire from employees with relevant exposure to organizational operations and digital transformation. The study applied a five-point Likert scale to measure the selected constructs. Partial Least Squares Structural Equation Modelling (PLS-SEM) using SmartPLS was employed for data analysis. Following Hair et al. (2022), the analysis involved the assessment of both the measurement and structural models, enabling the reliability and validity of the constructs as well as the proposed direct and mediating relationships to be examined.

3. RESEARCH METHODOLOGY

This study employed a quantitative cross-sectional design to examine the relationships among Digital Leadership, Technology Capability, Organizational Culture, and Water Utility Performance within the Malaysian water utility context. Data were collected using a structured questionnaire from employees with relevant exposure to organizational operations and digital transformation. A five-point Likert scale was used to measure the study constructs. Partial Least Squares Structural Equation Modelling (PLS-SEM) using SmartPLS was employed for data analysis. Following Hair et al. (2022), the analysis involved two stages: assessment of the measurement model followed by assessment of the structural model. This approach enables the reliability and validity of the constructs, together with the proposed direct and mediating relationships, to be examined.

Table 1. Research Design and Analytical Approach

Component	Approach
Research design	Quantitative, cross-sectional
Research context	Malaysian water utility sector
Data collection	Structured questionnaire
Measurement	Five-point Likert scale
Unit of analysis	Individual employee
Analytical technique	PLS-SEM
Software	SmartPLS
Mediation	Organizational Culture

Table 1 summarises the research design and analytical approach adopted in the study, providing a systematic basis for examining the relationships among leadership, technological capability, organizational culture, and water utility performance.

4. RESULTS AND ANALYSIS

The empirical analysis was conducted using SmartPLS based on 412 valid responses obtained from employees within the Malaysian water utility context. The analysis followed the PLS-SEM procedure, beginning with an assessment of the measurement model before examining the structural relationships among Digital Leadership

(DL), Technology Capability (TC), Organizational Culture (OC), and Water Utility Performance (WUP). The final sample represented a response rate of 91.6%, providing an adequate empirical basis for subsequent analysis.

4.1 Descriptive Analysis

The preliminary analysis indicated complete observations across the measurement items, with no missing values recorded in the final dataset. Mean scores ranged from 3.443 to 4.299, while standard deviations ranged from 0.661 to 1.224, indicating generally favourable perceptions with sufficient variation across the study constructs. These results provide an appropriate basis for subsequent measurement and structural model assessment.

4.2 Measurement Model Assessment

The measurement model was assessed before examining the structural relationships. Internal consistency reliability was evaluated using Cronbach's Alpha and Composite Reliability (CR), while convergent validity was assessed using Average Variance Extracted (AVE).

Table 2. Reliability and Convergent Validity

Construct	Cronbach's Alpha	CR	AVE
Digital Leadership (DL)	0.721	0.778	0.506
Technology Capability (TC)	0.800	0.862	0.555
Organizational Culture (OC)	0.711	0.813	0.526
Water Utility Performance (WUP)	0.811	0.869	0.569

The results demonstrate satisfactory internal consistency across the four constructs. Cronbach's Alpha values ranged from 0.711 to 0.811, while Composite Reliability values ranged from 0.778 to 0.869. In addition, all AVE values exceeded the recommended threshold of 0.50, ranging between 0.506 and 0.569. Collectively, the findings provide evidence of acceptable reliability and convergent validity and support subsequent assessment of the structural model. Discriminant validity was subsequently examined to determine whether Digital Leadership, Technology Capability, Organizational Culture, and Water Utility Performance represented empirically distinguishable constructs. The assessment indicated adequate separation among the constructs, supporting their treatment as conceptually distinct components within the proposed model.

4.3 Structural Model Assessment

Following confirmation of the measurement model, the structural model was assessed to examine the proposed relationships among the four constructs. The model incorporates five direct relationships and two indirect relationships, allowing the analysis to consider both the independent contributions of Digital Leadership and Technology Capability and the mediating role of Organizational Culture.

Table 3. Structural Relationships Examined

Hypothesis	Relationship	Effect
H ₁	DL → WUP	Direct
H ₂	TC → WUP	Direct
H ₃	DL → OC	Direct
H ₄	TC → OC	Direct

H₅	OC → WUP	Direct
H₆	DL → OC → WUP	Indirect
H₇	TC → OC → WUP	Indirect

The structural assessment focuses on whether managerial and technological capabilities contribute to Water Utility Performance independently and whether they simultaneously strengthen the organizational environment through which operational improvements can occur. This approach is particularly relevant within infrastructure-intensive utilities because technological resources alone may not translate automatically into improved organizational performance. Rather than interpreting Digital Leadership and Technology Capability as isolated predictors, the model positions them as complementary organizational capabilities. Digital Leadership represents the managerial capacity to provide strategic direction and facilitate digital adaptation, whereas Technology Capability represents the organization's capacity to deploy and utilize technological resources. Organizational Culture subsequently provides the internal organizational mechanism connecting these capabilities with operational performance.

4.4 Direct Relationships

The first five hypotheses examine the direct relationships among Digital Leadership, Technology Capability, Organizational Culture, and Water Utility Performance. H1 and H2 focus on the direct contributions of leadership and technological capability to utility performance, whereas H3 and H4 examine their relationships with Organizational Culture. H5 subsequently examines the relationship between Organizational Culture and Water Utility Performance. From an Industrial Management perspective, these relationships are important because water utility performance depends on the coordinated management of technological resources, people, operational systems, infrastructure, and organizational practices. The direct-effect analysis therefore provides a basis for determining whether digital transformation capabilities are associated with operational outcomes rather than merely reflecting the adoption of new technologies.

4.5 Mediating Role of Organizational Culture

The mediation analysis extends the direct-effect assessment by examining whether Organizational Culture provides an organizational pathway through which Digital Leadership and Technology Capability are associated with Water Utility Performance. H6 examines the indirect relationship:

Digital Leadership → Organizational Culture → Water Utility Performance while H7 examines:

Technology Capability → Organizational Culture → Water Utility Performance

The mediation analysis is particularly important to the study because it addresses the central proposition that digital transformation within a water utility is not solely a technological process. Leadership may establish strategic direction and support organizational adaptation, while technological capability provides the resources required for digital operations. However, these capabilities must become embedded within shared organizational practices, collaboration, learning, adaptability, and information sharing before their potential operational value can be fully realised. Accordingly, Organizational Culture is positioned not simply as another predictor of performance but as an organizational mechanism connecting managerial and technological capabilities with utility outcomes. This provides the basis for interpreting the findings through the combined

perspectives of Dynamic Capabilities Theory and the Technology–Organization–Environment framework.

5. DISCUSSION

The study examines digital transformation within the water utility sector from an integrated Industrial Management perspective. Rather than focusing exclusively on technology adoption, the model connects Digital Leadership, Technology Capability, Organizational Culture, and Water Utility Performance. This positioning is important because water utilities operate through highly interconnected technical and organizational systems where managerial decisions, digital resources, infrastructure, employees, and operational routines must function collectively. The role of Digital Leadership is particularly relevant in this environment. Digital transformation requires more than managerial approval of technological investments; it requires strategic direction, coordination, employee engagement, and organizational adaptation. This argument is consistent with Mollah et al. (2024), who demonstrate that the influence of digital leadership may operate through internal organizational mechanisms. Within a water utility environment, leadership therefore provides an important bridge between technological transformation and organizational implementation.

Technology Capability represents another critical element of this transformation. The ability to integrate digital infrastructure, information systems, data analytics, and technical expertise can strengthen operational monitoring and decision-making. Côte-Real et al. (2024) similarly associate dynamic IT capabilities with an organization's capacity to reconfigure technological resources in response to environmental change. For water utilities, such capabilities have particular relevance to asset management, infrastructure monitoring, operational efficiency, and service reliability. The inclusion of Organizational Culture extends this argument by recognizing that technological and leadership capabilities operate within an organizational environment. A culture characterised by collaboration, learning, adaptability, and information sharing can facilitate the integration of digital technologies into everyday organizational practices. This is consistent with Ghafoori et al. (2024), who emphasize the importance of organizational culture in supporting data-driven digital transformation.

The mediation perspective therefore provides an important theoretical dimension to the study. It suggests that the performance implications of Digital Leadership and Technology Capability should not necessarily be interpreted solely through direct relationships. Instead, Organizational Culture provides a potential internal pathway through which managerial and technological capabilities become embedded in organizational routines and subsequently connected with utility performance.

This interpretation is particularly relevant to the water sector. Sjöstrand et al. (2025) identify organizational and cultural transformation as an important challenge in water-sector digitalization. The present study consequently extends the discussion from technological adoption toward the broader organizational capabilities required to support sustainable digital transformation in an infrastructure-intensive environment.

6. THEORETICAL AND PRACTICAL IMPLICATIONS

6.1 Theoretical Implications

The study contributes to digital transformation and Industrial Management literature by integrating Digital Leadership, Technology Capability, Organizational Culture, and Water Utility Performance within a unified

analytical perspective. The application of Dynamic Capabilities Theory (DCT) explains how leadership and technological capabilities may enable organizations to respond and adapt to technological change. The TOE framework complements this perspective by emphasizing the interaction between technological and organizational conditions. Technology Capability reflects the technological dimension, while Digital Leadership and Organizational Culture represent important organizational conditions supporting digital transformation. The inclusion of Organizational Culture as a mediator further extends the theoretical argument by explaining the internal mechanism through which organizational capabilities may become associated with operational outcomes. The study therefore moves beyond a simple technology–performance relationship toward a more integrated explanation of digital transformation in infrastructure-intensive organizations.

6.2 Practical Implications

For water utility management, the study highlights the importance of developing technological resources together with managerial and organizational capabilities. Investment in digital systems alone may provide limited organizational value when employees, leadership practices, and organizational routines are not aligned with technological transformation. Managers should therefore strengthen digital leadership competencies, technological integration, cross-functional collaboration, employee learning, and information-sharing practices. These capabilities can support more effective utilization of digital resources across engineering, operations, maintenance, asset management, and other organizational functions. From an operational perspective, stronger alignment among leadership, technology, and culture may contribute to areas such as operational efficiency, infrastructure reliability, asset performance, water-loss management, data-driven decision-making, and service continuity. These outcomes reinforce the importance of approaching digital transformation as an organizational capability agenda rather than solely as an IT initiative.

7. CONCLUSION

Digital transformation is increasingly important for water utilities seeking to strengthen operational performance within complex and infrastructure-intensive environments. This study examines the interconnected roles of Digital Leadership, Technology Capability, Organizational Culture, and Water Utility Performance within the Malaysian water utility context. The study contributes an Industrial Management perspective by positioning digital transformation as an organizational capability challenge involving the alignment of leadership, technological resources, culture, and operational practices. Drawing on Dynamic Capabilities Theory and the TOE framework, it provides an integrated explanation of how managerial and technological capabilities can be considered alongside the organizational mechanisms required to translate digital transformation into operational value. For practitioners, the study highlights that successful digital transformation requires more than technological investment. Water utilities must simultaneously develop leadership capabilities, technological readiness, organizational adaptability, and collaborative working practices. Such alignment is increasingly important for supporting reliable, efficient, and sustainable utility operations.

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