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Article

Disaggregated effects of artificial intelligence, online and mobile banking on customer satisfaction in banks: An analysis using structural equation modelling

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Abstract: In the Fourth Industrial Revolution (4IR) era, the rapid digitalisation of services poses both opportunities and challenges for the banking sector. This study addresses how adopting artificial intelligence (AI) and online and mobile banking advancements can influence customer satisfaction, particularly in Kaduna State, Nigeria. Despite significant investments in AI and digital banking technologies, banks often struggle to align these innovations with customer expectations and satisfaction. Using Structural Equation Modeling (SEM), this research investigates the impact of customer satisfaction with online banking (C_O) on AI integration (I_A) and mobile banking convenience (C_M). The SEM model reveals that customer satisfaction with online banking significantly influences AI integration (path coefficient of 0.40) and mobile banking convenience (path coefficient of 0.68). These results highlight a crucial problem: while technological advancements in banking are growing, their effectiveness is highly dependent on customer satisfaction with existing digital services. The study underscores the need for banks to prioritise enhancing online banking experiences as a strategic lever to improve AI integration and mobile banking convenience. Consequently, the research recommends that Nigerian banks develop comprehensive frameworks to evaluate and optimise their technology integration strategies, ensuring that technological innovations align with customer needs and expectations in the rapidly evolving digital landscape.

Keywords: artificial intelligence; structural equation model; customer satisfaction; online banking; mobile banking; technology acceptance model

1. Introduction

Over the years, the Nigerian banking sector has faced financial instability and performance challenges, primarily due to inadequate customer services, outdated advisory methods, limited modern facilities, and a lack of widespread branch networks (Kanu and Nwali, 2019). These issues have eroded customer trust and satisfaction. However, introducing financial technology (Fintech) can transform the industry and significantly improve customer service (Alt et al., 2018; Gomber et al., 2018; Zavolokina et al., 2017). The Nigerian banking industry has recently undergone substantial changes due to fintech adoption (Inegbedion et al., 2020). This shift has disrupted traditional banking models, challenging brick-and-mortar banks as rapid technological advancements reshape consumer preferences and the regulatory environment (Murinde et al., 2022). New-generation banks that integrate fintech and artificial intelligence (AI) into their operations are leading this change, adapting to modern demands and setting new standards in the financial industry.

The Technology Acceptance Model specifically inspired this study (Davis et al., 1989; Kumar et al., 2023), as it examines fintech adoption and customer satisfaction in systemically important banks in Kaduna State, Nigeria, emphasising fintech's role in enhancing customer experience. In Nigeria, there are five systemically important banks: Access Bank, First Bank of Nigeria, Guaranty Trust Bank, United Bank for Africa, and Zenith Bank. These financial institutions are systemically important because they are considered "too big to fail". Tabak et al. (2013) stated that evaluating financial institutions classified as Too Big to Fail in different markets is expedient. This is because they are integral to the financial system's stability; their collapse can erode confidence, leading depositors to withdraw funds en masse from other banks, potentially causing widespread financial instability. Therefore, the failure of such banks could trigger a bank run within the financial system. To prevent this, the government employs strategies such as injecting intervention funds and appointing interim management to maintain banking system stability (Osuma et al., 2019).

Unlike previous studies, this study extends current literature on fintech, customer satisfaction and banking by making several contributions. Firstly, this study offers a comprehensive perspective on customer satisfaction from FinTech by examining from the demand side the diverse array of Fintech services rather than solely concentrating on payment services as previous studies have done (Khanal et al., 2023; Lantang et al., 2021; Rehman and Ha, 2021). Secondly, to the best of the researcher's knowledge, this is the first study that critically examines and conducts an analysis of AI-powered banking advisory services recently integrated into Nigerian banking online channels. Specifically, the study examined AI-powered banking advisory services from the customers' perspectives. Finally, the study adds to pieces of literature by investigating the effectiveness of AI-powered banking advisory services in enhancing customer satisfaction.

To achieve this, the study used Structural Equation Modeling (SEM) to analyse customer satisfaction critically. This is because SEM can help uncover complex relationships between fintech services, user experiences, and satisfaction levels. By modelling these interactions, SEM provides insights into how various factors impact customer satisfaction, enabling fintech companies and banks to enhance their offerings effectively. The remaining structure of this study is as follows: section 2 contains the literature review, section 3 dwells on the materials and methods, section 4 covers the analysis and results interpretations, while section 5 covers the conclusion and recommendations.

2. Literature review and hypotheses

2.1. AI financial advisory services and customer satisfaction

The financial services industry has experienced a significant transformation in recent years, primarily due to artificial intelligence (AI) integration. The traditional financial advisory services, which have long been the backbone of the industry, are now being challenged by the emergence of AI-powered financial advisory services. Unlike traditional advisory services, AI services offer scalable, data-driven personalisation and are more accessible and affordable, broadening options for a wider range of consumers (Ashta and Herrmann, 2021; Kurshan et al., 2021).

The adoption of artificial intelligence in the Nigerian banking sector has faced significant challenges, particularly in utilising AI-based advisory services (Okolo et al., 2023). The lack of a skilled workforce with the necessary training to develop and implement these AI solutions, coupled with insufficient infrastructure to support the computationally intensive training of algorithms, has hindered the effective implementation of responsible AI in the country (Okolo et al., 2023). Additionally, the limited availability of representative datasets and the absence of robust governmental support and regulation to govern the ethical use of these technologies have contributed to the shortage of AI-based solutions in the Nigerian banking industry.

One of the primary obstacles to adopting AI advisory services in Nigerian banks is the challenging access to large amounts of quality data (Mogaji and Nguyen, 2022; Rahman et al., 2023). The country's diverse and complex data landscape, with varying data availability, quality, and storage capabilities, has posed a significant barrier to developing and deploying AI-based solutions. Furthermore, the lack of precise data regulatory policies has created uncertainties around the appropriate use and management of sensitive customer information, further deterring the implementation of AI-based advisory services in Nigeria (Isagah and Musabila, 2020). Another key factor contributing to the reluctance of staff to utilise AI-based advisory services in banks is the concern over the potential displacement of jobs (Ozili, 2024).

Several studies have indicated that the AI advisory service cannot replace the traditional advisory service (Bhatia et al., 2021; Chhatwani, 2022; Filiz et al., 2022). Jung et al. (2018) highlighted that customers are satisfied with human experts confirming auto-generated responses from AI advisory services such as robo-advisors. In addition to the functionalities of AI advisory services, these AI tools cannot account for the emotional concerns of customers as they cannot maintain such relationships. Chhatwani (2022) opined that traditional advisory services should not be entirely eradicated, as AI advisory services may not handle specific queries effectively. This is true because customer satisfaction often depends on whether expectations are met or exceeded, highlighting the need for human intervention alongside AI solutions.

Despite this study being inspired by the Technology Acceptance Model, which focuses on the perceived usefulness and ease of use of modern technology, our study contributes to the research field by addressing a gap in the extent to which customers use AI advisory services, an area that has not been thoroughly explored in previous studies. Investors argue that the perceived usefulness of technology is a valid indicator of customers' acceptance of AI advisory services. However, past studies did not account for several factors that could influence the adoption of the Technology Acceptance Model. For instance, Luo et al. (2024) stated that the model cannot account for the importance of fiduciary responsibilities and risks associated with AI advisory services. Additionally, vital factors such as human interaction with computers and privacy protection were inadvertently left out of the model. To address this gap, our study poses the following research question and proposes a corresponding hypothesis.

Q1: Does integrating Artificial Intelligence (AI) in financial advisory services significantly affect customer satisfaction compared to traditional advisory services?

$H_0$1: Integrating Artificial Intelligence (AI) in financial advisory services does not significantly affect customer satisfaction compared to traditional advisory services.

2.2. Mobile banking and customer satisfaction

The disruptive shift towards various digitalised channels has prompted banks and other financial institutions to adopt several proactive strategies to meet the demands of the online market. This is why the use of mobile banking has increased over the years because of its convenience, accessibility, and affordability (Laukkanen and Kiviniemi, 2010). Lee et al. (2003) stated that mobile banking is one of the most valuable services banks offer because it allows users to manage finances anytime, anywhere, and reduces the need for physical bank visits. Additionally, increased smartphone penetration and improved internet connectivity have further driven its popularity. Several studies have revealed that the benefits of adopting mobile banking lead to customer satisfaction (Alalwan et al., 2017; Baabdullah et al., 2019; Benedicktus et al., 2010; Shaikh and Karjaluoto, 2015). Some of these benefits include convenience, control, ease of use, customisation, and privacy (Alalwan et al., 2016; Koksal, 2016; Laukkanen, 2016).

The use of mobile banking applications continues to grow at an increasing rate, aligning with the Bill Gates forecast that mobile banking apps will reach over two billion subscribers by 2030 (Siyal et al., 2019). His projection is driven by increasing smartphone use, greater internet access, and the growing demand for convenient financial management. Mobile banking's ability to offer accessible, real-time services is expected to significantly boost its user base worldwide. However, the increased adoption of mobile banking applications also leads to an increased number of complaints from customers (i.e., users of the mobile banking apps). Customer complaints range from service failures, failed transactions, app crashes, incorrect data display, and software bugs.

Chebat and Slusarczyk (2005) opined that banks are one of the most vulnerable financial institutions that experience service failures. Such service failures can negatively influence customers' perception and satisfaction (Maxham III and Netemeyer, 2002). Customers' dissatisfaction is a psychological state that results from the deviation of their projected expectations to actual experience. Amin et al. (2014) stated that when customers use mobile banking applications, their satisfaction is derived from the application's ease of use and perceived usefulness. Therefore, customer satisfaction is one of the most treasured assets of an organisation, especially banks (Amin et al., 2014). Based on the growing adoption and benefits of mobile banking, as well as the associated rise in customer complaints and service failures, this study poses the following question and proposes a corresponding hypothesis:

Q2: Does the convenience of mobile banking applications influence customer satisfaction with banking services?

$H_0$2: The convenience of mobile banking applications does not influence customer satisfaction with banking services.

This hypothesis reflects the notion that despite the increasing use and perceived benefits of mobile banking (Alalwan et al., 2017; Laukkanen and Kiviniemi, 2010; Lee et al., 2003), and its role in enhancing financial management, convenience may not always translate into higher customer satisfaction due to potential service issues and dissatisfaction (Chebat and Slusarczyk, 2005; Maxham III and Netemeyer, 2002).

2.3. Online banking and customer satisfaction

Online and mobile banking concepts are often addressed in the same context as extant literature (Baabdullah et al., 2019; Geebren et al., 2021; Hamidi and Safareeyeh, 2019; Usman et al., 2020). However, this study deviates from past studies by examining the disintegrated effects of online banking and mobile banking on customer satisfaction. Online banking, otherwise called Internet banking, is accessed via a computer or web browser, offering a broad range of banking services and features. Mobile banking, on the other hand, is accessed through a smartphone app, providing more convenient, on-the-go access with features optimised for mobile use. While both offer account management to customers, mobile banking emphasises portability and quick transactions. As the Nigerian digital landscape continues to evolve, online banking has become a crucial part of the financial services sector, addressing the rising demand for convenient and accessible banking solutions (Dharmavaram and Nittala, 2018).

Yoon (2010) examined how ease of use, speed, design, security, information content, and customer support impact online banking satisfaction in China. The findings revealed that security and information content are essential to customer satisfaction with online banking, and bank managers should invest in information technology (IT) to improve design and speed, with customer support being key to satisfaction. Ling et al. (2016) investigated factors influencing customer satisfaction with Internet banking, highlighting web design and content, convenience and speed as crucial elements. Their study adopted a survey of 200 working adults and the findings revealed that these factors significantly impact customer satisfaction. Their study recommended that addressing these areas can enhance customer satisfaction and attract customers to Internet banking services. Ong et al. (2017) developed and tested the consumer-based virtual brand personality concept (CBVBP) in online banking, identifying measurable dimensions like Excitement, Sophistication, and Competence. The study finds that CBVBP positively influences customer satisfaction and brand loyalty, with satisfaction partially mediating this relationship, offering insights for online banking brand strategy. Given these findings, this study poses the following research question and develops the third null hypothesis as stated:

Q3: Is there a difference in customer satisfaction between those who use online banking for transaction monitoring and those who use in-person or traditional banking services?

$H_0$3: There is no difference in customer satisfaction between those who use online banking for transaction monitoring and those who use in-person or traditional banking services.

3. Materials and methods

This section explains the methodological approach employed in the study, encompassing the design of the questionnaire, the sampling technique, and the study location. The study adhered to a positivist research philosophy, utilising a deductive research approach.

3.1. Questionnaire measurement

As seen in **Table 1**, the questions included in the questionnaire were meticulously designed to accurately reflect the core constructs and objectives of the research title. The data was gathered by administering an online Google survey form to 200 customers of the systemically important banks. The variables were measured using a 5-point Likert scale. The measured items were adapted from extant literature on customer satisfaction, AI advisory services, mobile and online/internet banking issues. For example, AI-related items were coined from (Bhatia et al., 2021; Zhu et al., 2023; Zhu et al., 2024). Other items related to the latent constructs were measured using indicators that were coined from the empirical works of (Alalwan et al., 2018; Baabdullah et al., 2019; Iyer et al., 2018; Jun and Palacios, 2016; Laukkanen, 2016; Ngubelanga and Duffett, 2021). The indicators/items coined from the empirical literature were subjected to various examinations. For example, the Confirmatory Factor Analysis (CFA) was conducted to examine if data fits a hypothesised model, validating latent constructs and their relationships with observed variables (Jöreskog et al., 2016; LaNasa et al., 2009). Further to this, the internal consistency of a questionnaire is crucial for ensuring reliability by measuring consistency among its items (Santos et al., 2016). This study also examined Cronbach's Alpha to investigate the reliability of the questionnaire. A Cronbach alpha value from 0.7 upwards indicates that the research instrument is highly reliable (Adamu and Mohamad, 2019). Other tests examined include composite reliability, average variance extracted, standard deviation, and mean and correlation matrix. The Average Variance Extracted measures the average variance captured by a construct's indicators, indicating convergent validity (Cheah et al., 2018). Composite Reliability assesses the overall reliability of a construct's indicators, similar to Cronbach's Alpha, ensuring internal consistency (Hair et al., 2020).

Table 1. Variable measurement.

Code	Items	Cronbach α
	Customer Satisfaction	0.98
CS1	financial technology such as Mobile Applications, Online Banking and Artificial Intelligence been of help to you	
CS2	financial technology such as Mobile Applications, Online Banking and Artificial Intelligence been of ease to use	
	The role of Artificial Intelligence in providing swift and accurate financial advisory services	0.67
AI1	Artificial intelligence has helped provide swift and accurate financial advisory service	
AI1	Artificial intelligence has helped provide better investment decisions	
AI3	Artificial intelligence should be encouraged by banks to it customers	
AI4	Artificial intelligence has helped improve customer experience	
AI5	Artificial intelligence has helped reduce cost	
AI6	Artificial intelligence chatbots has been of great help to you	
AI7	Would you recommend Artificial intelligence to other bank customers	

Table 1. (*Continued*).

Code	Items	Cronbach α
	The convenience of mobile applications for banking services	0.82
MA1	Mobile applications helpful in providing straightforward and readily available banking service	
MA2	Do you prefer transferring money through mobile applications than going to banks	
MA3	Mobile applications have helped saved cost in transferring money	
MA4	Mobile applications have helped in monitoring transactions	
MA5	Mobile applications have helped you reduce your visits to the bank	
MA6	You don't mind transferring money with mobile applications	
MA7	Mobile applications have helped in instant transfer of funds	
MA8	Mobile applications have helped provide remote banking	
MA9	Mobile applications have helped in bill payments	
	the usefulness of online banking for monitoring transactions.	0.68
OB1	Online banking has helpful in monitoring transactions	
OB2	Online banking has helped in checking balance	
OB3	Online banking has helped providing convenience in banking	
OB4	Online banking has provided lower transaction cost	
OB5	Online banking has provided better service quality	
OB6	Online banking has provided quicker banking services	
OB7	Online banking has developed your saving habit	

Source: Author's Compilation (2024).

3.2. Sampling technique and data collection

The study used stratified and simple random sampling to gather the data. The stratified sample was based on the selection of the five local governments and banks, while the simple random sampling technique was based on the general administration of the online survey to customers of the chosen banks. **Table 2** indicates that a significant portion of the respondents are youths aged 18 to 39, constituting 90.5% of the sample. Youths are the target respondents for this study because they are typically early adopters of technology, more likely to use digital banking services, and their satisfaction levels can provide valuable insights into the effectiveness and appeal of fintech solutions in the banking sector (Krupa and Buszko, 2023; Nourallah, 2022).

Table 2. Sample demographics.

Sample criteria		
Gender	Frequency	Percentage (%)
Male	103	52
Female	97	48

Table 2. (*Continued*).

Sample criteria		
Age Group of Respondents	Frequency	Percentage (%)
18–28	161	80.5
29–39	20	10
40–50	12	6
51–61	5	2.5
62–71	2	1
Highest educational qualification	Frequency	Percentage (%)
SSCE/OND/NC	79	39.5
HND/Bachelors	94	47
Masters	22	11
Others	5	2.5
Occupational Status	Frequency	Percentage (%)
Employed	56	28
Self- Employed	22	11
Student	122	61
Systemically Important Banks	Frequency	Percentage (%)
Access Bank	42	21
First Bank	22	11
Guaranty Trust Bank	71	35.5
United Bank of Africa	33	16
Zenith Bank	32	16

Source: Field Survey (2024).

3.3. Study area

As seen in **Figure 1**, Kaduna State is located in the northwest region of Nigeria. Katsina borders it and Kano states to the north, Bauchi and Plateau states to the east, Nasarawa State to the south, and Niger and Zamfara states to the west. The state capital, Kaduna, is a major city and a key economic hub in the region. Kaduna State is a central economic hub in Nigeria, strategically positioned to connect major northern and southern regions. Its robust transportation infrastructure, including rail and road networks, supports trade and commerce, while its diverse industries, such as agriculture and manufacturing, underscore its economic significance. As a central industrial hub, Kaduna has a growing need for efficient payment and settlement systems, which are crucial for facilitating business transactions and managing financial operations. The presence of established banks in the region is essential for supporting these needs, ensuring smooth financial processes, and fostering economic growth. Therefore, examining how Fintech solutions integrate with the existing banking infrastructure can offer insights into improving payment systems, addressing regional financial challenges, and enhancing digital transformation. The local governments from which responses were gotten include Zaria, Kaura, Kaduna South, Kachi, and Kagoro local government areas of Kaduna State.

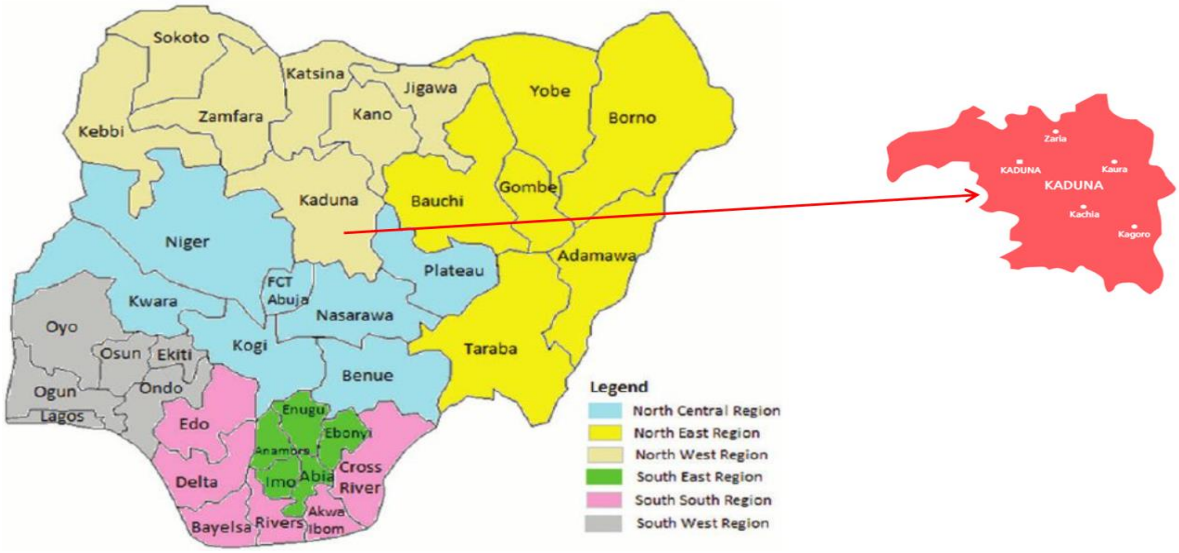

Figure 1. Map of Nigeria showing Kaduna state and the five local governments used.

3.4. Scaling method

The Likert scale coding for responses is as follows: Strongly Disagree is coded as 1 (SD), Disagree as 2 (D), Undecided as 3 (U), Agree as 4 (A), and Strongly Agree as 5 (SA). Additionally, demographic variables are coded as follows: Gender is coded with Male as (1) and Female as (2); Age groups are categorised as 18–28 (1), 29–39 (2), 40–50 (3), 51–61 (4), and 62–71 (5); Educational qualifications are coded as SSCE/OND/NC (1), HND/Bachelor's (2), Master's (3), and Others (4); Occupation is coded with Employed as (1), Self-Employed as (2), and Student as (3); and Banks are categorised as First Bank (1), United Bank for Africa (2), Guaranty Trust Bank (3), Access Bank (4), and Zenith Bank (5).

3.5. Ethical statement

This study adhered to ethical research standards to ensure all participants' rights, privacy, and well-being. Before participating in the study, informed consent was obtained through an online questionnaire. At the beginning of the questionnaire, participants were presented with an informed consent form that clearly outlined the study's purpose, benefits, potential risks, and procedures. They were assured that their responses would remain confidential and anonymous, with data securely stored and accessible solely to the research team. Participants indicated their consent by selecting "Agree" before completing the questionnaire. This method ensured that consent was automatically documented, capturing responses in the survey database for each participant who completed the questionnaire.

4. Data analysis and interpretation

As seen in **Table 3**, customer satisfaction having a mean and standard deviation of 4.265 and 0.516 indicates that, on average, customer satisfaction scores are high, with relatively low variability around the mean. The high mean scores and varying levels of standard deviation of AI indicate a moderate to high level of satisfaction dependent on the specific type of AI advisory services in use. Mobile and online

banking items exhibit a wider range of mean scores and standard deviations, indicating varying satisfaction levels across different aspects of online banking services.

Table 3. Variables mean and standard deviation.

Customer Satisfaction (CS)	**Mean**	**Standard Deviation**	**Level**
CS1	4.265	0.5158542	High
CS2	4.265	0.5158542	High
Artificial Intelligence (AI)	Mean	Standard Deviation	Level
AI1	4.12	0.7057552	Very High
AI2	4.045	0.7588506	High
AI3	4.03	0.7759578	High
AI4	4.025	0.7793664	High
AI5	3.49	1.00746	Very High
AI6	3.695	0.9253412	Very High
AI7	3.79	0.7931237	Moderate
Mobile Application (MA)	Mean	Standard Deviation	Level
MA1	4.235	0.6258863	High
MA2	4.575	0.675765	Very High
MA3	4.025	0.9690564	Very High
MA4	4.38	0.6985987	High
MA5	4.57	0.698239	Very High
MA6	4.515	0.6495263	Very High
MA7	4.52	0.6337255	Very High
MA8	4.3718593	0.7401966	Very High
MA9	4.39	0.707391	Very High
Online Banking (OB)	Mean	Standard Deviation	Level
OB1	4.245	0.7988528	High
OB2	4.33	0.7509458	Very High
OB3	4.365	0.6885824	High
OB4	3.92	0.8930778	Moderate
OB5	4.145	0.7116934	High
OB6	4.285	0.6900404	High
OB7	3.47	1.12937	Low

Source: R Studio Output (2024).

As seen in **Table 4**, the correlation matrix shows varying degrees of positive correlations among the latent variables. The strongest relationship of 0.634456 is between mobile applications and online banking, suggesting that improvements or growth in mobile applications are likely to be associated with increases in online banking activities. Customers who utilise mobile applications for financial transactions might also frequently use online banking services, reflecting a trend where mobile and online banking are complementary, as seen in previous studies (Baabdullah et al., 2019; Geebren et al., 2021; Hamidi and Safareeyeh, 2019; Usman et al., 2020). **Table 4** also indicates no incidence of multicollinearity among the

variables, as none of the variables were above 0.8. The variance inflation factor test agrees with this result.

Table 4. Correlation matrix among latent variables.

	CS	**AI**	**MA**	**OB**
CS	1			
AI	0.189305	1		
MA	0.159396	0.385633	1	
OB	0.222036	0.415709	0.634456	1

Source: R Studio Output (2024).

Table 5 provides factor loadings from a Confirmatory Factor Analysis (CFA), illustrating the strength of associations between observed variables and their latent factors. For example, variables under the AI factor, such as AI4 (0.567) and AI5 (0.575), show strong loadings, indicating their significant contribution to the AI construct (Brown, 2015). Conversely, variables like CS1 (0.114) have low loadings on the CS factor, suggesting a weaker measurement of this construct (Kline, 2023). High loadings for OB variables, such as OB1 (0.610) and OB2 (0.584), strongly represent the OB factor. This matrix aids in evaluating and refining the measurement model's validity (Hair, 2009).

Table 5. Confirmatory factor analysis.

	CS	**AI**	**MA**	**OB**
CS1	0.114			
CS2	0.095			
AI1		0.255		
AI2		0.289		
AI3		0.396		
AI4		0.567		
AI5		0.575		
AI6		0.401		
AI7		0.517		
MA1			0.298	
MA2			0.436	
MA3			0.452	
MA4			0.505	
MA5			0.526	
MA6			0.459	
MA7			0.498	
MA8			0.394	
MA9			0.480	
OB1				0.610
OB2				0.584
OB3				0.611

Table 5. (*Continued)*.

	CS	AI	MA	OB
OB4				0.308
OB5				0.551
OB6				0.526
OB7				0.284

Source: R Studio Output (2024).

The formula for composite reliability, Average Variance Extracted and variance inflation factor can be seen in Equations (1)–(3), respectively.

$$CR = \frac{(\sum \lambda_i)^2}{(\sum \lambda_i)^2 + \sum error_i} \tag{1}$$

$$AVE = \frac{\sum {\lambda_i}^2}{\sum {\lambda_i}^2 + \sum error_i} \tag{2}$$

$$VIF = \frac{1}{1 - R^2} \tag{3}$$

From **Table 6**, the descriptive statistics indicate the reliability and validity of the constructs. Customer satisfaction and mobile application exhibit an excellent Cronbach Alpha value of 0.988 and 0.820, respectively, indicating the measurement scale's high reliability and internal consistency. Artificial intelligence and online banking exhibit moderate reliability of 0.679 and 0.687, respectively. The variance inflation factor (VIF) across all variables suggests no multicollinearity concern, as none of the variables are above 5 (O'brien, 2007). Customer satisfaction has no VIF because it is the dependent variable. The results of the VIF positing the absence of multicollinearity align with the assertions of the correlation matrix in **Table 4**. The composite reliability values indicate moderate to high reliability for all constructs, but the high average variance extracted values suggest strong convergent validity, meaning the constructs adequately capture the variance of their respective indicators.

Latent Variable Measurement Equations is seen in Equations (4)–(6) respectively:

For artificial intelligence:

$$I_A = \lambda_{AI1} \cdot AI1 + \lambda_{AI2} \cdot AI2 + \lambda_{AI3} \cdot AI3 + \lambda_{AI4} \cdot AI4 + \lambda_{AI5} \cdot AI5 + \lambda_{AI6} \cdot AI6 + \lambda_{AI7} \cdot AI7 + \lambda_{cs1} \cdot CS1 + \in_{Int_{AI}} \tag{4}$$

For mobile banking:

$$C_M = \lambda_{MA1} \cdot MA1 + \lambda_{MA2} \cdot MA2 + \lambda_{MA3} \cdot MA3 + \lambda_{MA4} \cdot MA4 + \lambda_{MA5} \cdot MA5 + \lambda_{MA6} \cdot MA6 + \lambda_{MA7} \cdot MA7 + \lambda_{MA8} \cdot MA8 + \lambda_{MA9} \cdot MA9 + \lambda_{CS1} \cdot CS1 + \in_{Con_{MB}} \tag{5}$$

For online banking:

$$C\_O = \lambda_{OB1} \cdot OB1 + \lambda_{OB2} \cdot OB2 + \lambda_{OB3} \cdot OB3 + \lambda_{OB4} \cdot OB4 + \lambda_{OB5} \cdot OB5 + \lambda_{OB6} \cdot OB6 + \lambda_{OB7} \cdot OB7 + \lambda_{CS1} \cdot CS1 + \in_{Cus_{OB}} \tag{6}$$

Table 6. Construct variable descriptive statistics.

Variable	Std. Error	VIF	CR	AVE	CA
Customer Satisfaction (CS)			0.0216065	0.0110105	0.9887656
CS1	0.025				
CS2	0.026				
Artificial Intelligence (AI)			0.6158295	0.197938	0.6794669
AI1	0.04	1.226973			
AI2	0.052	1.242689			
AI3	0.047	1.39378			
AI4	0.04	1.746942			
AI5	0.079	1.395383			
AI6	0.073	1.351557			
AI7	0.044	1.685209			
Mobile Application (MA)			0.696487	0.2065807	0.8200999
MA1	0.029	1.359231			
MA2	0.022	1.883923			
MA3	0.075	1.347152			
MA4	0.023	2.091497			
MA5	0.023	2.34604			
MA6	0.02	2.119207			
MA7	0.012	2.964775			
MA8	0.041	1.391103			
MA9	0.024	1.963088			
Online Banking (OB)			0.7005918	0.263182	0.6867983
OB1	0.028	2.434173			
OB2	0.02	2.869801			
OB3	0.012	3.958214			
OB4	0.071	1.260222			
OB5	0.023	2.461568			
OB6	0.022	2.356591			
OB7	0.119	1.192697			

Note: VIFs = Variance Inflation factor, AVEs = Average Variance Extracted, CR = Composite reliability, CA = Cronbach Alpha, Std. Error = Standard Error. Source: R Studio Output (2024).

The SEM model in **Figure 2** provides a deep explanation of how customer satisfaction with online banking (C_O), the integration of artificial intelligence (I_A), and the convenience of mobile banking (C_M) interrelate. Customer Satisfaction with Online Banking (C_O) has a strong positive impact on both I_A and C_M, with path coefficients of 0.40 and 0.68, respectively. This suggests that improving customer satisfaction in online banking significantly enhances both the perception and integration of AI in banking services and the perceived convenience of mobile banking.

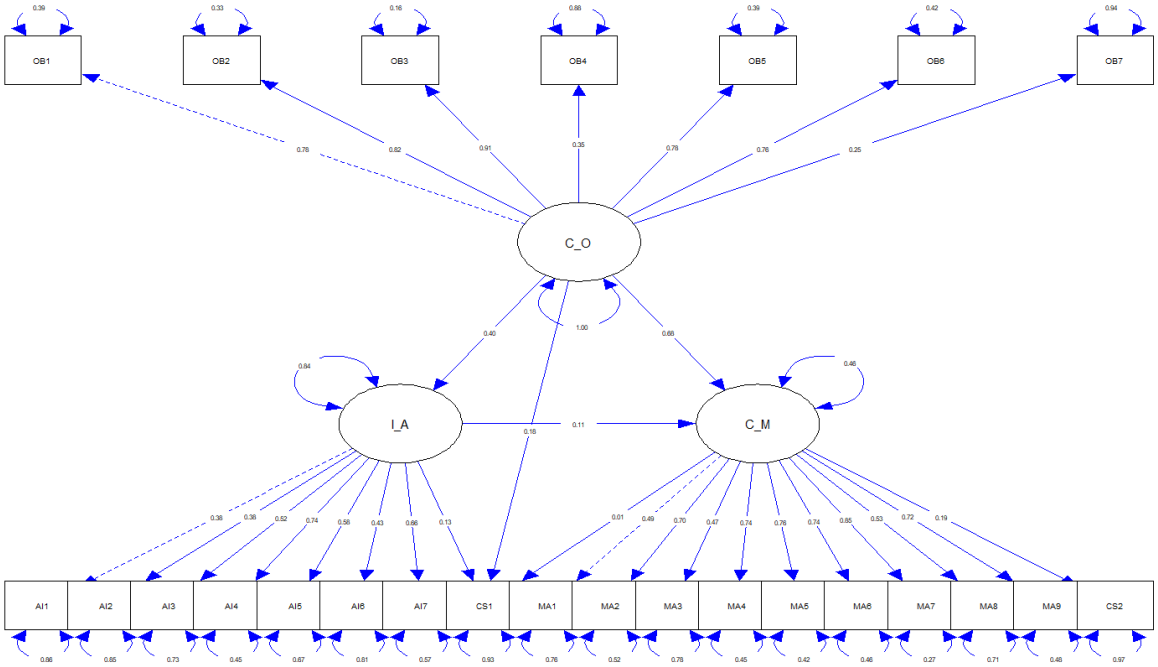

Figure 2. Path diagram of the structural equation model.

Integration of Artificial Intelligence (I_A), while having a less pronounced effect on C_M (coefficient 0.11), still indicates that better AI integration can slightly improve the convenience of mobile banking services. The observed variables (OB1 to OB7 for C_O, AI1 to AI8 for I_A, MA1 to MA9, CS1, and CS2 for C_M) have substantial loadings, indicating reliable measures of their respective latent constructs.

Overall, the SEM model underscores the importance of customer satisfaction in online banking as a critical driver of technological integration and service convenience. By enhancing customer satisfaction in online banking, banks can foster better integration of AI and improve the overall convenience of their mobile banking services, ultimately leading to a more cohesive and satisfactory banking experience for customers.

Equations (7) to (12) depict the formula for the Structural Equations model in **Figure 2**.

$$I\_A = \beta_1 \cdot C\_O + \beta_2 \cdot C\_M + \beta_3 \cdot (C\_O \times C\_M) + \beta_4 \cdot C\_O^2 + \zeta_1 \quad (7)$$

Convenience of Mobile Banking (Con_MB)

$$C\_M = \beta_5 \cdot C\_O + \beta_6 \cdot I\_A + \beta_7 \cdot (C\_O \times I\_A) + \beta_8 \cdot I\_A^2 + \zeta_1 \quad (8)$$

Error Terms

$$\zeta_1 \sim \mathcal{N}\left(0, \sigma_{\zeta_1}^2\right) error\ term\ for\ I\_A \quad (9)$$

$$\zeta_2 \sim \mathcal{N}\left(0, \sigma_{\zeta_2}^2\right) error\ term\ for\ C\_M \quad (10)$$

Covariance between Latent Variables

$$Cov\ (\zeta_1, \zeta_2) = \sigma_{\zeta_1, \zeta_2} \quad (11)$$

Variance-Covariance matrix

$$\sum = \begin{pmatrix} \sigma_{\zeta_1}^2 & \sigma_{\zeta_1,\zeta_2} \\ \sigma_{\zeta_2}^2 & \sigma_{\zeta_2}^2 \end{pmatrix} \quad (12)$$

As seen in **Table 7**, the Root Mean Square Error of Approximation (RMSEA) of 0.0372 suggests an excellent fit, while the Tucker-Lewis Index (TLI) of 0.8601 and Comparative Fit Index (CFI) of 0.8713 are slightly below the ideal threshold of 0.90, indicating an acceptable fit with room for improvement. Overall, the model shows reasonable adequacy. The chi-square value of 2286.319 indicates a significant difference between observed and expected data, which is influenced by the sample size of 200.

Table 7. Goodness of fit test.

	AVE
RMSEA	0.0372
TLI	0.8601
CFI	0.8713
Chi Square	2286.319

Note: RMSEA is Root Mean Square Error of Approximation, TLI is Tucker-Lewis Index, CFI is Comparative Fit Index. Source: R Studio Output (2024).

Table 8 tests the hypotheses of the study. From hypothesis one, it can deduced that integration of artificial intelligence (I_A) positively affects customer satisfaction (CS) with a significant *p*-value of 0.000; this means that the alternative hypothesis, which supports that Integrating Artificial Intelligence (AI) in financial advisory services significantly affect customer satisfaction compared to traditional advisory services should be accepted. This hypothesis agrees with the empirical studies of (Belanche et al., 2019; Patil and Kulkarni, 2019). Hypothesis two indicates that mobile banking convenience (C_M) also positively impacts CS, with a coefficient of 0.322 and a *p*-value of 0.015, demonstrating its importance in improving satisfaction. This also connotes that the null hypothesis will be rejected, while the alternative hypothesis supports that the convenience of mobile banking applications influences customer satisfaction. This finding is in tandem with the findings of extant literature, such as (Alalwan et al., 2017; Baabdullah et al., 2019; Benedicktus et al., 2010; Laukkanen and Kiviniemi, 2010; Shaikh and Karjaluoto, 2015). With a probability value of 0.000 which is statistically significant at 5%, hypothesis three indicates that customer satisfaction is positively influenced by online banking convenience (C_O), supporting the acceptance of the alternative hypothesis. The results of **Table 8** highlight the significance of AI, mobile, and online banking convenience in enhancing customer satisfaction.

Table 8. SEM hypotheses test.

Hypothesis	**Path**	**Coefficient**	**Std Error**	***P* Value**	**Decision**
H_1	I_A → CS	0.165	0.047	0.000	Supported
H_2	C_M → CS	0.322	0.133	0.015	Supported
H_3	C_O → CS	0.165	0.047	0.000	Supported

Source: *R* Studio Output (2024).

Discussion of results

Based on the analysis, it can be deduced that integrating Artificial Intelligence in financial advisory services significantly affects customer satisfaction, but the impact varies based on how AI is utilised. While AI can enhance the speed and accessibility of financial advice, complex AI applications may lead to customer dissatisfaction, as they sometimes lack the personalised touch of traditional advisory services. Customers value the human element in financial advisory, especially when dealing with intricate or sensitive financial decisions, suggesting that AI alone may not completely replace traditional services (Mehrotra, 2019; Taylor and Cotter, 2014; Vocke et al., 2019).

Regarding mobile banking, the convenience offered by mobile banking applications is a crucial driver of customer satisfaction. Performing banking transactions seamlessly from anywhere and anytime improves convenience, leading to higher satisfaction. This convenience reduces the need for physical branch visits (traditional banking), offering a more flexible and user-friendly experience. Furthermore, customers who use online banking for transaction monitoring generally report higher satisfaction than those relying on traditional, in-person banking services. The efficiency of online banking, which allows customers to monitor transactions in real-time, is highly appreciated. In contrast, in-person banking may involve longer wait times and limited accessibility, leading to lower satisfaction.

5. Conclusion

Conclusively, this study offers valuable insights into the disaggregated effects of Artificial Intelligence, online banking, and mobile banking on customer satisfaction in the banking sector, drawing on the key constructs of the Technology Acceptance Model. By dissecting these technologies' individual and combined impacts, the research provides a clear understanding of their roles in shaping customer experiences, focusing on the perceived usefulness and ease of use. The study highlights that AI-financial advisory services significantly boost customer satisfaction. Also, AI's capabilities in predictive analytics and automated support systems are crucial in meeting customer needs swiftly, thereby elevating satisfaction levels through improved perceived usefulness. However, the impact of AI is maximised when effectively integrated with online and mobile banking platforms, emphasising the need for a cohesive technological approach. Online banking is essential for customer satisfaction due to its convenience and accessibility, particularly when augmented by AI functionalities such as chatbots, robo-advisors and tailored financial advice.

Similarly, mobile banking's contribution to customer satisfaction is significant, underscoring the importance of real-time access and portability. This study recommends that Nigerian banks provide a framework to evaluate and optimise their technology integration strategies, offering actionable strategies to improve customer interactions and service quality. By leveraging these insights, banks can refine their technological offerings to meet customer expectations better and maintain a competitive edge in the dynamic financial landscape.

5.1. Study limitation

This study's limitations include its focus on Kaduna State, potentially limiting generalizability to other regions or broader contexts. Additionally, the data is based on self-reported measures from a specific demographic (youths aged 18–39) comprising 90.5% of the study's sample, which may not capture the perspectives of older or less tech-savvy customers. The cross-sectional nature of the survey also restricts insights into long-term trends or changes over time.

5.2. Policy implications

The practical implications of this study are significant for banks and policymakers in Nigeria. By highlighting the positive impact of fintech, particularly AI-powered advisory services and mobile applications, on customer satisfaction, banks can prioritises investments in these technologies to enhance user experience and loyalty. Policymakers can leverage these insights to promote financial inclusion and encourage the adoption of innovative banking solutions. Additionally, understanding the preferences of younger customers can help banks tailor their services to meet the evolving needs of this tech-savvy demographic, ultimately improving service quality and competitive advantage in the financial sector.

5.3. Future research implications

Future research can investigate the long-term effects of fintech adoption on customer satisfaction and retention across different demographics and regions beyond Kaduna State, Nigeria. Investigating the impact of emerging technologies like blockchain and advanced AI on financial services could provide deeper insights into evolving trends. Comparative studies between Nigeria and other countries might reveal global best practices and regional differences in fintech effectiveness. Examining the interplay between fintech adoption and financial literacy could help refine strategies for improving financial inclusion and customer engagement. Longitudinal studies could also track changes in user satisfaction over time as technology evolves.

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