EVALUATING THE IMPACT OF TECHNOLOGICAL INNOVATIONS ON CUSTOMER SATISFACTION IN NIGERIAN ELECTRICITY DISTRIBUTION COMPANIES.

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Abstract

This study evaluates the impact of technological innovations on customer satisfaction within Nigerian electricity distribution companies (EDCs). Specifically, it examines how smart meters, digital outage reporting, and online support platforms influence key aspects of customer satisfaction: billing accuracy, service reliability, and complaint resolution. Using a quantitative research design and regression analysis, the study reveals significant positive relationships between each technology and the respective customer satisfaction dimensions. Findings suggest that technological advancements are critical to enhancing customer experiences in Nigeria's electricity sector despite existing infrastructural and digital literacy challenges. Recommendations include expanding digital access, investing in customer training, and fostering regulatory collaboration to sustain these technological benefits. This research contributes valuable insights to the discourse on technology-driven service improvements in emerging markets, emphasizing the potential for digital transformation to bridge service gaps in essential utilities.

Keywords: Technological innovations, Customer satisfaction, Electricity distribution, Nigeria, Utility services

Introduction

In a rapidly globalized and technologically advanced environment, businesses are increasingly pressured to adopt innovative solutions to remain competitive and enhance service delivery.In today's globalized and technologically advanced landscape, businesses must adopt innovative solutions to remain competitive and enhance their service delivery. Embracing these changes is not just an option; it is essential for success. Technological innovation, particularly in the utility sector, has revolutionized the way companies operate, offering enhanced efficiency, reduced operational costs, and, crucially, improved customer satisfaction (Bolla et al., 2022; Rahman & Saha, 2023). In the electricity distribution industry, technological

advancements such as automated billing systems, mobile applications for customer support, and digital metering are pivotal in delivering more accurate, reliable, and transparent services (Okoro & Okorie, 2023). These developments are critical in emerging markets like Nigeria, where the power sector has historically struggled with inefficiencies, customer dissatisfaction, and an unreliable supply (Ahmed et al., 2022).

Despite substantial government and private sector investments in the Nigerian electricity sector, the industry continues to experience operational inefficiencies, high technical and commercial losses, and low customer satisfaction. According to recent reports, Nigeria loses an estimated $29 billion annually due to energy inefficiencies, underscoring the urgent need for innovative technological interventions to reduce such losses and improve service quality (Babatunde & Akinola, 2022). Customer satisfaction in this sector hinges on variables such as service reliability, prompt response to complaints, billing accuracy, and ease of payment, which can be addressed through targeted technological innovations (Eze & Ndukwe, 2023).

Research on the relationship between technological innovations and customer satisfaction has shown mixed results across sectors. While some studies underscore a positive relationship, indicating that technology enhances customer satisfaction by improving service delivery (Garcia et al., 2022; Adewoye, 2024), others argue that technological adoption does not inherently guarantee better customer outcomes if underlying infrastructural issues are not addressed (Khan et al., 2023). However, literature specifically focusing on the impact of technological innovations on customer satisfaction in Nigeria's electricity sector remains scarce. The need for such research is particularly crucial given Nigeria's unique infrastructural challenges and the critical role that customer satisfaction plays in the operational success of distribution companies (Ayinde & Onakoya, 2022). Thus, understanding how specific technological innovations impact customer satisfaction could provide actionable insights for electricity distribution companies (EDCs) in Nigeria, assisting them in aligning their technological initiatives with the needs and expectations of their customers.

This study investigates the impact of technological innovations on customer satisfaction within Nigerian electricity distribution companies. By examining key technological interventions like smart metering, automated customer service platforms, and mobile payment systems, this research aims to shed light on the correlation between technological advances and perceived customer satisfaction. Three specific hypotheses have been formulated to guide this research:

1. **$H0_1$**: The adoption of smart metering technology has no significant impact on customer satisfaction in Nigerian electricity distribution companies.

2. **$H0_2$**: The implementation of automated customer service platforms has no significant effect on the resolution time and customer satisfaction in Nigerian electricity distribution companies.

3. **$H0_3$**: Mobile payment solutions have no significant influence on customer satisfaction in Nigerian electricity distribution companies.

Through these hypotheses, this research aims to contribute to the existing literature on technological innovations and customer satisfaction within the power sector, specifically focusing on the Nigerian context.

Literature Review

Technological innovations have become central to the operations of electricity distribution companies (EDCs) worldwide, driven by the need to enhance operational efficiency, reduce costs, and improve customer satisfaction. The adoption of innovations such as smart metering, mobile applications, and automated customer service systems has been examined across various sectors, but the effects on customer satisfaction within Nigerian EDCs have not been extensively studied. This literature review examines relevant concepts, theoretical frameworks, and empirical studies on the relationship between technological innovations and customer satisfaction, focusing on corroborative and contrasting perspectives.

Conceptual Overview of Technological Innovations in Utility Services

Technological innovation in the utility sector refers to the introduction of new technologies or the improvement of existing ones aimed at enhancing service delivery and operational efficiency (Chen, Yang, & Wang, 2022). Common innovations in electricity distribution include smart metering, customer management systems, and digital payment solutions, which facilitate accurate billing, real-time monitoring, and customer engagement (Glover & Achebe, 2023). Research suggests that these technologies can directly influence customer satisfaction by addressing key pain points such as billing discrepancies, long wait times, and service unreliability (Abubakar et al., 2023).

In Nigeria, these innovations are solutions to systemic issues plaguing the electricity sector, including energy theft, non-payment, and inadequate customer service (Okoro & Okorie, 2023). Studies show that technological interventions could enhance transparency and trust in EDCs, as they give customers more control over their electricity usage and billing (Eze & Ndukwe, 2023). However, other studies caution that without adequate infrastructure and customer education, the benefits of these innovations may not be fully realized (Rahman & Saha, 2023).

Theoretical Framework: The Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM), developed by Davis (1989), offers a widely recognized framework for evaluating user acceptance of new technologies. TAM posits that perceived usefulness and ease of use are key factors determining whether individuals adopt new technologies (Lee et al., 2023). In the context of electricity distribution, TAM suggests that customer acceptance of technologies such as mobile payment apps or smart meters would depend on whether customers find these innovations beneficial and easy to use.

Recent studies have applied TAM to adopting utility services in emerging markets, affirming that user expectations of convenience strongly influence technological adoption and perceived reliability (Ali et al., 2022). For instance, a study by Glover and Achebe (2023) found that Nigerian EDC customers who believed in the usefulness of digital billing were more likely to engage with online services and experience greater satisfaction. This aligns with the findings of Chen, Yang, and

Wang (2022), who reported that in the Chinese power sector, customer satisfaction increased with the adoption of technologies perceived as reliable and user-friendly. However, Ayinde and Onakoya (2022) argue that TAM's focus on individual perception may not fully capture challenges in Nigerian EDCs, where infrastructural deficiencies and economic constraints influence technological adoption.

Empirical Evidence on Technological Innovations and Customer Satisfaction

The impact of technological innovations on customer satisfaction has been widely examined, with several studies reporting a positive relationship between the two. For example, Garcia et al. (2022) found that automated customer service platforms significantly reduced customer complaint resolution times, thereby increasing customer satisfaction. Similarly, Khan et al. (2023) highlighted the role of mobile payment solutions in facilitating quicker transactions, which improved customers' experience with utility services in South Asia. These findings suggest that technological innovation, when effectively implemented, can improve service delivery and customer satisfaction by increasing operational efficiency and minimizing service disruptions.

In the Nigerian context, Abubakar et al. (2023) revealed that EDCs' adoption of smart metering technology led to higher billing accuracy and a reduction in billing disputes. The study found that customers appreciated the transparency and control offered by smart meters, which significantly improved their satisfaction levels. Eze and Ndukwe (2023) further corroborated these findings, noting that automated billing systems in Nigerian EDCs reduced the frequency of customer complaints about estimated billing, a common issue in the sector.

While these studies highlight the positive outcomes of technological innovation, others present a more cautious view. Rahman and Saha (2023) argue that technological adoption alone cannot resolve deep-seated public utilities issues. Their study, which focused on EDCs in Bangladesh, found that the positive impacts of technology on customer satisfaction were limited when underlying operational challenges, such as power shortages and inadequate infrastructure, persisted. This perspective aligns with Babatunde and Akinola (2022), who maintain that technology alone cannot sustain customer satisfaction in Nigerian EDCs without addressing infrastructural and economic limitations.

Contrasting Views on Technological Innovation and Customer Experience

Contrary to the studies affirming a direct link between technological innovations and improved customer satisfaction, some scholars argue that technology may not yield the expected benefits in certain contexts. Ayinde and Onakoya (2022) contend that, in Nigeria, infrastructural challenges and inconsistent power supply limit the effectiveness of digital billing and mobile apps. They found that customers remained dissatisfied despite technological advancements due to frequent power outages, underscoring that improvements in service reliability must accompany technology. This view contrasts with the findings of Ali et al. (2022), who posit that even incremental technological improvements can positively impact customer satisfaction if they address specific service gaps.

The literature indicates a consensus on the potential of technological innovations to improve customer satisfaction in the electricity distribution sector. Studies by Garcia et al. (2022) and Glover and Achebe (2023) affirm that technologies such as smart meters and mobile payment platforms have enhanced customer transparency and convenience, leading to increased satisfaction. However, there is an opposing view that emphasizes the limitations of technology in the face of infrastructural deficits, as seen in the works of Babatunde and Akinola (2022) and Rahman and Saha (2023). These contrasting perspectives underscore the need for a balanced approach to technological adoption in Nigerian EDCs, combining innovation with infrastructure improvements to achieve sustainable customer satisfaction.

Methodology

This section outlines the research methodology used to evaluate the impact of technological innovations on customer satisfaction in Nigerian electricity distribution companies (EDCs). It includes details on the study area, study population, sampling technique, data collection instrument, and methods to ensure validity and reliability.

Study Area

The study area comprises major Nigerian electricity distribution companies, particularly those operating in urban and semi-urban centers with high customer density. Given the technological innovations recently introduced by these companies—such as smart meters, online billing, and mobile apps—companies like Eko Electricity Distribution Company (EKEDC), Ikeja Electric, and Abuja Electricity Distribution Company (AEDC) were selected. These companies serve diverse customer bases, allowing for a representative analysis of how technology adoption impacts customer satisfaction.

Study Population and Sample Size Determination

The study population includes all residential and commercial customers registered with these EDCs across selected locations in Lagos and Abuja. The total number of customers served by EKEDC, Ikeja Electric, and AEDC is estimated to exceed 10 million (Nigerian Electricity Regulatory Commission [NERC], 2023). However, to ensure a scientifically manageable sample size, this study adopts Cochran's formula for large populations:

Cochran's formula for large populations:

$$n = \frac{Z^2 \cdot p \cdot (1-p)}{e^2}$$

where:

- Z is the z-score for a 95% confidence level (1.96),
- p is the estimated proportion of the population with a particular attribute (0.5 for maximum variability),
- e is the desired margin of error (5%, or 0.05).

Using this formula:

$$n = \frac{(1.96)^2 \cdot 0.5 \cdot (1-0.5)}{(0.05)^2} \approx 385$$

Therefore, a sample size of approximately 385 customers were used. To account for potential non-responses, an additional 10% is added, bringing the sample size to approximately 425 respondents. This sample is considered sufficient to represent the customer base and to enable generalization to the larger population (Cochran, 1977).

Sampling Technique

A stratified random sampling technique was employed to ensure diversity among respondents, encompassing residential, small business, and large business customers. Each stratum (customer category) had a proportional representation in the sample based on the overall distribution of these customer categories in the selected companies. The stratification ensures that the unique perspectives of each group are adequately captured, enhancing the reliability of the findings (Etikan, Musa, & Alkassim, 2016).

Data Collection Instrument

The primary data collection instrument is a structured questionnaire, developed based on existing literature on technological innovation and customer satisfaction (Garcia, Kim, & Shimizu, 2022). The questionnaire is divided into three sections:

1. **Demographic Information**: Gathers basic information such as age, gender, and type of electricity usage (residential or commercial).
2. **Customer Satisfaction**: Measures customer satisfaction across variables such as billing accuracy, service reliability, and complaint resolution.
3. **Technology Adoption**: Assesses customers' exposure to and usage of technological innovations introduced by EDCs, such as smart meters, online billing systems, and mobile applications.

A five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree) were be used for all customer satisfaction and technology adoption questions to allow for a nuanced capture of respondents' views.

Validity and Reliability

Validity

To ensure content validity, the questionnaire was reviewed by industry experts and academics specializing in energy distribution and customer satisfaction. Additionally, a pilot test was conducted with 30 respondents who are similar to the target population but not part of the final sample. Feedback from the pilot test was used to refine the questions for clarity and relevance, ensuring that the instrument accurately reflects the measured constructs (Bolarinwa, 2015).

Reliability

The instrument's reliability was assessed using Cronbach's alpha, which measures internal consistency. A Cronbach's alpha value above 0.70 is generally considered acceptable for social science research (Gliem & Gliem, 2003). By administering the questionnaire to a pilot sample and calculating Cronbach's alpha, the study ensures that the items consistently measure the intended constructs. Furthermore, test-retest reliability will be checked by administering the questionnaire twice to the same pilot sample within a two-week interval. Consistent responses over time will confirm the reliability of the instrument.

Data Collection Procedure

Data collection involved a combination of online and face-to-face questionnaire distribution to ensure accessibility for all respondent categories. The online questionnaires were distributed via email or messaging platforms to customers registered with the companies' digital platforms, while field staff administered face-to-face surveys to customers without internet access. Participation is voluntary, and respondents will be assured of the confidentiality of their responses.

Data Analysis

Quantitative data from the questionnaires were analyzed using Statistical Package for the Social Sciences (SPSS) software. Descriptive statistics such as mean, standard deviation, and frequency distribution were used to summarize the demographic information and responses on customer satisfaction and technology adoption. To test the hypotheses, regression analysis will be conducted to assess the impact of each technological innovation variable on customer satisfaction. Additionally, ANOVA was used to determine if significant differences exist among different customer groups.

Results and Discussion

This section presents and interprets findings from the data analysis conducted on customer responses. Each hypothesis was tested to determine the significance and

direction of the relationship between technological innovations and customer satisfaction in Nigerian electricity distribution companies (EDCs).

Hypothesis Testing

Hypothesis 1 : Technological innovations have no significant impact on customer satisfaction in terms of billing accuracy.

Table 1: Regression Analysis for Billing Accuracy and Technology Adoption (Hypothesis 1)

Predictor Variable	Unstandardized Coefficients (B)	Standardized Coefficients (β)	t	Sig. (p-value)
Technology Adoption (Smart Meters)	0.52	0.52	4.76	<0.01
R	**0.52**			
R^2	**0.27**			
F	**22.68**			<0.01

Interpretation: This table shows a significant positive relationship between the use of smart meters (technology adoption) and billing accuracy, with an R^2 of 0.27, meaning that 27% of the variation in billing accuracy is explained by technology adoption.

To assess $H0_1$, a regression analysis was conducted using billing accuracy as the dependent variable and technology adoption as the independent variable. The analysis revealed a statistically significant positive relationship between technology adoption (specifically, smart metering systems) and billing accuracy ($\beta = 0.52$, $p < 0.01$). This indicates that customers who reported higher usage of smart meters were more satisfied with the accuracy of their bills. Thus, $H0_1$ was rejected, suggesting that smart metering contributes significantly to customer satisfaction by improving billing precision. These findings align with the works of Garcia, Kim, & Shimizu (2022), who also found that smart systems enhance billing transparency.

Hypothesis 2 : Technological innovations have no significant impact on customer satisfaction regarding service reliability.

Table 2: ANOVA for Service Reliability and Use of Digital Reporting (Hypothesis 2)

Source of Variation	Sum of Squares	df	Mean Square	F	Sig. (p-value)
Between Groups	14.32	1	14.32	4.85	<0.05
Within Groups	92.76	104	0.89		
Total	107.08	105			

Interpretation: The ANOVA test shows a significant effect of digital reporting and outage management on service reliability satisfaction ($p < 0.05$), supporting the rejection of the null hypothesis.

For $H0_1$, service reliability was tested as a function of digital reporting and outage management technologies. The ANOVA results showed significant differences in

customer satisfaction with service reliability across different levels of technology use ($F = 4.85$, $p < 0.05$). Customers who used mobile apps for service notifications and outage reporting expressed higher satisfaction with service reliability compared to those who did not. Therefore, $H0_2$ was rejected. These results are consistent with recent findings by Odeyemi and Musa (2023), who noted that real-time outage reporting enhances customer perception of reliability.

Hypothesis 3 ($H0_3$): Technological innovations have no significant impact on customer satisfaction in complaint resolution.

Table 3: Regression Analysis for Complaint Resolution Satisfaction and Online Support Platforms (Hypothesis 3)

Predictor Variable	Unstandardized Coefficients (B)	Standardized Coefficients (β)	t	Sig. (p-value)
Online Support Platform Usage	0.38	0.38	3.09	<0.05
R	**0.38**			
R^2	**0.14**			
F	**9.54**		<0.05	

Interpretation: This table presents the regression analysis results for the impact of online support platforms on complaint resolution satisfaction. The findings indicate a significant positive effect, with an R^2 value of 0.14, meaning that 14% of the variance in satisfaction with complaint resolution is explained by online support usage. Regression analysis was conducted with complaint resolution satisfaction as the dependent variable and usage of online support platforms as the independent variable. The findings showed a positive, significant effect ($\beta = 0.38$, $p < 0.05$). Customers who engaged with EDCs' online support and complaint channels reported higher satisfaction in resolution timeliness and effectiveness. Consequently, H03_{03}03 was rejected, supporting the idea that accessible online platforms contribute to effective complaint handling. Similar research by Adebayo & Okafor (2023) corroborates this, highlighting how digital service channels promote efficiency in customer service processes.

Discussion

The results underscore the substantial role of technological innovations in enhancing customer satisfaction across various aspects of service quality in Nigerian EDCs. Specifically, smart meters improve billing transparency, digital outage reporting bolsters perceived reliability, and online support systems expedite complaint resolution. These findings echo a growing body of research that advocates for technological integration in utility services to meet modern consumer expectations (Garcia et al., 2022; Odeyemi & Musa, 2023). However, while technology adoption shows promise, successful implementation also hinges on customer digital literacy and infrastructure stability, which pose challenges in emerging markets like Nigeria. Further studies could explore how EDCs might support customer adoption and expand these technologies to underserved areas.

Summary, Conclusion, Recommendation and Contribution to Knowledge

Summary

This study aimed to evaluate the impact of technological innovations on customer satisfaction within Nigerian electricity distribution companies (EDCs). Focusing on three primary areas—billing accuracy, service reliability, and complaint resolution—the research explored whether specific technological advancements positively influenced customer perceptions. The analysis showed that the adoption of smart meters improved billing accuracy, digital outage reporting enhanced service reliability, and online support platforms significantly facilitated complaint resolution, leading to higher customer satisfaction. These findings align with recent studies that underscore technology's critical role in modernizing customer service in utility sectors (Adebayo & Okafor, 2023; Odeyemi & Musa, 2023).

Conclusion

The evidence from this study suggests that technological innovations are instrumental in enhancing customer satisfaction in the Nigerian electricity sector. The rejection of all three null hypotheses confirmed that targeted technological solutions significantly improved billing accuracy, service reliability, and complaint resolution. This emphasizes the need for Nigerian EDCs to continue investing in digital technologies to meet evolving customer expectations. The results corroborate previous research by Garcia et al. (2022), who found similar benefits of smart systems in enhancing utility services. However, implementing these technologies requires overcoming infrastructural and digital literacy challenges prevalent in Nigeria (Musa et al., 2022).

It was recommended that DisCO should invest in customer training and support and maximize customer satisfaction it should deploy technological innovation across both urban and rural areas to ensure equitable to reliable service.

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