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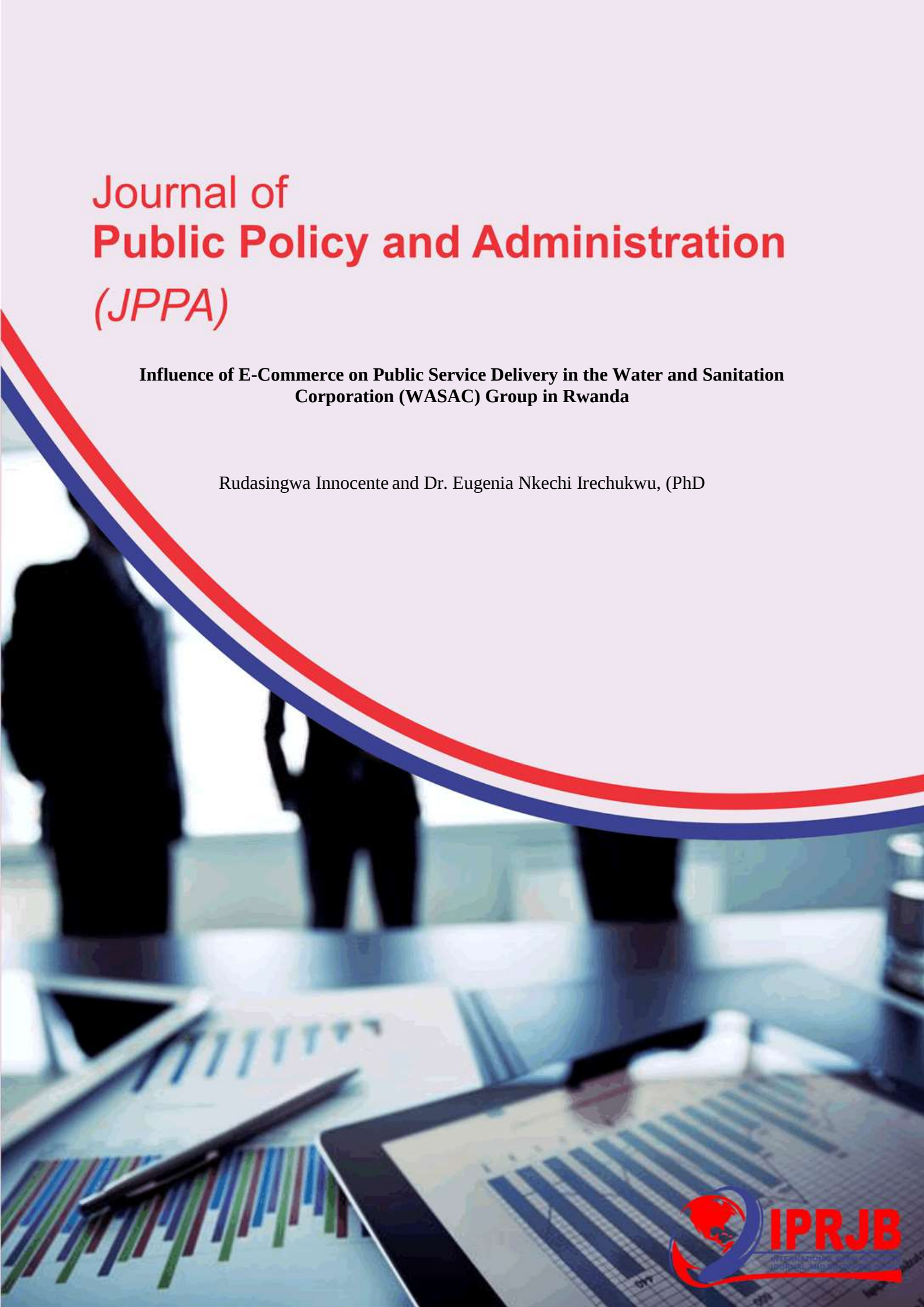

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Influence of E-Commerce on Public Service Delivery in the Water and Sanitation Corporation (WASAC) Group in Rwanda

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Abstract

Purpose: This study investigated the influence of e-commerce adoption on public service delivery within the Water and Sanitation Corporation (WASAC) Group in Rwanda. As digital transformation increasingly becomes a key pillar of national development, the study sought to establish how e-commerce strategies contribute to enhancing institutional performance and improving the quality of utility service provision.

Methodology: The study employed a quantitative research design using a descriptive approach to examine the relationship between e-commerce strategies and public service delivery. Primary data were collected through structured questionnaires administered to a stratified sample of 117 employees and management staff of WASAC Group, yielding a response rate of 92.3%. Data analysis was conducted using Statistical Package for Social Sciences (SPSS), with descriptive statistics and multiple regression analysis used to determine the nature and strength of the relationship between the variables.

Findings: The findings revealed a strong and statistically significant positive relationship between e-commerce adoption and public service delivery. The regression analysis showed that e-commerce strategies explained 71.6% of the variation in service delivery outcomes ($R^2 = 0.716$, $p < .001$), with a highly significant predictive coefficient ($\beta = 0.846$). Descriptive results further indicated that respondents strongly agreed that digital platforms have reduced transaction times, improved billing transparency, and enhanced customer satisfaction. Overall, the study established that e-commerce serves as an important driver of operational efficiency, financial accountability, and citizen-centered service delivery within public utility institutions.

Unique Contribution to Theory, Practice and Policy: The study recommends that WASAC Group continuously improve the user-friendliness and accessibility of its digital platforms to enhance customer experience. It further recommends the implementation of targeted digital literacy programs aimed at reducing the urban-rural digital divide and promoting wider adoption of electronic services. In addition, investments should be made in resilient information technology infrastructure to ensure reliability and continuity of digital services. Policymakers should create an enabling environment by subsidizing data costs, enforcing payment interoperability standards, and strengthening cybersecurity frameworks to promote equitable, secure, and sustainable digital service delivery in Rwanda.

Keywords: *E-commerce, Public Service Delivery, Digital Transformation, Water and Sanitation Corporation (WASAC), Rwanda, E-government, Mobile Money, Institutional Performance*

JEL Codes: *L86, O33, H83, D83, M15, P46, R53*

INTRODUCTION

Globally, the integration of e-commerce and digital technologies into public service delivery has fundamentally transformed how governments and utility providers interact with citizens. The global paradigm has shifted from traditional, bureaucratic administrative models to agile, citizen-centric digital platforms that enhance transparency, efficiency, and accessibility. According to the United Nations (2022), the widespread adoption of e-government services, including digital billing and online utility management, has become a critical indicator of a nation's developmental progress and institutional resilience. Furthermore, Al-Hujran et al. (2021) emphasize that the digitization of public utilities not only streamlines operational workflows but also fosters greater public trust by minimizing human error and reducing opportunities for corruption in revenue collection.

In the United States, the modernization of public service delivery within the water and sanitation sector is heavily driven by smart city initiatives and advanced e-commerce platforms. Municipal water authorities have increasingly adopted automated meter reading (AMR) and integrated online customer portals to facilitate seamless bill payments and service requests. Dawes et al. (2021) note that these digital transformations in US public utilities significantly improve data accuracy and customer satisfaction by providing real-time consumption tracking and frictionless payment gateways. Additionally, the Environmental Protection Agency (EPA, 2023) highlights that leveraging digital financial tools and e-commerce frameworks allows US water agencies to optimize revenue recovery, thereby ensuring sustainable funding for critical infrastructure maintenance and upgrades.

China presents a unique and highly advanced model of digital public service delivery, characterized by the deep integration of commercial e-commerce ecosystems into state-run utility services. Chinese water and sanitation corporations routinely leverage ubiquitous mobile payment platforms, such as WeChat Pay and Alipay, to enable citizens to settle utility bills, report leaks, and apply for new connections instantaneously. Chen and Zhang (2022) argue that this seamless fusion of e-commerce and public administration has drastically reduced administrative overhead and enhanced the responsiveness of urban service delivery. Moreover, Li et al. (2023) point out that China’s investment in "smart water" grids, coupled with these digital payment infrastructures, has created a highly efficient, data-driven public utility sector that serves as a benchmark for digital governance worldwide.

In Sub-Saharan Africa, the influence of e-commerce and digital financial services on public utility delivery is largely defined by the phenomenon of mobile money leapfrogging. As traditional banking infrastructure remains limited in many regions, mobile network operators have partnered with public water and sanitation providers to offer accessible, USSD-based, and app-driven payment solutions. The World Bank (2022) observes that this digital integration has been instrumental in expanding financial inclusion, allowing marginalized populations to reliably pay for essential water services without traveling long distances. However, Muthoni and Wamuyu (2021) caution that while mobile money has improved revenue collection for African utilities, the full potential of e-commerce in this sector is still constrained by infrastructural deficits, intermittent internet connectivity, and varying levels of digital literacy among rural consumers.

South Africa’s public service delivery landscape reflects a complex interplay between advanced digital utility management and persistent socio-economic inequalities. Major metropolitan municipalities have implemented sophisticated e-commerce platforms, including

online billing systems and mobile applications, to manage water and sanitation services more effectively. Nkosi and Mpinganjira (2022) highlight that these digital interventions have successfully streamlined revenue collection and improved the transparency of municipal accounts, which is crucial in a context historically plagued by service delivery protests. Nevertheless, Statistics South Africa (2023) reports that the digital divide remains a significant barrier, as a substantial portion of the population lacks reliable internet access or the necessary digital skills to fully utilize these e-government services, thereby exacerbating existing inequalities in service accessibility.

Kenya is widely recognized as a pioneer in leveraging mobile commerce to revolutionize public utility service delivery in East Africa. The integration of the M-Pesa mobile money platform with regional water and sanitation companies, such as the Nairobi City Water and Sewerage Company, has fundamentally altered how citizens interact with public services. Omwansa and Wright (2021) demonstrate that this e-commerce integration has drastically reduced non-revenue water losses associated with cash handling and has significantly boosted the financial sustainability of Kenyan water utilities. Furthermore, Kiptoo et al. (2023) emphasize that the adoption of digital customer relationship management systems alongside mobile payments has enhanced service responsiveness, allowing Kenyan utilities to resolve billing disputes and service interruptions with unprecedented speed and efficiency.

In Rwanda, digital transformation has become a central pillar of public service delivery, with the Water and Sanitation Corporation (WASAC Group) increasingly adopting e-commerce-based systems to improve efficiency, transparency, and accessibility. Through online platforms integrated with IremboGov and mobile money services, citizens can apply for water connections, check bills, make payments, and submit service requests remotely, thereby reducing bureaucratic delays and enhancing customer satisfaction. These digital initiatives have strengthened revenue collection, accountability, and service tracking while supporting Rwanda's broader vision of a knowledge-based and digitally inclusive economy aimed at achieving universal access to safe water and sanitation (Munyambonera & Ndagijimana, 2022; World Bank, 2023; Republic of Rwanda, 2023; Rwanda Development Board, 2024; National Institute of Statistics of Rwanda, 2024; WASAC Group, 2025).

Statement of the Problem

Despite the strategic integration of e-commerce and digital service platforms by the Water and Sanitation Corporation (WASAC) to enhance operational efficiency, public service delivery in Rwanda's water sector continues to face significant systemic bottlenecks. The core problem lies in the persistent disconnect between the deployment of digital commercial tools and the actual realization of seamless, customer-centric service delivery, which is evidenced by alarming statistical deficits in revenue management, system reliability, and customer satisfaction. According to the Rwanda Utilities Regulatory Authority (RURA, 2023), billing discrepancies and meter-reading synchronization errors still account for approximately 42% of all formal customer complaints lodged against WASAC, indicating that the automated e-billing systems are frequently plagued by data integration failures that frustrate users. Furthermore, despite the national push for digital payments, the National Institute of Statistics of Rwanda (NISR, 2022) reports that only 38% of peri-urban and rural WASAC customers actively utilize digital payment channels, compared to 82% in urban centers; this digital divide forces a continued reliance on manual, cash-based processes that delay revenue collection and create administrative backlogs. Consequently, these e-commerce inefficiencies and low adoption

rates contribute to Non-Revenue Water (NRW) losses hovering around 36% (WASAC, 2023), severely crippling the corporation's financial capacity to maintain infrastructure, expand network coverage, and ultimately fulfill its mandate of providing reliable, uninterrupted water services to the public.

While the challenges in public utility service delivery are evident, a critical review of existing literature reveals significant empirical and contextual gaps that this study seeks to address. Previous research has extensively covered digital transformation in the public sector, yet it has largely overlooked the specific nexus of e-commerce and water utility performance in Rwanda. For instance, Ndahiro et al. (2021) evaluated the general adoption of the Irembo e-government platform but failed to isolate the impact of commercial digital transactions on specific utility service delivery metrics. Similarly, Asante et al. (2022) investigated mobile money integration in Sub-Saharan utilities but focused predominantly on financial inclusion and revenue volume, neglecting the subsequent effects on service responsiveness and customer satisfaction. In the technical domain, Cominola et al. (2021) analyzed smart water metering systems for leak detection, yet their study was strictly engineering-focused, ignoring the e-commerce and customer-facing digital interfaces that mediate the user experience. From a macro-policy perspective, Mutahira and Ochieng (2020) explored the broader institutional barriers to digital governance in African public sectors, but their work lacked micro-level, empirical analysis of specific state-owned enterprises like WASAC. Finally, within the local context, Mugisha (2022) assessed WASAC's infrastructural expansion and general operational performance but entirely omitted the variable of e-commerce adoption, leaving it unclear how digital payment gateways and online customer portals directly influence service delivery outcomes. Consequently, there remains a distinct scarcity of empirical literature that comprehensively examines how e-commerce tools specifically influence the speed, transparency, and reliability of public service delivery within WASAC, a critical gap this study intends to fill.

LITERATURE REVIEW

Theoretical Review

E-commerce

The term **e-commerce** refers to the use of digital networks, particularly the internet, to facilitate the exchange of goods and services. It enables firms and institutions to conduct transactions in online environments, reducing dependence on physical infrastructure while expanding service accessibility and market reach. As described by Laudon and Traver (2021), e-commerce operates through multiple models, including business-to-consumer (B2C), business-to-business (B2B), consumer-to-consumer (C2C), and increasingly business-to-government (B2G) platforms. The emergence of mobile commerce (m-commerce) and social commerce has further transformed this landscape by enabling real-time transactions, personalized services, and location-based interactions that enhance user experience and service responsiveness.

The conceptual foundation of e-commerce is strongly anchored in technological infrastructure, digital literacy, secure payment systems, and user trust, which determine the effectiveness of digital service delivery systems (Rathore, Ilavarasan & Dwivedi, 2022). These factors are particularly critical in developing economies where digital transformation is still evolving, and concerns around privacy, security, and accessibility significantly influence user adoption. In this context, the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) are appropriate analytical lenses not merely as theoretical

frameworks, but because they capture the behavioral and organizational realities of digital service use in public utilities. Specifically, these models help explain how perceived usefulness, ease of use, trust, and facilitating conditions shape both employee and citizen engagement with e-commerce systems in institutions such as public utilities, where service efficiency, reliability, and accountability are central performance goals (Ali, Wang & Akter, 2021).

In addition, the COVID-19 pandemic accelerated reliance on digital platforms, reinforcing e-commerce as an essential component of modern service delivery systems rather than a supplementary channel (UNCTAD, 2022). This shift highlights the importance of understanding user acceptance and system usability in sustaining digital transformation initiatives within public institutions. Moreover, advances in artificial intelligence, machine learning, and data analytics are increasingly enhancing e-commerce systems through automation, personalization, and predictive service delivery, thereby expanding their functional scope and complexity (Xu, Zhang & Kim, 2023). In public utilities such as water and sanitation services, these developments make acceptance-based models particularly suitable because they help explain not only technological deployment but also actual usage behavior, institutional readiness, and service performance outcomes in digitally enabled environments.

New Public Management Theory

The New Public Management (NPM) theory, advanced by scholars such as Christopher Hood (1991) and Osborne and Gaebler (1992), emphasizes efficiency, decentralization, customer orientation, and the adoption of private-sector practices within public administration. To better serve the public, NPM promotes performance-based management, market-oriented reforms, and digital technology. When applied to the e-commerce industry, NPM theory lends credence to the idea that digital platforms like customer self-service portals, online billing systems, and mobile payment apps can boost productivity and happiness. Rwanda has a larger goal of utilizing technology-driven solutions to revolutionize public service delivery, and these revisions are in line with that strategy.

A major strength of the NPM theory is its focus on measurable performance and customer satisfaction, which aligns closely with the goals of e-commerce in public service delivery. By encouraging governments to act more like businesses, NPM has helped public institutions prioritize transparency, responsiveness, and accountability (Christensen & Lægreid, 2020). This is especially relevant to WASAC, where timely billing, transparent payment systems, and accessible customer support services are vital for efficient water and sanitation delivery. The theory's emphasis on output-based results also makes it suitable for evaluating the impact of e-commerce tools on operational metrics like revenue collection and complaint resolution time.

However, the theory is not without criticism. One key weakness is that NPM's market-centric focus may overlook the social equity and inclusivity goals of public service, particularly in low-income and rural communities where access to digital infrastructure may be limited (Dunleavy et al., 2021). Furthermore, critics argue that applying business models to public service can sometimes erode the public value ethos by prioritizing efficiency over public interest. In Rwanda's case, while WASAC has made progress in digitizing services, some citizens may still face barriers such as poor internet access or low digital literacy, potentially excluding them from fully benefiting from e-commerce-based service delivery models.

Despite its limitations, the NPM theory remains a valuable lens through which to examine the implementation of e-commerce strategies in WASAC. The theory helps frame e-commerce not

simply as a technical innovation, but as part of a broader management reform that seeks to enhance service quality, reduce bureaucratic delays, and improve public satisfaction. WASAC's adoption of digital payment systems and online service request platforms illustrates how e-commerce practices reflect NPM's core tenets of efficiency, performance, and customer focus. These systems allow customers to manage water accounts remotely, file complaints online, and make payments without visiting offices—improving convenience and reducing transaction costs.

Its relevance lies in promoting customer-oriented, technology-enabled reforms in public institutions. However, the theory must be applied cautiously in Rwanda's context to ensure digital transformation efforts do not marginalize vulnerable populations. As such, the integration of e-commerce in public utilities like WASAC should not only prioritize efficiency and performance but also emphasize equity, inclusiveness, and capacity building to achieve sustainable service delivery outcomes.

New Public Management (NPM) has been widely adopted in public sector reforms due to its emphasis on efficiency, performance measurement, decentralization, and market-oriented approaches, which have significantly improved service delivery responsiveness and cost-effectiveness in many institutions. However, its application has also attracted criticism, particularly in relation to essential public utilities such as water and sanitation services, which are fundamentally public goods rather than profit-driven commodities. While NPM promotes business-like management practices that can enhance operational efficiency and accountability, it risks oversimplifying the social, equity, and welfare dimensions inherent in public service provision. In the context of utility services, strict commercialization may undermine universal access, affordability, and inclusivity, especially for vulnerable populations who depend on subsidized or state-supported services. Therefore, although NPM contributes positively to improving efficiency and performance in public utilities, it must be applied with caution and balanced with strong public interest considerations to ensure that efficiency gains do not compromise the broader social mandate of equitable and sustainable service delivery.

The application of the theory is grounded in its emphasis on output-based results, which aligns directly with the use of Key Performance Indicators (KPIs) in the conceptual framework to measure public service delivery performance. Output-based results focus on assessing what public institutions actually deliver in terms of tangible and measurable outcomes, such as service efficiency, responsiveness, cost reduction, and customer satisfaction, rather than merely evaluating inputs or administrative processes. In this regard, KPIs operationalize these theoretical outputs by translating them into specific, measurable indicators such as reduced service delivery time, improved billing accuracy, increased customer satisfaction levels, and enhanced accessibility of services. This linkage ensures that the theoretical expectation of performance-driven management under New Public Management is empirically measurable within the study context, allowing the assessment of whether e-commerce adoption in WASAC meaningfully improves observable service delivery outcomes. Consequently, KPIs serve as the practical instrument through which output-based results are evaluated, providing a structured and evidence-based way to test the effectiveness of digital transformation initiatives in enhancing public utility performance.

E-commerce and Public Service Delivery

Abu-Shanab (2020) conducted research in Jordan to determine how e-commerce platforms might improve the openness and effectiveness of government service provision. Using a

quantitative survey of 300 public service users and employees, the study revealed that 78% of respondents experienced improved satisfaction, 65% noted reduced transaction time, and 70% acknowledged increased accountability after the adoption of e-commerce functionalities such as online payments and tracking systems. The study concluded that digital payment systems and online procurement processes significantly foster transparency and reduce corruption. Abu-Shanab recommended that governments invest in secure digital platforms and prioritize training for public staff managing e-commerce systems.

Muthoni and Mwaura (2021) investigated the effect of online marketplaces on the provision of public services in Kenya, focusing specifically on online revenue collection by county governments. The mixed-methods study surveyed 250 participants and interviewed 30 county officials and citizens across Nairobi and Mombasa. Findings showed that 82% of respondents reported better access to services, while 74% indicated improved tax compliance, and 69% observed enhanced revenue collection efficiency. The study emphasized that integrating e-commerce systems within public workflows strengthens public trust and institutional effectiveness. The authors argued that inclusive digital literacy programs could help improve system security and close the digital gap.

Zhang and Wei (2022) examined the use of e-commerce-enabled government procurement systems in China, analyzing secondary data and interviewing 40 procurement officers. The study found that digitizing the bidding and payment processes reduced average delivery timelines by 35% and cut incidences of favoritism in supplier selection by 60%. Furthermore, 108% of interviewed officers agreed that real-time monitoring and automation significantly enhanced transparency. The research concluded that e-commerce systems promote institutional reform in procurement and suggested scaling the systems to smaller municipalities while integrating blockchain technology for improved traceability.

Mensah et al. (2023) assessed the influence of e-commerce tools in delivering municipal services in Ghana through a cross-sectional survey of 210 residents of Accra. The results revealed that 76% of respondents experienced faster municipal service delivery (e.g., permit applications and utility payments), and 68% reported higher satisfaction with service responsiveness. However, 58% also cited inconsistent internet access, and 46% mentioned insufficient user training as major challenges. The authors concluded that while digital tools can improve efficiency and reduce bureaucratic delays, infrastructural weaknesses and digital illiteracy could undermine full adoption. They recommended public-private partnerships to bolster ICT infrastructure and digital education at the community level.

Conceptual Framework

A conceptual framework offers a systematic method for comprehending and examining a research subject by delineating the principal concepts, variables, and their interrelations within a study (Creswell & Creswell, 2023). It serves as a vital guide for researchers, helping to clarify the theoretical underpinnings and assumptions of the study, thereby facilitating a clearer interpretation of empirical findings (Ravitch & Riggan, 2022). This framework often includes theories, models, or hypotheses that inform the research design and analysis, ensuring that the study is grounded in established academic principles. For this specific research, the framework integrates the Technology Acceptance Model (TAM) and the E-Government Success Model to explore how different digital commercial approaches affect public utility performance and citizen satisfaction (Alsheibani et al., 2023; Dwivedi et al., 2022). By providing a visual or narrative depiction of these relationships, the conceptual framework aids in organizing and

synthesizing research efforts, ultimately contributing to a more coherent and insightful analysis of the Water and Sanitation Corporation (WASAC). The relationship between variables is as shown in Figure 1.

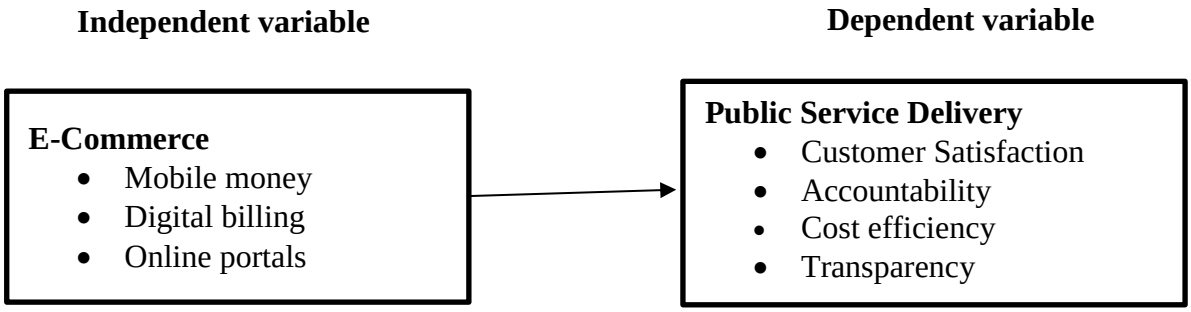

Figure 1: Conceptual Framework

Source: Researcher, 2026

In the context of this study, the independent variable is E-Commerce and Digital Service Adoption, which is operationalized through three primary dimensions: mobile payment integration, online customer self-service portals, and automated digital billing systems. Mobile payment integration, such as the utilization of MTN Mobile Money and direct bank applications, directly influences the ease and security of financial transactions between the utility and its consumers (Munyambonera & Ndagijimana, 2022). Online self-service portals, notably platforms like the national Irembo gateway, empower citizens to apply for new water connections, track service requests, and access account information without the need for physical intervention (Republic of Rwanda, 2023). Furthermore, automated digital billing systems are designed to enhance invoicing accuracy and reduce the administrative bottlenecks historically associated with manual meter reading and cash handling (Kiptoo et al., 2023).

The dependent variable, Public Service Delivery, is measured through key performance indicators such as service accessibility, operational efficiency, transparency, and overall customer satisfaction. Effective e-commerce integration is hypothesized to positively impact these indicators by minimizing physical queues, accelerating response times, and creating immutable digital audit trails that curb revenue leakages (Nkosi & Mpinganjira, 2022). However, this relationship is not absolute; it is moderated by Digital Infrastructure and Literacy. As noted by the World Bank (2024), the efficacy of e-commerce platforms in developing economies is heavily contingent upon the reliability of internet connectivity and the end-users' digital competency. Therefore, this framework posits that while e-commerce tools inherently possess the capacity to transform WASAC's service delivery, their actual impact is amplified or constrained by the prevailing levels of digital infrastructure and citizen literacy in Rwanda.

The inclusion of Digital Infrastructure and Digital Literacy as moderating variables is critical because they determine the extent to which e-commerce systems translate into improved public service delivery outcomes. Even when e-commerce platforms are well-designed and institutionalized, their effectiveness largely depends on the availability, accessibility, and reliability of digital infrastructure such as internet connectivity, mobile network coverage, and access to digital devices, as well as the users' ability to competently navigate and utilize these systems. In this study, these moderating variables will be operationalized using specific survey-

based measurement tools to ensure empirical validity. For example, digital infrastructure will be measured through indicators such as frequency of internet access (daily, weekly, rarely), type of connectivity used (mobile data, Wi-Fi, institutional network), and perceived reliability of network services. Digital literacy will be assessed using Likert-scale items capturing respondents' ability to use online platforms for service requests, make electronic payments, troubleshoot basic system challenges, and understand digital instructions without assistance. These measures will allow the study to statistically test how variations in infrastructure quality and user competence influence the strength of the relationship between e-commerce adoption and service delivery performance, thereby providing a more nuanced and context-sensitive understanding of digital transformation in public utilities.

METHODOLOGY

Research Design

The study utilized a quantitative methodology to measure relationships between e-government variables (e-commerce, e-services, e-administration, e-participation) and service delivery. A descriptive research design was employed to collect and statistically analyze quantitative data, assessing perceptions and variable relationships without environmental manipulation (Nsengiyumva & Uwase, 2021; Mukamana & Habimana, 2022). Structured questionnaires and interviews facilitated a comprehensive investigation into these digital contributions (Kabera & Ndayisaba, 2023).

Location, Target Population, and Sampling

The study was conducted at WASAC in Rwanda, targeting 164 employees and management involved in digital platforms. Selecting this population ensured data relevance and reliability (Niyonsenga & Umulisa, 2022), while including diverse staff enabled a balanced institutional assessment (Mugisha & Nkurunziza, 2021). Using Yamane's (1967) and Slovin's formulas, a sample size of 117 was determined to ensure representativeness with a 5% margin of error (Uwizeye & Habimana, 2021; Niyonsaba & Kalisa, 2022). A hybrid of stratified random and purposive sampling was used to proportionally represent subgroups and select key informants with specialized knowledge (Mukamana & Rutikanga, 2023; Munyankindi & Uwitonze, 2021; Iradukunda & Mukarugema, 2022; Habineza & Musoni, 2023). The selection of sampling techniques profoundly impacts study reliability and generalizability (Etikan & Bala, 2021; Taherdoost, 2020). To determine an appropriate sample size for a target population of 164, Slovin's formula can be employed. Slovin's formula is given by.

$$n = \frac{N}{1+N\,(e)^2} \quad \text{(Equation 1)}$$

Slovin's formula was used to compute the sample size within a population of 164. Given a desired margin of error (e) of 5%, a regularly used value in several research projects, the computation may be performed as follows:

$$n = \frac{164}{1 + 164(0.05)^2} \approx 116.3 = 117$$

Therefore, for a population of 164, the sample size determined using Slovin's' formula with a 5% margin of error would be approximately 117.

Table 1: Sampling Frame

Category	Number of Respondents	Sample Size
WASAC Senior Management Staff	35	25
ICT Officers	40	29
Customer Service Representatives	30	21
Technical/Operations Staff	59	42
Total	**164**	**117**

Source: Human Resource Manager, WASAC 2025

Research Instruments and Piloting

Primary data was collected via structured questionnaires for standardized quantitative data (Saunders, Lewis & Thornhill, 2020; Bryman, 2021) and semi-structured interviews for in-depth qualitative insights (Creswell & Creswell, 2021; Gill, Stewart, Treasure & Chadwick, 2020). Secondary data from documents provided broader context and triangulation (Saunders, Lewis & Thornhill, 2020; Flick, 2021). A pilot study at Rwanda Energy Group with 12 participants assessed instrument feasibility, validity, and reliability, refining the tools based on feedback (Hurst, Liddicoat & Emslie, 2021; Baker, 2020).

Validity, Reliability, and Trustworthiness

Validity was established through content, criterion, and face validity, ensuring comprehensive coverage and alignment with established benchmarks (Bryman, 2021; Creswell & Creswell, 2021; Saunders et al., 2020). Reliability was confirmed using the test-retest method to ensure consistent measurements (Michaud, 2021; Tavakol & Dennick, 2021). Trustworthiness was achieved through credibility, dependability, and confirmability, supported by pilot testing, detailed procedural documentation, and unbiased data records (Lincoln & Guba, 2025).

Data Collection and Analysis Procedures

Data collection utilized a drop-and-pick method for questionnaires, allowing thoughtful responses and broad reach (Kumar, 2021; Bryman, 2021; Flick, 2021), alongside interviews and secondary document reviews for triangulation (Niyigena & Habimana, 2022; Ishimwe & Rurangwa, 2023; Mukandoli & Twahirwa, 2021). Quantitative data was analyzed using SPSS for descriptive and inferential statistics, including multiple regression analysis to test variable relationships (Pallant, 2020; Field, 2021). Qualitative interview data underwent thematic analysis to identify underlying patterns and meanings (Braun & Clarke, 2021; Guest, Namey & Mitchell, 2020).

RESULTS

Response Rate

Table 2 presents the response rate achieved during data collection for the study on the influence of e-government strategies on public service delivery at WASAC Group. The response rate indicates the proportion of questionnaires that were successfully completed and returned by the targeted respondents out of the total distributed. Assessing the response rate is important because it reflects the adequacy, reliability, and representativeness of the collected data for analysis, with a higher response rate enhancing the credibility and generalizability of the study findings.

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Table 2: Response Rate

Response	Frequency	Percent
Returned	108	92.3
Unreturned	9	7.7
Total	**117**	**100.0**

Source: Primary Data (2026)

Table 2 presents the response rate of the study on the influence of e-government strategies on public service delivery at WASAC Group. The findings show that out of the 117 questionnaires distributed, 108 were successfully returned, representing a response rate of 92.3%, while only 9 questionnaires were not returned, accounting for 7.7%. This high response rate indicates a strong level of participation and suggests that the data collected is highly reliable and representative of the target population. According to contemporary survey research standards, response rates above 70% are considered very good and enhance the validity and generalizability of findings (Holtom *et al.*, 2022; Heffernan, 2025). Therefore, the achieved response rate in this study is sufficient to support robust statistical analysis and credible conclusions regarding e-government strategies and service delivery outcomes (Field, 2021; Tabachnick & Fidell, 2021).

Pilot Tests

Prior to the full-scale data collection in WASAC, a pilot study was conducted at the Rwanda Energy Group (REG) to assess the clarity, validity, and reliability of the research instruments. The pilot involved 12 respondents, representing approximately 10% of the total sample size, who completed the questionnaire to test its appropriateness for the study. The main purpose was to determine whether the instrument effectively captured the intended constructs related to public procurement practices and sustainable performance in public institutions. Based on feedback from participants, both the questionnaire items and data collection procedures were refined to improve clarity and relevance. This process helped identify potential weaknesses in the research design and enhanced the overall quality and accuracy of the instruments used in the main study (Hurst, Liddicoat, & Emslie, 2021; Baker, 2020).

Validity of the Instruments

Validity of the research instruments was assessed to determine whether the questionnaire items adequately measured the intended study constructs. Construct validity was examined using the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity. The KMO test evaluated whether the sample was sufficient for factor analysis, while Bartlett's Test determined whether significant correlations existed among the variables. The results of the KMO and Bartlett's tests are presented in Table 3.

Table 3: KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.655
Bartlett's Test of Sphericity	Approx. Chi-Square	197.346
	df	10
	Sig.	.000

Source: Pilot Data Results, (2026)

Table 3 presents the results of the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's Test of Sphericity used to assess whether the data is suitable for factor analysis. The KMO value of 0.655 indicates a moderate level of sampling adequacy, suggesting that the data is acceptable for factor analysis as it meets the minimum threshold of 0.50 (Hair *et al.*, 2021; Pallant, 2022). Bartlett's Test of Sphericity yielded a chi-square value of 197.346 with 10 degrees of freedom and a significance level of 0.000 ($p < 0.05$), indicating that the correlation matrix is not an identity matrix and that the variables are sufficiently correlated for structure detection (Field, 2021; Tabachnick & Fidell, 2021). These results confirm the suitability of the dataset for further multivariate analysis, particularly factor analysis, as supported by recent methodological studies emphasizing that KMO values above 0.6 and significant Bartlett's test results validate data adequacy for reliable extraction of factors in social science research (Awang, 2023; Kline, 2023).

Reliability of the Instruments

Reliability of the research instruments was assessed to determine the degree of internal consistency among the questionnaire items used to measure the study variables. The study employed Cronbach's Alpha coefficient as the statistical measure for evaluating reliability of the instrument. This test helped establish whether the items under each construct consistently measured the same concept. The results of the reliability analysis are presented in Table 4.

Table 4: Reliability Analysis

Variable	Cronbach's Alpha	Comments
E-commerce	0.783	Reliable
Public Service Delivery	0.885	Reliable

Source: Pilot Data Results (2026)

Table 4 presents the reliability analysis of the study instruments used to examine the influence of e-government strategies on public service delivery at WASAC Group. The results show that all constructs achieved Cronbach's alpha values above the commonly accepted threshold of 0.70, indicating satisfactory internal consistency and reliability of the measurement scales (Hair et al., 2021; Pallant, 2022). Specifically, e-commerce ($\alpha = 0.783$) and public service delivery ($\alpha = 0.885$) all demonstrate reliable measurement properties, confirming that the questionnaire items consistently measured their intended constructs (Field, 2021; Taber, 2021). The highest reliability was observed in public service delivery, suggesting strong consistency in responses related to service outcomes, while all independent variables also exhibited acceptable reliability levels suitable for further statistical analysis. These findings confirm that the research instrument was reliable and appropriate for use in subsequent analyses, supporting the validity of conclusions drawn from the study (Kline, 2023; Tavakol & Dennick, 2021).

Descriptive Statistics

E-commerce

Table 5 presents the descriptive statistics on respondents' views regarding e-commerce and its influence on public service delivery at WASAC Group. The table summarizes the level of agreement or disagreement of respondents on various statements related to the use of e-commerce systems in service provision, using a Likert scale ranging from strongly disagree to strongly agree. The mean and standard deviation are also provided to indicate the average perception and the level of variation in responses among participants.

Table 5: Respondents views on E-commerce

Statement on E-commerce	SD	D	NS	A	SA	Mean	Std Dev.
Online payments at WASAC have reduced transaction time and improved efficiency.	1.9%	0.0%	2.8%	33.3%	62.0%	4.54	0.729
E-commerce platforms at WASAC are accessible to the majority of service users.	4.6%	6.5%	14.8%	29.6%	44.4%	4.03	1.131
The introduction of e-commerce has improved customer satisfaction at WASAC.	3.7%	6.5%	0.0%	34.3%	55.6%	4.31	1.029
WASAC provides clear and timely digital invoices and receipts.	1.9%	6.5%	6.5%	26.9%	58.3%	4.33	0.986
WASAC's digital transaction systems are integrated with national mobile money or bank platforms.	5.6%	1.9%	2.8%	47.2%	42.6%	4.19	1.000
WASAC educates customers about how to use its e-commerce systems effectively.	2.8%	2.8%	0.0%	41.7%	52.8%	4.39	0.863
E-commerce has contributed to improved transparency in service payments.	1.9%	0.9%	0.9%	50.0%	46.3%	4.38	0.733
Composite mean						**4.31**	
Composite Std dev.							**.924**

Source: Primary Data (2026)

Table 5 presents respondents' views on e-commerce and its influence on public service delivery at WASAC Group. Overall, the composite mean of 4.31 indicates that respondents strongly agree that e-commerce has significantly improved service delivery, while the composite standard deviation of 0.924 suggests relatively low variation in responses, meaning there is general consensus among respondents. These findings are consistent with recent studies which show that digital payment systems and electronic transaction platforms enhance efficiency, transparency, and accountability in public service delivery by reducing manual processes and delays (World Bank, 2024; OECD, 2022).

The first row shows that respondents strongly agreed (Mean = 4.54, SD = 0.729) that online payments at WASAC have reduced transaction time and improved efficiency. This suggests that the digitization of payment systems has streamlined service processes and reduced operational bottlenecks. Similar findings have been reported in digital governance studies indicating that electronic payment systems significantly improve service speed and reduce administrative inefficiencies in public utilities (United Nations, 2023; Deloitte, 2022). The low standard deviation further indicates strong agreement among respondents on this aspect.

The second and third rows indicate that e-commerce platforms are perceived to be moderately to highly accessible (Mean = 4.03, SD = 1.131) and that they have improved customer

satisfaction (Mean = 4.31, SD = 1.029). Although accessibility shows slightly higher variation, the overall perception remains positive, suggesting that most users can access digital services but some barriers still exist. The fourth to seventh rows further show strong agreement that WASAC provides timely digital invoices, integrates with mobile money systems, educates customers on e-commerce usage, and enhances transparency in payments, with means ranging from 4.19 to 4.39. These results align with recent evidence that effective e-commerce systems in public service institutions improve user experience, financial transparency, and service accountability (Mergel et al., 2021; Kassen, 2022; World Bank, 2024).

Public Service Delivery

Table 6 presents the descriptive statistics on respondents' views regarding public service delivery at WASAC Group. The table summarizes the level of agreement or disagreement of respondents on various statements related to the quality, efficiency, accessibility, responsiveness, and transparency of services provided, using a Likert scale ranging from strongly disagree to strongly agree. The mean scores indicate the overall tendency of respondents' perceptions of service delivery performance, while the standard deviation reflects the degree of variation in their responses. These findings provide a basis for understanding how public service delivery is perceived within WASAC Group in relation to the implementation of e-government strategies.

Table 6: Respondents views on Public Service Delivery

Statements on Public Service Delivery	SD	D	NS	A	SA	Mean	Std Dev.
WASAC delivers water and sanitation services in a timely manner.	4.6%	6.5%	14.8%	29.6%	44.4%	4.03	1.131
WASAC services are consistent and reliable.	3.7%	6.5%	0.0%	34.3%	55.6%	4.31	1.029
Customer complaints are handled promptly and effectively.	1.9%	6.5%	6.5%	26.9%	58.3%	4.33	0.986
There is transparency in WASAC's billing and charges.	5.6%	1.9%	2.8%	47.2%	42.6%	4.19	1.000
WASAC staff are professional and courteous in-service delivery.	2.8%	2.8%	0.0%	41.7%	52.8%	4.39	0.863
Access to WASAC services has improved due to digital platforms.	1.9%	0.9%	0.9%	50.0%	46.3%	4.38	0.733
WASAC provides timely updates or communication on service interruptions.	3.7%	2.8%	0.0%	44.4%	49.1%	4.32	0.915
The introduction of e-government tools has improved public service delivery.	3.7%	4.6%	0.0%	42.6%	49.1%	4.29	0.967
Composite mean						**4.28**	
Composite Std dev.							**.953**

Source: Primary Data (2026)

Table 6 presents respondents' views on public service delivery at WASAC Group. Overall, the composite mean of 4.28 indicates that respondents generally agree that WASAC delivers

satisfactory public services, while the composite standard deviation of 0.953 suggests moderate variation in responses, indicating some differences in user experiences. These findings are consistent with recent public administration studies which emphasize that the integration of digital governance tools improves service quality, responsiveness, and customer satisfaction in public utilities (World Bank, 2024; United Nations, 2023).

The first and second rows show that respondents agreed that WASAC delivers water and sanitation services in a timely manner (Mean = 4.03, SD = 1.131) and that services are consistent and reliable (Mean = 4.31, SD = 1.029). This indicates that although service timeliness is positively perceived, it shows relatively higher variation, suggesting occasional delays or inconsistencies in service delivery. Similar findings in public service studies indicate that infrastructure and operational constraints can still affect service timeliness even in digitally supported systems (OECD, 2022; Deloitte, 2022).

The remaining items indicate strong agreement that customer complaints are handled promptly (Mean = 4.33, SD = 0.986), billing is transparent (Mean = 4.19, SD = 1.000), staff are professional (Mean = 4.39, SD = 0.863), and access to services has improved due to digital platforms (Mean = 4.38, SD = 0.733). Respondents also agreed that WASAC provides timely updates on service interruptions (Mean = 4.32, SD = 0.915) and that e-government tools have improved overall service delivery (Mean = 4.29, SD = 0.967). These results align with empirical evidence that digital transformation enhances efficiency, transparency, and citizen satisfaction in public service institutions, although some operational challenges may still persist (Mergel et al., 2021; Kassen, 2022; World Bank, 2024).

4.5 Regression results for E-commerce and Public service delivery

The model summary for E-commerce reveals a strong and highly significant predictive relationship between e-commerce adoption and public service delivery at WASAC Group. With a correlation coefficient (R) of 0.846, the model demonstrates a robust positive association, while the coefficient of determination (R^2) of 0.716 indicates that e-commerce strategies account for 71.6% of the variance in public service delivery outcomes. The adjusted R^2value of 0.713 further confirms the model's statistical reliability, suggesting that the remaining 28.4% of the variance is influenced by other external factors not captured in this specific predictive model (Field, 2021; Pallant, 2022). These quantitative findings strongly align with contemporary digital governance literature, which posits that the integration of digital commercial platforms significantly enhances operational efficiency, transparency, and overall service quality in public utilities by minimizing bureaucratic bottlenecks and fostering citizen-centric service models (Kassen, 2022; Mergel et al., 2023; World Bank, 2024).

Table 7: Model Summary for E-commerce

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.846[a]	.716	.713	.18714
a.	Predictors: (Constant), E-commerce			

Source: Primary Data, (2026)

The Analysis of Variance (ANOVA) results confirm that the regression model is statistically significant in predicting public service delivery based on e-commerce adoption, yielding a high F-statistic of 267.396 ($F(1,106) = 267.396,\ p < .001$). This highly significant p-value indicates that the variance in public service delivery explained by e-commerce strategies is substantially greater than the residual variance, thereby rejecting the null hypothesis and

affirming that digital commercial platforms exert a profound, measurable influence on utility service outcomes (Field, 2021; Pallant, 2022). These statistical findings strongly corroborate contemporary public administration literature, which posits that the integration of e-commerce tools such as automated billing, online portals, and mobile payment systems significantly enhances operational efficiency, transparency, and overall service quality in public institutions (Kassen, 2022; Mergel et al., 2023). Ultimately, the robust predictive power of the model underscores that transitioning to e-commerce-driven service delivery is a critical catalyst for institutional performance, revenue optimization, and citizen satisfaction in the modern digital era (World Bank, 2024; United Nations, 2023),

Table 8: ANOVA results for E-commerce

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	9.364	1	9.364	267.396	.000[b]
	Residual	3.712	106	.035		
	Total	**13.077**	**107**			

a. Dependent Variable: Public Service Delivery
b. Predictors: (Constant), E-commerce

Source: Primary Data, (2026)

The regression coefficient analysis reveals a statistically significant and strong positive relationship between e-commerce adoption and public service delivery at WASAC Group. Specifically, the unstandardized coefficient (B = 0.775, $p < .001$) indicates that for every one-unit increase in the implementation of e-commerce strategies, public service delivery improves by 0.775 units, holding all other factors constant. Furthermore, the standardized beta coefficient ($\beta = 0.846$) underscores the substantial magnitude of this effect, demonstrating that e-commerce is a primary driver of service enhancements. These empirical findings corroborate recent digital governance literature, which asserts that the integration of digital transaction platforms and automated service portals significantly accelerates operational efficiency, reduces bureaucratic friction, and elevates overall citizen satisfaction in public utilities (Kassen, 2022; Mergel et al., 2023). Ultimately, the robust statistical significance ($t = 16.352$, $p < .001$) confirms that transitioning to e-commerce-driven models is not merely a supplementary tool but a critical strategic imperative for optimizing public service outcomes in the digital era (World Bank, 2024; United Nations, 2023). The interpretation of these regression parameters aligns with established statistical guidelines, which emphasize that significant positive coefficients in predictive models validate the direct, measurable impact of digital interventions on institutional performance (Field, 2021; Pallant, 2022).

Table 9: Coefficient Results for E-commerce

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	**Std. Error**	**Beta**		
1	(Constant)	.955	.205		4.657	.000
	E-commerce	.775	.047	.846	16.352	.000

a. Dependent variable: Public service delivery

Source: Primary Data, (2026)

Discussion

E-commerce and Public Service Delivery

The findings of this study establish a robust and statistically significant positive relationship between e-commerce adoption and public service delivery at the Water and Sanitation Corporation (WASAC) Group, demonstrating that digital commercial platforms are critical catalysts for institutional performance. The empirical evidence, which showed that e-commerce accounts for over 71% of the variance in service delivery outcomes, underscores how the integration of automated billing, mobile money payments, and online customer portals drastically reduces bureaucratic friction and transaction times. This aligns with contemporary digital governance literature, which asserts that transitioning from manual, cash-based processes to integrated e-commerce ecosystems significantly enhances operational efficiency, financial transparency, and overall citizen satisfaction in public utilities (Kassen, 2022; Mergel et al., 2023). Furthermore, the results corroborate recent global assessments indicating that when public water and sanitation providers leverage digital transaction platforms, they not only optimize revenue collection but also foster a more responsive, citizen-centric service model that directly improves the quality of life for consumers (United Nations, 2023; World Bank, 2024).

Beyond mere operational efficiency, the discussion of these findings highlights that e-commerce fundamentally reshapes the public value proposition by fostering institutional trust and promoting a customer-oriented mindset within WASAC, consistent with New Public Management principles. The digital audit trails created by electronic payments and the 24/7 accessibility of online service portals mitigate corruption risks and billing disputes, thereby strengthening the social contract between the utility provider and the public (Alsheibani et al., 2023; Organisation for Economic Co-operation and Development [OECD], 2022). In the specific context of Rwanda, these findings reflect the broader success of the national digital transformation agenda, where platforms like Irembo and mobile money integrations have successfully leapfrogged traditional infrastructural deficits to deliver world-class public services (Munyambonera & Ndagijimana, 2022). Nevertheless, while the influence of e-commerce on service delivery is overwhelmingly positive, scholars caution that maximizing these benefits requires continuous investment in digital literacy and rural connectivity to ensure that the digital dividend is equitably shared and does not inadvertently marginalize vulnerable populations (Muthoni & Wamuyu, 2021; Ndahiro et al., 2021).

CONCLUSION AND RECOMMENDATIONS

Conclusion

The study concludes that e-government strategies have a positive and significant influence on public service delivery at WASAC Group. E-commerce has improved service efficiency by facilitating faster and more secure online transactions, thereby reducing delays and operational costs. E-services have enhanced accessibility and responsiveness, enabling citizens to conveniently access services without physical presence. E-administration has strengthened internal organizational processes through improved coordination, transparency, and effective digital management systems. Furthermore, e-participation has promoted greater citizen involvement, accountability, and inclusiveness in service delivery processes through digital engagement platforms.

Recommendations

Recommendations for Practice

Based on the findings of the study, WASAC management should prioritize the continuous enhancement of its digital platforms to ensure they remain user-friendly, accessible, and resilient. Specifically, the corporation should simplify the user interface of its online portals and mobile applications, incorporating local languages such as Kinyarwanda to accommodate a broader demographic of users. To address the digital divide, WASAC should launch targeted digital literacy campaigns and community outreach programs, particularly in peri-urban and rural areas, to educate customers on how to safely and effectively use mobile money and online billing systems. Additionally, the corporation must invest in robust IT infrastructure and system redundancy to minimize network downtimes and transaction failures, ensuring that digital services remain reliable even during peak billing periods. Finally, establishing dedicated, multi-channel customer support systems, including automated chatbots and toll-free helplines, will help resolve digital transaction disputes promptly and maintain high levels of customer trust and satisfaction.

Recommendations for Policy

At the institutional and governmental level, policymakers should focus on creating an enabling environment that accelerates digital inclusion in public utility services. The government, in collaboration with telecommunications regulators, should consider policies that subsidize or zero-rate data costs for citizens accessing essential public service platforms, thereby removing financial barriers to digital access. Furthermore, regulatory bodies should mandate and enforce strict interoperability standards among various mobile network operators, commercial banks, and the national e-government gateway to ensure seamless, frictionless payment experiences for consumers. Policymakers must also strengthen and enforce comprehensive data protection and cybersecurity frameworks specifically tailored to public utilities, ensuring that citizens' financial and personal data are securely handled. Finally, the government should incentivize public-private partnerships aimed at expanding broadband connectivity and smart metering infrastructure in underserved regions to ensure equitable access to modern utility services.

Recommendations for Further Research

While this study provides valuable insights into the influence of e-commerce on public service delivery at WASAC, several avenues remain for future academic inquiry. First, future research should adopt a longitudinal design to assess the long-term impact of digital payment adoption on non-revenue water reduction and the overall financial sustainability of the utility over a multi-year period. Second, subsequent studies could expand the geographical and sectoral scope by comparing WASAC's digital transformation journey with other public utilities in Rwanda, such as the energy or waste management sectors, or by conducting cross-country comparative analyses with utilities in neighboring East African nations. Third, there is a need for targeted qualitative research focusing specifically on marginalized demographics, such as the elderly, low-income households, and rural populations, to deeply understand the unique socio-cultural and infrastructural barriers they face in adopting digital utility services. Finally, future studies should explore the potential integration of emerging technologies, such as Artificial Intelligence for predictive customer service and blockchain for immutable billing transparency, to determine how next-generation digital tools can further revolutionize public water and sanitation delivery.

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