

Impact of Service Digitalization on Operational Efficiency and Company Performance: Mediating Effect of Customer Satisfaction in Perumda Tirta Benteng

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This study is of critical significance as it addresses the increasing demand for digital transformation within public utilities, where operational efficiency and performance are essential. It explores the transformative impacts of service digitalisation on operational efficiency and corporate performance, with a particular emphasis on the mediating role of customer satisfaction within the context of Perumda Tirta Benteng, a leading public utility in Indonesia. Employing a quantitative research design, the study utilises a structured survey methodology, drawing on responses from a stratified random sample of n=100 employees. Through the application of advanced statistical analyses, including Partial Least Squares Structural Equation Modelling (PLS-SEM), the study operationalises the constructs of service digitalisation, operational efficiency, customer satisfaction, and corporate performance, thereby ensuring rigor and validity in measurement. The findings indicate that service digitalisation significantly enhances both operational efficiency and corporate performance directly. Notably, customer satisfaction emerges as a crucial mediator,

amplifying the impact of digitalisation efforts on organisational outcomes. These results not only underscore the necessity of integrating digital technologies within public utilities but also illuminate the central role of customer satisfaction in translating digital advancements into measurable performance gains. The implications of the study extend to both theory and practice, suggesting that public utilities can achieve substantial improvements in operational efficiency and performance by prioritising customer-centric digital service initiatives. For policymakers and managers within the public utilities sector, this study presents a compelling case for adopting a holistic approach to digital transformation, emphasising the strategic significance of customer satisfaction in realising the full potential of digitalisation efforts.

Keywords: Service Digitalization, Operational Efficiency, Customer Satisfaction, Company Performance, Public Utilities, Structural Equation Modelling.

Introduction

Digital transformation is central to strategic development across industries, reshaping service delivery and consumption. The Technology Acceptance Model (TAM) explains digital service adoption, highlighting perceived ease of use and usefulness as key factors influencing uptake by employees and customers. For Perumda Tirta Benteng, digitalisation can revolutionise utility services, enhancing workflows and boosting customer satisfaction, a core outcome of TAM. The Resource-Based View (RBV) Barney (1991) further supports digital transformation as a strategic resource that enhances operational efficiency and performance. Traditionally, regulatory barriers and complex implementation processes have slowed digital adoption in the utility sector (Tsou & Chen, 2023). However, the need to increase efficiency, reduce costs, and improve service quality has driven Perumda Tirta Benteng towards digital transformation (Al-Ayed et al., 2023), necessitating significant shifts in organisational culture, processes, and customer engagement (Liu et al., 2023).

This study focuses on the impact of digital service transformation on organisational performance, particularly in public utilities in developing countries—a topic that remains underexplored (Al-Shboul et al., 2024). While existing research has examined the direct effects of digital transformation, the moderating roles of organisational culture, employee engagement, and customer satisfaction are less studied (Arslan, 2018). The case of Perumda Tirta Benteng provides insight into how neoliberal policies affect social groups and operations in developing nations (Dewi et al., 2019). This research aims to bridge this gap by examining the relationship between digital transformation and organisational performance, contributing to public sector discourse and practice (Tang & Yang, 2022). The study is timely, reflecting how the global 'digital push' during the COVID-19 pandemic has highlighted the importance of adaptability and innovation in public utilities (Hess et al., 2016; Kapoor & Kapoor, 2021).

For establishing a developing economy, considerations of infrastructure, consumer concerns, and environmentally sustainable operations are paramount. Perumda Tirta Benteng exemplifies the challenges inherent in fostering a developing economy, with

the primary challenge being the transition to digitised service delivery. Recognising the transformative potential of digital technology in service provision is crucial for community development. However, public utilities such as Perumda Tirta Benteng may still face significant obstacles in translating digital initiatives into tangible performance improvements (Bakker & Albrecht, 2018; Shehadeh et al., 2023).

While this research aims to address the existing gap, a comprehensive analysis is still needed to fully understand how digital service transformation impacts the organisational performance of Perumda Tirta Benteng across various dimensions (Bhatti, 2022). This involves aligning desired outcomes with the mapped digital programmes. To uncover deeper mediating mechanisms, such as organisational culture, it is essential to identify pivotal changes in customer engagement strategies that may either hinder or facilitate these outcomes (Hanelt et al., 2021). To achieve this, the research will commence with an in-depth assessment of Perumda Tirta Benteng's digital maturity, which serves as a prerequisite for establishing a baseline for evaluating digital initiatives (Vial, 2021). The subsequent focus will be on documenting and categorising the utility's digital transformation initiatives, enabling the creation of a tracking system that links these efforts to performance metrics (Hanelt et al., 2020; Wirtz & Daiser, 2018).

This study offers valuable insights for various stakeholders. It concludes that Perumda Tirta Benteng and other public utility companies can leverage the findings to strengthen their digital transformation initiatives, enhancing both operational efficiency and customer satisfaction. Policymakers and regulators in the public utilities sector can also benefit by recognising best practices related to customer-centric digital strategies for organisational improvement (Sakdapat, 2022). Additionally, customers stand to gain through improved service delivery, greater accessibility, and a user-friendly interface with the utility provider (Hussein et al., 2022). The study further contributes to academia by enriching the literature on digital transformation in the public sector, particularly in emerging nations where challenges such as infrastructural deficiencies and regulatory barriers persist.

Literature review

Service Digitalization and Operational Efficiency

Digitalisation involves integrating digital technologies into the operational frameworks of various sectors, and it is evident that digitalization plays a crucial role in enhancing efficiency within public utilities. In this context, operational efficiency implies that public utility authorities can reduce resource use and associated costs while delivering high-quality services at scale. Numerous studies indicate that digitalization supports operational improvements by enhancing service delivery, streamlining processes, and facilitating data-driven decision-making (Filz et al., 2024). Automated platforms, in particular, decrease the need for manual labour and reduce the time spent on routine tasks, thereby minimizing the risk of human error (Liu et al., 2023). Automation also benefits customer service by accelerating the handling of complaints and online billing, providing more accurate and trackable solutions that lead to quicker issue resolution and more efficient resource management (Zhang et al., 2023).

IoT has significantly improved operational monitoring and management in public

utilities, with smart metering and sensor systems enabling real-time data on service usage, infrastructure conditions, and climate. This data helps utilities enhance operations, anticipate and quickly address issues, and respond effectively to emergencies, leading to efficiency gains and cost reductions (Singh et al., 2021). Data analytics is also crucial, allowing utilities to handle vast amounts of data, predict demand, analyse trends, and improve service quality (Wamba et al., 2017). Despite its benefits, digitalisation faces challenges such as cyber threats, high initial investment, and literacy gaps among staff and customers (Nasiri et al., 2020; Verhoef et al., 2009). Nonetheless, literature highlights that strategic digitalisation efforts, supported by robust policies, can lead to substantial efficiency gains and better service delivery (Bharadwaj et al., 2013; Heeks, 2017). Based on this literature, the following hypothesis is proposed,

H1: *Service digitalization positively impacts operational efficiency in public utilities.*

Service Digitalization and Customer Satisfaction

Digitalisation within public utilities entails the integration of digital technologies into infrastructure and operations to automate processes, enhance service delivery, and improve customer interactions (Bhattacharjee & Park, 2014). The adoption of digital services aims to increase efficiency, transparency, and responsiveness to customer needs, which are crucial for customer satisfaction (Belhadi et al., 2022). A significant aspect of digitalisation that boosts customer satisfaction is the improved accessibility and convenience of services. Digital platforms enable real-time access to billing information and consumption data, empowering customers to manage their usage effectively (Kılıç & Uludağ, 2021). This immediacy and transparency align with the expectations of modern, tech-savvy consumers, positively influencing customer satisfaction (Lusch & Nambisan, 2015). Utility providers leverage data analytics to gain deeper insights into customer preferences, allowing them to predict behaviours and customise services accordingly, thereby enhancing customer experience (Kannan, 2017). For instance, smart metering technologies not only optimise operational efficiency and cut costs but also offer users detailed consumption data, helping them make informed choices to reduce expenses or conserve energy, thereby supporting environmental efforts (Wang, 2022). Such advancements also impact customer retention, acquisition costs, and the supply-demand dynamics of services (Chen & Kim, 2023).

Customer feedback mechanisms are crucial in digitalisation, enabling users to communicate their needs and preferences. These interactive platforms allow utilities to respond swiftly, adapt services based on feedback, and boost customer satisfaction (Davies et al., 2023). The responsiveness facilitated by digital tools enhances customer perceptions and satisfaction. However, challenges such as the digital divide, privacy concerns, and significant infrastructure and skills investment pose barriers (Pandya & Rao, 2022). These factors may moderate the link between digital services and customer satisfaction, highlighting uneven impacts (Rodrigues et al., 2021). Empirical evidence supports the positive influence of digitalisation on satisfaction, as noted by Oliveira et al. (2016). Based on the presented literature, the following hypotheses is proposed,

H2: *Service digitalization enhances customer satisfaction in public utilities.*

Service Digitalization and Company Performance

Service digitalisation significantly enhances operational efficiency, defined as “how effectively an organization utilises its resources to produce its services” (Legner et al., 2017). By transforming business processes, digitalisation reduces costs and improves service quality (Legner et al., 2017; Li et al., 2024). For instance, advanced data analytics and IoT technologies enable predictive maintenance, allowing service providers to make informed decisions about equipment servicing, thereby improving services and reducing costs. Operational efficiency is critical for enhancing business performance, measured through financial results, customer satisfaction, and market competitiveness. More efficient operations lower costs, enabling reinvestment in innovation and service quality, directly influencing organisational success (Haloul et al., 2024; Rodrigues et al., 2021). Improved operational efficiency often leads to better service delivery and higher quality, fostering customer satisfaction and loyalty, which drives overall performance (Asif & Mansoor, 2024; Chen & Kim, 2023). Thus, the impact of digitalisation on company performance is moderated by operational efficiency. Empirical studies have explored the mediating role of resource productivity in the relationship between digitalisation and company performance. For instance, He et al. (2023) found that companies adopting digitalisation streamline operations, yielding positive financial outcomes. Similarly, Haskasap et al. (2022) noted increased profitability due to reductions in operating and supply chain costs, exemplified by supply chain improvements with lower operational costs (Albarq et al., 2022).

Operational efficiency is of paramount importance to public utilities, and digitalisation plays a crucial role in enhancing this efficiency. By adopting a customer-oriented approach facilitated through digital platforms, public utilities can optimise their use of essential resources (Verbin, 2022). This operational efficiency not only supports the infrastructure but also leads to the provision of more reliable and qualitative services, ultimately resulting in improved financial performance and increased customer satisfaction (Juvika & Ardi, 2023). Furthermore, leveraging operational efficiency is essential for successfully implementing digitalisation initiatives across various companies and industries. However, challenges such as cybersecurity concerns, data privacy issues, and employee resistance to adopting new digital tools can undermine the benefits of digitalisation, restricting the capacity of operational efficiency to act as a mediator in the relationship between digitalisation and performance (Verhoef et al., 2009). Additionally, the effectiveness of operational efficiency as a mediating factor in the digitalisation-performance relationship may vary significantly across different companies, industries, and regulatory environments (Legner et al., 2017). Based on the literature reviewed, the following hypotheses is proposed,

H3: *Service digitalization enhances company performance in public utilities.*

Customer Satisfaction, Service Digitalization and Company Performance

Among the various factors that influence a company's performance, customer satisfaction is often regarded as the most significant. It reflects the degree to which a customer's expectations regarding service are met or exceeded. Satisfied customers are more likely to exhibit loyalty, engage in repeat purchases, and disseminate positive word-of-mouth endorsements, thereby driving revenue growth and solidifying the

company's position in the market (Awadhi et al., 2021). This relationship capitalises on customer feedback in a two-fold manner (Arslan, 2018). Through digitised platforms, companies can implement essential improvements in service delivery and innovation, which further enhance their performance. Numerous empirical studies support the mediating role of customer satisfaction in the relationship between digitalisation and performance. For instance, Ribeiro-Navarrete et al. (2021) demonstrated that digitalisation initiatives aimed at enhancing customer experience directly contribute to increased customer satisfaction, which, in turn, leads to improved company performance in terms of sales growth and profitability. Similarly, Legner et al. (2017) found that customer satisfaction serves as a critical mediator between companies' digitalisation efforts and their overall success. Therefore, the alignment of digital initiatives with customer needs and preferences cannot be overstated.

The mediating effect of customer satisfaction is particularly pronounced in sectors where service quality and customer experience are paramount, such as public utilities, retail, and banking (Demirel, 2022). In these industries, digitalisation facilitates the simplification of transactions and interactions, enabling the delivery of customised and innovative services. However, the relationship between digitalisation, customer satisfaction, and firm performance is not without its challenges. To effectively integrate digital technologies, organisations must make substantial investments in infrastructure and capabilities, alongside fostering a culture that promotes change and supports innovation. Additionally, privacy concerns and data security issues have emerged as critical challenges that necessitate resolution. Based on the literature reviewed, the following hypotheses is proposed,

H4: *Customer satisfaction mediates the relationship between service digitalization and company performance.*

Digital Transformation

Digital transformation refers to the comprehensive integration of digital technology across all facets of a business, fundamentally altering the manner in which organisations operate and deliver value to their customers (Vial, 2021). Scholars such as Hess et al. (2016) and Kane (2015) have established a theoretical framework for understanding the strategic implications of digitalisation. They assert that digital technologies empower organisations to cultivate new capabilities, innovate their business processes, and enhance customer engagement. The Resource-Based View (RBV) and Dynamic Capabilities Theory (Barney, 1991; Teece et al., 1997) are commonly utilised to elucidate how digital resources and capabilities serve as sources of competitive advantage and facilitate strategic renewal, respectively.

Digitalization and Service Delivery

The impact of digitalisation on service delivery emerges from the convergence of multiple research streams within the technology and human infrastructure nexus. Existing literature highlights various advantages of digitalisation, including improvements in organisational efficiency, customer satisfaction, and operational flexibility (Appio et al., 2021; Kapoor & Kapoor, 2021). A notable example is the implementation of smart metering systems, which communicate wirelessly with utility companies to transmit real-time power usage data, thereby significantly transforming

the utility services sector. This shift from a traditional consumer product devoid of feedback to a smart service enhances transparency and convenience, often at a reduced cost (Bakker & Albrecht, 2018; Zouari & Abdelhedi, 2021). However, research also identifies several challenges, such as the digital divide and citizens' access to information regarding public sector services. Additional barriers include the willingness of citizens to utilise government services, concerns about privacy and security in digitalised service delivery, and the nature of regulatory frameworks that facilitate such services. Addressing these challenges is crucial for effectively unlocking the full potential of digitalised products (Wirtz & Daiser, 2018).

Digital Transformation in the Utility Sector

In the utility sector, digital transformation has been extensively examined in developed economies, often concentrating on specific technologies such as smart grids, Internet of Things (IoT) platforms, and data analytics (Lepistö et al., 2024). Various methodologies, including case studies, longitudinal studies, and quantitative surveys, have been employed to investigate this phenomenon. For instance, Abou-Foul et al. (2021) utilised SEM to analyse survey data from European utility companies, revealing that digital transformation initiatives enhanced operational efficiency and reduced service delivery times. Their research indicated that integrating smart grids with customer-facing digital platforms could reduce costs by up to 20%, significantly improving customer satisfaction and system reliability. Similarly, studies in the United States and Western Europe have employed data envelopment analysis (DEA) and panel data regression models to evaluate the impact of digital technologies on efficiency in the public utility sector. Findings indicate that early adopters of these technologies have experienced considerable enhancements in operational efficiency and customer engagement, with Singh et al. (2021) demonstrating that digitalisation efforts could yield efficiency improvements of up to 30%.

Despite valuable findings, existing research on digital transformation in the utility sector has notable limitations, particularly in measuring the factors that comprise the proposed frameworks. Developing economies are often underrepresented in such studies due to their unique challenges, resulting in research that tends to be tentative rather than empirically robust. Key obstacles include infrastructure constraints, regulatory hurdles, and significant digital illiteracy, particularly in developing countries (Abou-Foul et al., 2021). For instance, Nasiri et al. (2020) conducted qualitative interviews on digital transformation in Southeast Asia's utilities sector, concluding that the impact of new technologies is severely hindered by institutional challenges and high initial capital requirements. These barriers highlight the need for further investigation into how utilities in developing nations can effectively navigate the digital transformation landscape.

Novelty of This Study

This study addresses the existing research gap by examining Perumda Tirta Benteng, a public utility in Indonesia, a developing country. Utilizing a quantitative research design with PLS-SEM, the research analyses the interrelationships among service digitalization, operational efficiency, customer satisfaction, and company performance. This approach offers robust empirical validation of the effects of digital transformation

within a developing country context. Furthermore, the study introduces the mediating role of customer satisfaction, a perspective not extensively explored in current literature, particularly in the public utilities sector of developing nations. The findings will not only contribute to the academic discourse but also provide valuable insights for policymakers and strategic decision-makers in the Global South, where the dynamics of digital transformation may differ significantly due to diverse infrastructural and regulatory frameworks.

Theoretical Background

This study is underpinned by two key theoretical frameworks: the RBV (Barney, 1991) and Dynamic Capabilities Theory (Teece et al., 1997), both of which provide insights into effectively leveraging digital resources for organizational development amid digital transformation. The RBV posits that a firm's competitive advantage stems from its ability to utilise resources that are valuable, rare, inimitable, and non-substitutable (VRIN). In the context of service digitalization, digital assets such as advanced data analytics, IoT, and automated platforms are crucial for public utilities like Perumda Tirta Benteng. These resources enable better management of organizational processes, minimising inefficiencies in service delivery. For instance, smart metering and real-time data analysis align with the RBV by allowing firms to optimise resource allocation, thereby reducing costs and enhancing customer satisfaction.

The Dynamic Capabilities Theory complements the RBV by describing how firms adapt their configurations in response to environmental dynamics (Teece et al., 1997). This theory is particularly relevant for public utilities like Perumda Tirta Benteng, as it assesses how these organizations can leverage digital strategies during strategic repositioning. The findings support the second hypothesis, indicating that dynamic capabilities—such as flexibility, creativity, and decision-making processes—serve as critical sources of competitive advantage in industries experiencing globalization and rapid changes in customer preferences and technology. For Perumda Tirta Benteng, dynamic capabilities enable the firm to integrate new technologies, adapt services, and respond promptly to customer feedback. This agility allows the utility to reposition its operations, anticipate customer demands, and enhance service delivery, ultimately improving operational and organizational effectiveness. Figure 1 illustrates the relationships between service digitalization, operational efficiency, and customer satisfaction, with the latter moderating company performance. In this framework, customer satisfaction is central to understanding how organizational digitalization enhances overall performance.

Research method

Research Design

This study employs a quantitative research approach to empirically examine the effects of service digitalization on the operational efficiency, customer satisfaction, and organizational performance of Perumda Tirta Benteng. A structured survey methodology is utilized to operationalize the core constructs of the research, ensuring both validity and reliability in measurement. The key constructs—service

digitalization, operational efficiency, customer satisfaction, and company performance—are measured using established scales adapted from prior studies.

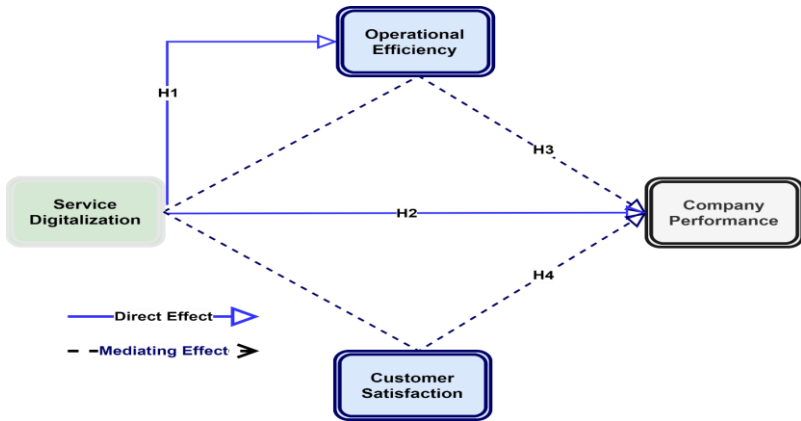


Figure 1: Research Model

Ethical Statement

In conducting this study, we adhered to the highest ethical standards throughout all stages of the research, from design to dissemination, recognising that participants' sentiments could influence the findings. This section outlines the concrete ethical guidelines established to protect the rights, privacy, and well-being of all participants involved in the research process. Prior to participation, each respondent was provided with comprehensive information regarding the research objectives, a detailed description of their role, and the data privacy policy. An informed consent form, specifically tailored to the context of Perumda Tirta Benteng and its stakeholders, was distributed to all potential participants. We made it clear from the outset that participation was entirely voluntary, and that individuals could withdraw from the study at any time without facing any repercussions. Additionally, the consent form highlighted the significance of addressing service loads and operational efficiency within the utility sector.

Instrument Design

Service digitalization is defined as the extent to which digital technologies are integrated into the service delivery process to enhance access, efficiency, and customer satisfaction. This construct is based on the framework developed by (Bharadwaj et al., 2013), who conceptualised digital business strategy as the organisational processes that incorporate digital technologies to gain a competitive advantage. The measurement scale comprises items pertaining to the utilisation of digital platforms for customer interaction, the automation of service delivery processes, and the application of data analytics for service enhancement. Additionally, operational efficiency is characterised as the organisation's capacity to deliver services effectively and efficiently. This definition is drawn from the work of Legner et al. (2017), which examines the impact of technology on improving operational processes, reducing lead times, and enhancing

productivity within the organisation.

Customer satisfaction is defined as the extent to which an organization's services meet or exceed customer needs and expectations. This construct is operationalized using a scale developed by Verhoef et al. (2009), which evaluates customer perceptions of service quality and overall satisfaction with the service experience. It encompasses customer feedback on the usability of digital services, the quality of customer support, and their general satisfaction with the services provided. Additionally, measures of company performance are derived from Wamba et al. (2017) and include indicators of financial performance (such as revenue growth and profitability) and market competitiveness (including market share and customer acquisition rates). This comprehensive framework facilitates a holistic assessment of company performance within the context of digitalization initiatives. Each variable is assessed using a structured questionnaire, with items rated on a five-point Likert scale ranging from strongly disagree (1) to strongly agree (5). The wording of the scales has been adapted from the original studies to suit the context of Perumda Tirta Benteng and the public utility sector, with only minor modifications made for clarity and relevance.

Sampling Technique and Sample Size

In the quantitative investigation of the impact of service digitalisation on operational efficiency and company performance, one strategy employed to minimise error was the selection of an appropriate sampling technique. We calculated a sample size that would yield statistically significant, reliable, and generalisable results within the constraints of the study and available resources. The sampling method adopted for this study was stratified random sampling, which ensured comprehensive and equitable representation of participants. This approach involved grouping study participants into distinct strata based on relevant criteria, from which individuals were then randomly selected. For the execution of this investigation, a sample cohort of 100 individuals was purposefully chosen, guided by a thorough evaluation of key parameters, including the research design, anticipated effect size, statistical power (the probability of detecting a true effect), and the alpha level (indicating the risk of a Type I error).

Data Collection

The data collection process was designed to ensure accuracy and reliability. A questionnaire was developed based on key constructs such as service digitalisation, operational efficiency, customer satisfaction, and company performance. A stratified random sample of 100 employees from Perumda Tirta Benteng was selected, and the survey was administered online to facilitate participation across varied schedules and locations. Email invitations with survey links were distributed, complemented by local online media outreach. The online platform was chosen for its robust data security, user-friendliness, and scalability. After data collection, responses were meticulously cleaned to address gaps, remove duplicates, and screen for outliers or biases, ensuring high-quality data aligned with the study's objectives to assess the impact of digital transformation on organisational performance.

Analysis Techniques

This entrepreneurial academic strategy effectively employed descriptive statistics and PLS-SEM to thoroughly examine the research hypothesis. Initially, descriptive statistical analysis was conducted using SPSS to summarize the dataset, providing an overview of sample characteristics, including means, standard deviations, and distribution patterns for key variables such as service intervention, operational efficiency, and customer satisfaction. Descriptive statistics facilitated the identification of unclear data patterns for further investigation. Subsequently, PLS-SEM was utilised to validate the theoretical relationships among service digitalisation, operational efficiency, customer satisfaction, and organisational performance. This method is particularly well-regarded for analysing multi-construct factors and potential mediating effects, thereby enhancing the rigor of the study.

Empirical Findings

Descriptive Statistics Results

Table 1 presents the findings of the Perumda Tirta Benteng study, which included data from 100 participants. The sample demonstrates gender balance, with an equal representation of males and females, each constituting 50% of the group. Age distribution skews towards younger and middle-aged individuals, with the largest demographic being participants aged 25-34 years (30 participants, 30%), followed by those aged 35-44 years (25 participants, 25%). In terms of employment, the sample is evenly divided, comprising 50 employees from Perumda Tirta Benteng and 50 customers. Regarding educational attainment, most participants possess a bachelor’s degree (50 participants, 50%), while those with a master’s degree or higher account for 30 participants (30%). An internal survey of the company’s structure revealed that managerial positions constitute a minority compared to non-managerial roles (20% versus 80%). Notably, a significant portion of the sample comprises experienced workers, with 50 participants (50%) having over five years of tenure in their respective roles.

Table 1: Demographic Information of Participants (N=100)

Demographic Variables	Categories	Number of Participants	Percentage (%)
Gender	Male	50	50%
	Female	50	50%
Age Group	18-24	20	20%
	25-34	30	30%
	35-44	25	25%
	45-54	15	15%
	55 and above	10	10%
Employment Status	Perumda Tirta Benteng Employee	50	50%
	Perumda Tirta Benteng Customer	50	50%

Education Level	High School or Equivalent	20	20%
	Bachelor's Degree	50	50%
	Master's Degree or Higher	30	30%
Position	Managerial	20	20%
	Non-Managerial	80	80%
Years of Service	<1 Year	10	10%
	1-5 Years	40	40%
	>5 Years	50	50%
Department	Customer Service	30	30%
	Operations	20	20%
	IT/Technical Support	20	20%
	Administration and Finance	15	15%
	Other	15	15%

Table 2 presents descriptive statistics summarising the digital transformation of water services provided by Perumda Tirta Benteng during the study period. Measurements for each variable were derived from a sample of 100 respondents. The findings indicate that both Service Digitalization (mean = 3.75) and Operational Efficiency (mean = 3.90) were regarded as very effective approaches by most respondents, although opinions varied moderately (standard deviations of 0.89 and 0.92, respectively). Customer Satisfaction emerged as the primary indicator of success in the digital transformation process, exhibiting a high mean score of 4.10 and a standard deviation of 0.85, suggesting a strong positive influence on customer perceptions. Additionally, Company Performance, with a mean of 3.85 and a standard deviation of 0.88, reflects the organisational benefits associated with the implementation of digital services.

Table 2: Descriptive Statistics of Key Study Variables

Variable	Mean (SD)	Median	Min	Max	N
Service Digitalization	3.75 (0.89)	4.00	2	5	100
Operational Efficiency	3.90 (0.92)	4.00	2	5	100
Customer Satisfaction	4.10 (0.85)	4.00	2	5	100
Company Performance	3.85 (0.88)	4.00	2	5	100

Table 3 presents the correlations among the four factors examined in our study on digital service transformation at Perumda Tirta Benteng, including means, standard deviations, Cronbach's alpha for reliability, and Pearson correlation coefficients. The strongest correlation identified is between Service Digitalization and Operational Efficiency, with a mean score of 3.95 and a Cronbach's alpha of 0.64 ($r=0.57$). This indicates that improvements in service digitalization are associated with enhanced operational flexibility, greater customer satisfaction ($r=0.59$), and improved Company Performance ($r=0.47$). Operational Efficiency also plays a significant role, achieving a

mean score of 4.00 and Cronbach’s alpha of 0.70, with strong correlations to Customer Satisfaction ($r=0.65$) and Company Performance ($r=0.52$). This underscores the importance of efficient operations in shaping customer experiences and organizational performance metrics. Additionally, Customer Satisfaction and Company Performance display mean scores of 4.08 and 3.88, with Cronbach's alphas of 0.81 and 0.79, respectively, and a correlation of $r=0.68$, suggesting that customer satisfaction is a crucial factor in perceived company success.

Table 3: Correlation Between Measures of Study Variables

Variables	Mean	SD	Alpha	SD	OE	CS	CP
Service Digitalization (SD)	3.95	0.5	0.64	1			
Operational Efficiency (OE)	4	0.52	0.7	0.57*	1		
Customer Satisfaction (CS)	4.08	0.55	0.81	0.59*	0.65*	1	
Company Performance (CP)	3.88	0.6	0.79	0.47*	0.52*	0.68*	1

Measurement Model Results

The study adhered to the recommendations provided by (Hair et al., 2019) for establishing the measurement model. Key criteria included a factor loading exceeding 0.60 and a CR greater than 0.70. Additionally, the AVE was expected to be above 0.50, while the VIF needed to remain below an acceptable threshold. To ensure discriminant validity, the researcher employed both the HTMT ratio and the Fornell-Larcker criterion (FLC) as outlined by (Fornell, 1981).

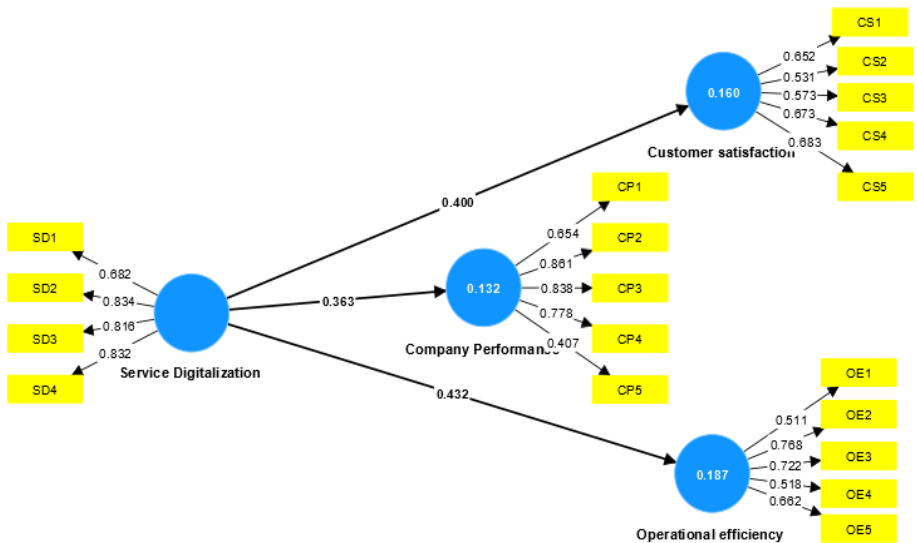


Figure 2: Established Measurement Model

Table 4 presents the factor loadings, composite reliability, average variance extracted, and variance inflation factors for the constructs examined in this study on the impact of digitalization in public utilities. For service digitalization, factor loadings between 0.739 and 0.765 demonstrate strong representation by its items, supported by a composite reliability of 0.82 and an average variance extracted of 0.58, indicating solid internal consistency and variance capture. Variance inflation factors remain well below 3, suggesting no multicollinearity issues. Operational efficiency displays similar results, with loadings from 0.738 to 0.761, reliability at 0.83, and sufficient variance explained (0.59), without multicollinearity concerns. Customer satisfaction and company performance also show robust loadings, moderate reliability, and adequately explained variance. Figure 2 illustrates the structural equation model, revealing positive impacts of service digitalization on company performance ($\beta = 0.363$), operational efficiency ($\beta = 0.432$), and customer satisfaction ($\beta = 0.400$). Additionally, operational efficiency ($\beta = 0.187$) and customer satisfaction ($\beta = 0.160$) further support company performance, confirming the measurement model's reliability and validity.

Table 4: Factor Loadings, Composite Reliability, AVE, and VIF for Study Constructs

Constructs	Items	Loadings	CR	AVE	VIF
Service Digitalization (SD)	SD1	0.765	0.82	0.58	1.23
	SD2	0.748			1.18
	SD3	0.762			1.22
	SD4	0.739			1.17
Operational Efficiency (OE)	OE1	0.761	0.83	0.59	1.25
	OE2	0.745			1.21
	OE3	0.753			1.2
	OE4	0.738			1.18
	OE5	0.759			1.24
Customer Satisfaction (CS)	CS1	0.714	0.85	0.57	1.29
	CS2	0.782			1.45
	CS3	0.769			1.47
	CS4	0.758			1.44
	CS5	0.771			1.42
Company Performance (CP)	CP1	0.725	0.9	0.61	1.51
	CP2	0.794			1.76
	CP3	0.718			1.49
	CP4	0.803			2.12
	CP5	0.784			2.05

Table 5 highlights discriminant validity through the HTMT ratio of correlations for the four main constructs in the study on service digitalization in public utilities. The HTMT values, representing correlations between Service Digitalization and Operational Efficiency, Customer Satisfaction, and Company Performance, are 0.43, 0.35, and 0.57, respectively. These values fall well below the conservative threshold of 0.85, indicating clear discriminant validity between constructs. Additionally, the HTMT ratio between Operational Efficiency and Customer Satisfaction is 0.6, while

between Operational Efficiency and Company Performance, it is 0.37, further affirming discriminant validity. The HTMT value between Customer Satisfaction and Company Performance stands at 0.41, underscoring the distinction between these constructs. Thus, all items within the scale demonstrate sufficient distinctiveness across constructs, ensuring that each is reliably measured without overlap.

Table 5: *Discriminant Validity by HTMT Method*

S. No.	Constructs	1	2	3	4
1	Service Digitalization (SD)				
2	Operational Efficiency (OE)	0.43			
3	Customer Satisfaction (CS)	0.35	0.6		
4	Company Performance (CP)	0.57	0.37	0.41	

Table 6 presents the criterion validity of constructs in a study on the non-functional performance of public utilities achieved through service digitalization, evaluated via the FLC. The diagonal elements representing the square roots of the AVE are 0.76 for Service Digitalization, 0.77 for Operational Efficiency, 0.78 for Customer Satisfaction, and 0.79 for Company Performance. Since these values exceed the off-diagonal correlations (e.g., 0.58 between Service Digitalization and Operational Efficiency, 0.56 between Service Digitalization and Customer Satisfaction), the criterion is satisfied. This confirms that each construct explains more of its own variance than that of other constructs, reinforcing discriminant validity.

Table 6: *Discriminant Validity by FLC Method*

S. No.	Constructs	1	2	3	4
1	Service Digitalization (SD)	0.76			
2	Operational Efficiency (OE)	0.58	0.77		
3	Customer Satisfaction (CS)	0.56	0.71	0.78	
4	Company Performance (CP)	0.55	0.69	0.75	0.79

Table 7 illustrates a study on discriminant validity for digital service transformation constructs in public utilities, evaluated through the cross-loadings method. This approach assesses each indicator's correlation with its assigned construct, requiring that correlations are stronger with the target construct than with other constructs to confirm discriminant validity. For the Service Digitalization construct, all indicators displayed high loadings (0.739 to 0.763) with their own construct, as compared to lower loadings on Operational Efficiency, Customer Satisfaction, and Company Performance, underscoring distinctiveness. Operational Efficiency items, for instance, exhibited strong loadings within their construct (0.393 to 0.778) and comparatively lower loadings on others. Similarly, Customer Satisfaction items showed the highest loadings with their construct, reaching up to 0.831, while Company Performance indicators also had robust factor loadings, peaking at 0.815. These patterns confirm the constructs' conceptual distinctiveness.

Table 7: Discriminant Validity by Cross Loadings

Constructs	Items	SD	OE	CS	CP
Service Digitalization (SD)	SD1	0.763	0.406	0.379	0.285
	SD2	0.739	0.432	0.45	0.295
	SD3	0.748	0.458	0.431	0.292
	SD4	0.741	0.46	0.443	0.301
Operational Efficiency (OE)	OE1	0.419	0.704	0.465	0.276
	OE2	0.462	0.778	0.54	0.23
	OE3	0.393	0.764	0.521	0.252
	OE4	0.467	0.75	0.605	0.418
	OE5	0.432	0.772	0.588	0.424
Customer Satisfaction (CS)	CS1	0.451	0.588	0.723	0.357
	CS2	0.498	0.57	0.797	0.358
	CS3	0.349	0.475	0.712	0.363
	CS4	0.461	0.545	0.798	0.399
	CS5	0.423	0.586	0.831	0.391
Company Performance (CP)	CP1	0.573	0.483	0.52	0.815
	CP2	0.407	0.475	0.528	0.777
	CP3	0.525	0.52	0.534	0.794
	CP4	0.561	0.482	0.519	0.813
	CP5	0.545	0.468	0.503	0.801

Table 8 presents findings on the impact of service digitalization across key aspects of public utilities. The first hypothesis, examining the relationship between service digitalization and operational efficiency, demonstrates a significant positive effect ($\beta = 0.673$, $t = 17.231$, $p = 0.00$), with a substantial effect size ($F^2 = 0.781$) and explanatory power ($R^2 = 0.445$, adjusted $R^2 = 0.443$), thus supporting the hypothesis. The second hypothesis, which analyzes the impact of digitalization on customer satisfaction, is also strongly supported, showing a coefficient of 0.310, effect size $F^2 = 0.792$, and $R^2 = 0.452$, confirming a notable improvement in customer satisfaction due to digitalization. The third hypothesis, investigating digitalization's influence on company performance, reveals a positive correlation (0.643) with significant t and p -values, affirming its positive impact on performance outcomes. Additionally, customer satisfaction is validated as a mediator between service digitalization and company performance, with a significant indirect effect ($\beta = 0.511$, $t = 10.022$, $p = 0.00$), effect size of 0.165, and $R^2 = 0.165$, underscoring the critical role of customer satisfaction in enhancing company performance through digitalization.

Table 8: Hypotheses Testing Summary for Service Digitalization Impact

Hypotheses	Beta	SD	T Values	P Values	5.00%	95.00%	F2	Q2	R2	Adj. R2	Decision
SD -> OE	0.673	0.039	17.231	0.00	0.597	0.729	0.781	0.251	0.445	0.443	Supported
SD -> CS	0.687	0.042	16.357	0.00	0.604	0.733	0.792	0.259	0.452	0.45	Supported
SD -> CP	0.643	0.046	13.978	0.00	0.553	0.707	0.724	0.237	0.421	0.419	Supported
CS -> CP ->SD (Mediating Effect of CS)	0.511	0.051	10.022	0.00	0.411	0.611	0.368	0.215	0.368	0.365	Mediation

Note: SD= Service Digitalization, OE= Operational Efficiency, CS= Customer Satisfaction and CP=Company Performance.

Discussion

This study on the effects of service digitalisation on operational and company performance, along with the moderating role of customer satisfaction in Perumda Tirta Benteng, has yielded significant insights. The findings align with prior research in public utilities management within digital environments, indicating that digital transformation is indeed a substantial driver of operational effectiveness and organisational performance (Bharadwaj et al., 2013; Wamba et al., 2017). The results strongly affirm that service digitalisation positively influences performance, underscoring the role of digital initiatives in achieving competitive differentiation and technological advancement in public utilities (Heeks, 2017). Similar to the findings of Singh et al. (2021) and Abou-Foul et al. (2021), this study shows that digitalisation enhances operational efficiency by reducing manual tasks, minimising human error, and allocating resources more effectively. Our results demonstrate that digital services contribute significantly to operational gains, as reflected in the high beta values indicating enhanced efficiency.

Our findings confirm that digitalisation significantly enhances company performance, aligning with theories suggesting digital services as key drivers of organisational outcomes (Appio et al., 2021; Kapoor & Kapoor, 2021). Consistent with Lepistö et al. (2024) and Filz et al., (2024) digital initiatives are shown to advance strategic and operational objectives, offering competitive advantages through flexibility, accelerated service delivery, and improved performance. This alignment with existing literature underscores the universal benefits of digital transformation, particularly for traditionally technology-lagging sectors like public utilities (Nasiri et al., 2020). A notable contribution of this research is its exploration of customer satisfaction as a mediating factor—an area less examined in public utilities. Our results reveal that customer satisfaction is positively influenced by digital service improvements and mediates the relationship between digitalisation and organisational performance, supporting our hypothesis and complementing the work of Bhattacharjee and Park (2014) and Chen and Kim (2023). Additionally, Ribeiro-Navarrete et al. (2021) highlight that customer insights and experiences are critical drivers of successful digital initiatives, further affirming the value of customer-focused digital strategies in achieving operational and performance goals.

These insights into the impact of service digitalisation on performance hold significant value for both theory and practice. Theoretically, this research advances the argument that digitalisation is strategically essential in the operations of PSOs and reinforces the notion that customer satisfaction should be central to their digital initiatives, as suggested by (Kannan, 2017) and (Legner et al., 2017). For management, this study highlights crucial recommendations for leaders and policymakers at Perumda Tirta Benteng and similar organisations, advocating for digital services that boost not only internal performance but also customer satisfaction, ultimately enhancing organisational outcomes. Consistent with Belhadi et al. (2022), a customer-first culture that prioritises digital transformation drives meaningful gains in service quality and organisational performance. This research thus provides a roadmap for public utilities pursuing digital transformation to achieve sustainable growth and high-quality service delivery.

Policy Implications

The study's findings on the effects of service digitalisation on operational efficiency and organisational profitability, moderated by customer satisfaction at Perumda Tirta Benteng, suggest several policy recommendations relevant for this utility company and similar public sector organisations. These insights are crucial for policymakers and managers aiming to leverage digital transformation to enhance service delivery, improve efficiency, and boost organisational performance. Firstly, the strong positive impact of service digitalisation on operational efficiency underscores the need for prioritising digital process development. Digital technology should be central to the operational processes of public utility providers. Specifically, the strategic planning committee should emphasise the adoption of smart technologies for water management, such as the IoT for real-time monitoring and Artificial Intelligence (AI) for predictive maintenance. Furthermore, it is essential to update employee training policies to include specialised programmes on emerging technologies, ensuring that the workforce is fully equipped to maximise the potential of these digital tools.

Secondly, the digitalisation of services, alongside its positive impact on business performance, indicates that policy development should not only facilitate the implementation of innovations and digital technologies but also foster an organisational culture that embraces innovation and continuous improvement. Policymakers should strive to establish a framework that promotes the creation of innovative digital services, with clearly defined pathways for scaling successful innovations across the organisation. This may involve allocating funds for digital innovation projects and forming cross-functional teams to pilot these initiatives. Given that customer satisfaction is linked to enhanced organisational performance, it is crucial to design digital services that prioritise the customer experience, as this perspective provides a compelling rationale for effective service delivery. Policies should incorporate mechanisms for gathering customer feedback, such as regular interviews, to inform ongoing improvements. Additionally, establishing digital platforms that facilitate easy customer feedback and access to information is recommended. Social media and other online platforms should be utilised to engage customers and solicit their opinions. Moreover, customer satisfaction metrics should be integrated into the performance measurement systems of the utility, ensuring that the success of digitalisation efforts is aligned with a strong focus on customer-centricity.

Conclusion and Recommendations

The findings of this research concerning the effects of service digitalisation at Perumda Tirta Benteng provide significant insights into the role of digitalisation in enhancing productivity, fostering better consumer relations, and improving organisational performance within public utilities. By examining these relationships, the study underscores the critical importance of customer satisfaction as a moderating variable that links digital strategies to organisational performance. The results indicate that further advancements through digitalisation are a strategic necessity for achieving sustained efficiency and effectiveness in public utilities. The efficacy of the tools and options provided by information technologies within the utility's core processes is primarily attributed to their capacity to facilitate streamlined workflows and effective resource management, thereby enhancing service delivery and providing a competitive

advantage.

However, the study reveals that Perumda Tirta Benteng, along with similar public utility organisations, should not only continue the digital transformation journey but also prioritise customer satisfaction at the heart of this process. For digital transformation initiatives to yield maximum value, they must adopt a customer-centric approach. Practical strategies should include creating more accessible channels for client feedback, ensuring the continuous enhancement of digital services in accordance with client perceptions, and equipping employees with adequate training to effectively engage with new technologies. By implementing these measures, Perumda Tirta Benteng can enhance organisational performance, reflected in improved operational effectiveness and customer satisfaction. It is recommended that policymakers and managers incorporate these strategies into their planning for technological advancements that align with customer satisfaction and organisational objectives.

Limitations and Future Research

While this study presents a comprehensive analysis and findings, several limitations merit consideration. Firstly, the research is centred on Perumda Tirta Benteng, a single public utility in Indonesia, which may limit the generalisability of the findings to other public utilities in different regions or countries that possess varying levels and types of IT development or operate within different regulatory contexts. The organisational setting and local conditions may have influenced the results, suggesting that applying this methodology in other locations could yield divergent outcomes. Additionally, the study focuses solely on employees, and while the sample size of 100 is deemed appropriate for this project, it may not encompass the complete organisational perspective or the insights of other stakeholders, such as customers or policymakers.

Future research could benefit from employing a longitudinal design to capture changes over time resulting from firms' digitalisation strategies, particularly in relation to measures of operational efficiency, customer satisfaction, and overall company performance. Although this study provides a contemporary overview of digital transformation initiatives at Perumda Tirta Benteng, the full impact of such efforts may require a longer timeframe to manifest, influenced by factors such as shifts in organisational culture and the reliability of customer satisfaction indices. Furthermore, additional studies could explore the implications of other technologies, such as artificial intelligence, blockchain, or big data, to assess their effects on enhancing digital services within public utilities.

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