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Ph. D. Dissertation in Engineering

**Assessing the Impact of IT
Governance Mechanisms, Service
Innovation Adoption and Quality
on Performance, Customer
Satisfaction and Accessibility**

Case: Nigerian Mobile Banking Services

IT 거버넌스 메커니즘, 서비스 혁신 채택 및 품질이
성능, 고객 만족 및 접근성에 미치는 영향 평가

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Technology Management, Economics, and Policy

Program

Abdullahi Garba Ali

**Assessing the Impact of IT Governance
Mechanisms, Service Innovation Adoption
and Quality on Performance, Customer
Satisfaction and Accessibility**

Case: Nigerian Mobile Banking Services

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이 논문을 공학박사학위 논문으로 제출함

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Abstract

Assessing the impact of IT Governance Mechanisms, Service Innovation Adoption and Quality on Performance, Customer Satisfaction and Accessibility Case: Nigerian Mobile Banking Services

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Technology Management, Economics and Policy

Program

College of Engineering

Seoul National University

According to World Bank statistics, more than two billion people in the world have no access to banks and financial services. In Nigeria, which has over 200 million people, making it one of the highest populations in sub-Saharan Africa, more than 60% of the adult population are unbanked. On

the other hand, mobile technology penetration has been gaining ground and has experienced more than 90% penetration into the country.

This research explores how innovative financial services on mobile technology can be leveraged to increase financial inclusion in Nigeria. Three different perspectives were developed to determine the following:

1. How Nigerian banks can become more organized to adopt the right innovative services that will improve their firm performance in achieving more financial inclusion;

2. The present quality of digital financial services that are provided to customers' need to improve and adapt to new innovative services to ensure they remain satisfied; and

3. With service delivery innovations, it is vital for banks to understand the perceptions of their customers on quality, pricing charges, and trust of services to increase user accessibility and satisfaction.

Our results from these three research frameworks have shown that IT governance mechanisms, service quality performance, price value, and trust are influencing factors of firm performance, customer satisfaction, and user accessibility when service innovation is adopted as a tool to increase financial inclusion in Nigeria.

This dissertation provides insight into how mobile banking as a form of technology in combination with innovative financial services can be

utilized to provide and increase the accessibility of financial services. The study's managerial policy implications can be used to increase the rate at which people can access financial services and the theoretical implications can be used by academicians to assess banks' readiness in adopting innovative ways to achieve more financial inclusion.

Keywords: Service Innovation, IT Governance, Firm Performance, Service Quality, Customer Satisfaction, User Accessibility, Mobile Banking, Structural Equation Modeling, Artificial Neural Network.

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Chapter 1. Overall Introduction

1.1 Motivation

With the advent of the digital economy, many countries are migrating toward becoming cashless. Coupled with the world experiencing high penetration of mobile phone usage, sub-Saharan Africa was assessed to have over 60% of females and 70% of males among its adult population without bank accounts. This issue has deprived them access to any close, easy, fast, and quality financial services.

Although the problem of not accessing quality financial services is experienced all over Africa, most countries within the region have experienced a high penetration of mobile phone access and its services. The availability of financial service innovations has brought about the success of mobile money services. For example, M-PESA in Kenya is now viewed as a solution to bridge the large un-bankable population and still pending to solve the problem of financial inclusion. The provision of banking innovative services on mobile technology can provide a solution for financial access to a large number of people in developing countries.

The adoption of new innovative services like social media banking, unstructured supplementary service data (USSD), and the mobile banking application Interface are good examples of innovative efforts adopted by the banking industry. These achievements can be attributed to decisions based on IT governance, service innovation, and quality so that the delivery of

accessible financial services can reach most of the citizens.

One can learn from other countries that have invested in digital transformation to boost their emerging economies, and Nigeria is no exception. Looking into decisions that can lead to more service innovation in the commercial banking sector can provide customers with easier, affordable, qualitative, and accessible financial services through mobile technology.

1.2 Problem Statement

There are clear indications that having access to quality financial services is a determinant of wealth creation in a nation, and this will subsequently improve a nation's economic growth. The provision of accessible financial services can become an effective channel for reducing poverty in developing countries like Nigeria. Presently, there is a substantial percentage of Nigerian adults that have no bank accounts and also no access to any form of financial services (Efobi, Beecroft, & Osabuohien, 2014).

A World Bank selected key indication for the percentage of adults in 2017 shows that only 40% owned a transaction account in Nigeria (World Bank, 2019). This leaves a considerable amount of 60% without transaction bank accounts (Efobi et al., 2014). Even though government initiatives and banking policies have improved financial inclusion, there have been no promising results (CBN, 2018). This problem has left billions of Nigeria's Naira to circulate within the informal sector, negatively impacting Nigeria's

economic and developmental growth (CBN, 2013).

With 9.7% growth in the ICT sector in 2018, 84% mobile phone penetration, and a \$13 billion value of e-commerce in 2018, Nigeria's GDP has experienced a 55.8% service contribution growth (NCC, 2020). With the following gaps, this research will explore how banks can adopt service innovations that can help draw more Nigerians to open bank accounts using their mobile phones and conduct financial transactions over mobile banking.

Since these banks use IT for most of their service provisions, this research is employed to use IT governance mechanisms for better decision-making on service innovation adoption to show its impacts on firm performance (Lunardi, Becker, Maçada, & Dolci, 2014). This is followed by exploring how service innovation (based on exploitative and explorative) features impact service quality for current customers. This allows both banking regulators and banks to understand their innovation choices and how service quality should be assessed from a customer's perspective. Lastly, this research will seek to understand the success of the services the banks provide, transaction prices charged, and trust in how these service innovations are delivered. Success in delivering these can help to determine an increase in user accessibility as well as improve customer satisfaction that can draw in unbanked customers.

1.3 Research Objectives

1. To examine the effects of IT governance mechanisms on the dimensions of service innovation as mediating variables that can improve firm performance.
2. To determine how explorative–exploitative service innovations influence service quality performance (SERVPERFV) elements and how they can affect customer satisfaction.
3. To examine, evaluate, and make a predictive analysis of IS success qualities, price charge, and trust as impacting factors of user accessibility and customer satisfaction as a means of achieving an increase in financial inclusion.

1.4 Research Questions

1. How does the IT governance mechanism of banks influence their choice of service innovation adoption in consideration of improving their firm performance?
2. How can banks use service innovations to determine service quality to provide customer satisfaction?
3. What influence do IS success factors of service delivery innovation have on user accessibility and customer satisfaction?

1.5 Research Methodology

This research work was conducted based on evaluating three different proposed research models that are centered on service innovation of mobile banking systems within the Nigerian financial and banking industries. The study was carried out in three different circumstances. Individually, structural equation modeling (SEM) was used as our analysis methodology; also, mediation effect and artificial neural networks were used for deriving better results. In general, this study was carried out through the following seven steps:

1. Conduct a broad literature review to understand the current state of the predefined research area and discover the existing problems and the need gaps to be filled.
2. Design a research model to address the important existing problems based on Step One (1) above.
3. Assess and evaluate the variables with the use of measurable model analysis.
4. Check for the reliability, validity, and multicollinearity of the data collected.
5. Apply a structural model analysis to test our hypotheses.
6. Carry out a mediation assessment to understand the service innovation effect nature.

7. Combine structural equation modeling and artificial intelligence neural network (ANN) to generate a hybrid methodology for estimating prediction.

Structural Equation Modeling

Hair, Black, Babin, Anderson, & Tatham (2006) defined structural equation modeling as a visualized representation of numbered structural equations that entail relationships that are causal from suggested constructs. Their model has given researchers the ability to identify how a relationship between an observed and unobserved variable takes place. Another definition from Xiong, Skitmore, & Xia, (2015) stated that SEM is a multivariate statistical analysis that can be applied through its techniques to obtain results. Similarly, by developing a graphical user interface, the model has made the methodology easier and much more appealing for researchers' use.

The two main variables used for these observations are manifested and latent variables (Xiong et al., 2015). Latent variables are those regarded as hypothetical factors with the absence of a complete measurement to be described, while manifested (observed) variables are variables that a researcher collects and can be used for direct analysis, since it has a more defined narrative (Blunch, 2012).

Kline (2012) further explained that SEM can measure path analysis of unobserved variables based on their causality. This has given the model a unique way of assessing causality from a statistical standpoint. Schumacker and Lomax (2004) also suggested that SEM gives a researcher the ability to assess if the data collected can support the model and the hypotheses. When compared to previous statistical tools that conduct multivariate regression and factor analysis, SEM does both path analysis and factor analysis. This gives the methodology important advantages like evaluating and accommodating errors of a variable from the observed groups. Latent variables can be represented as ambiguous constructs and simultaneously estimate both latent and observed variables based on causal relationships (Xiong et al., 2015). Another feature of SEM is its ability to compare groups within a whole model, thereby giving results that are much better than the traditional ANOVA test. Also, SEM can be used to handle variables that are of a time interval nature.

Hoyle (2012) expressed how SEM stands to be different from multiple regression analysis (MRA) using ordinary least square (OLS). SEM uses both variance (partial least square) and covariance () for estimation and data observation. Multiple regression utilizes values of individual data to estimate the difference range between observed individual data and structures that were estimated to reduce the differences of all data that were observed. SEM is also suitable for measuring variables that are dependent and independent

(or predictors). Schumacker and Lomax (2004) stated that in SEM, simultaneous analysis of the connection between latent variables and outcome variables is implemented. Therefore, the conceptual model can include concurrent variables to explain more about the hypotheses used to analyze a hypothesized model.

Most of the features mentioned above demonstrate SEM as a modeling statistical technique with many characteristics that can give researchers the ability to work in more efficient and accommodating ways for advanced estimation and prediction. Therefore, SEM has emerged as an important statistical methodology that can provide researchers the ability to test basic assumptions to validate their model hypotheses and all the expected theories (especially if latent variables have been introduced in the analysis). Based on the fit indices of the research model, the outcome is expected to show that the assumptions made have abided by the results obtained.

1.6 Research Outline

This study is structured as follows:

Chapter 2 is a literature review of previous research. This is followed up with Chapter 3, which gives theoretical frameworks as the foundation for this research.

Chapter 4 investigates the direct impact of IT governance mechanisms on service innovation dimensions and its indirect effect on firm performance.

Chapter 5 focuses on service innovation adoption (from the perspective of exploitation and exploration) to determine its influence on service quality provision to investigate how customers are satisfied.

Chapter 6 works on examining IS success based on service delivery innovation of mobile banking services' influence on user accessibility and satisfaction.

Finally, Chapter 7 presents the overall conclusion of the study by summarizing all the results obtained through the study. It also highlights the contribution of this research and how it has added knowledge to the existing literature. This is followed by some practical implications and policy recommendations to help decision-makers work with empirical evidence. This closes with the limitations experienced during the study and suggestions on future research.

1.6.1 Research Design

Our research design will help in mapping out our scope and boundaries for investigating the important aspects of the study (see Figure 1 below). It can be regarded as a map plan of the entire research project. Cooper and Schindle (2001) stated that a research design will aid in obtaining answers that address the research questions. Previous literature has examined three different research designs, namely descriptive, exploratory, and causal or explanatory. Our study has taken a causal or explanatory direction since we are

investigating cause and effect relationships that are analyzing a specific situation.

The research was carried out in the following steps (see Figure 1 below for a graphical overview of the research design map):

1. Start with an extensive literature review.
2. Identify existing gaps in the literature.
3. Establish these gaps in an existing theoretical background and develop hypotheses.
4. Select measuring variables and develop survey questionnaires according to each research (i.e., Papers 1, 2, and 3).
5. Conduct sampling and pilot testing to evaluate the variables and the questionnaire.
6. Survey and collect data (target different respondents for the specific study).
7. Apply SMART PLS 3.2.9 for results and data analysis (to determine the descriptive analysis).
8. Conduct a reliability and validity test to confirm how reliably the research model is measured (measurement analysis).
9. Test the hypothesis to confirm the support or rejection of what was suggested (structural analysis, mediation effects, and hybrid model analysis).

10. Present the findings, discussion, contributions, implications, and conclusion.

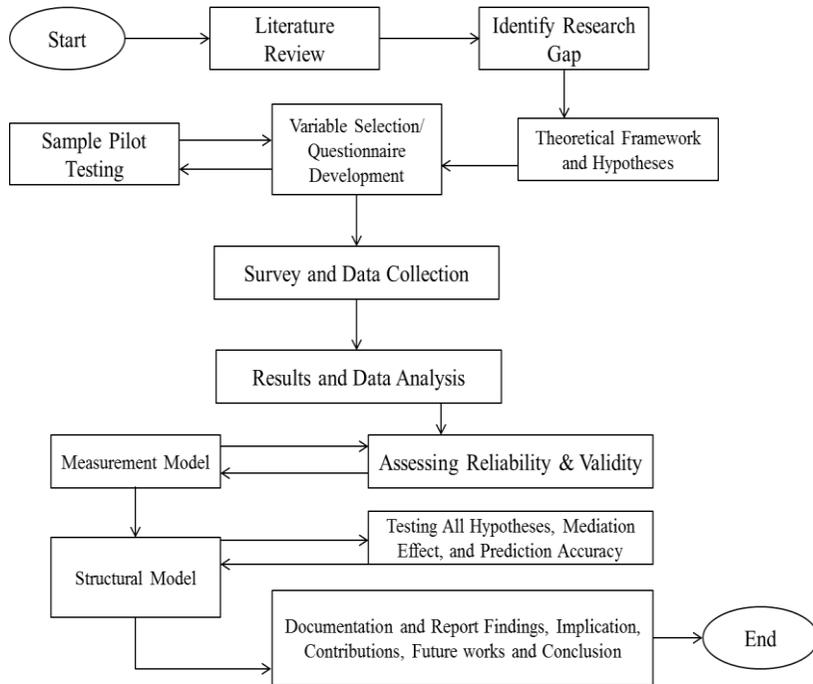


Figure 1 Research Design Map

1.6.2 Nigeria: Case Study

Nigeria was selected as the designated country for collecting data to analyze for this research. As a West African country, Nigeria is estimated to have a population of 200 million (Trading Economics, 2020c), making it the most populous Black nation and the seventh most populous nation in the world. The country has a Gross Domestic Product (GDP) of USD 410 billion with an annual growth rate of 2.55% (Trading Economics, 2020b). The penetration of the internet in Nigeria is estimated at 84.5% and the rate of mobile phone usage is estimated at 71% (Statista, 2020). Some of the reasons

for selecting Nigeria as our country of study are as follows:

1. More than half of the adult population in Nigeria are excluded from having access to financial and banking services.
2. The Nigerian banking sector is investing funds in IT infrastructure and standards that are mandated from the Central Bank, but among all these investments, digital financial services have failed to reduce the high rate of financial exclusion.
3. With quite an impressive rate of fast mobile phone penetration in the country, the Nigerian population is a big potential market yet to fully use mobile money services in boosting its economy.

Due to the lack of a nationwide cabling system, Nigerians are left to source internet services only through wireless mobile telecommunications. This indicates coverage of 39.3% of the country's population and a growth of 11.6% (Internet World Stats, 2020). According to the Nigerian Communications Commission (NCC), internet users in the country have reached 126,078,999, which is more than half the country's current population (Internet World Stats, 2020). In 2017, ITU has ranked Nigeria in the 143rd position in terms of ICT development, i.e. regionally ranked 15th in Africa. This shows that the number of mobile-cellular telephone subscribers per 100 inhabitants is 81.83 when compared to a very low rate of 0.08 fixed-telephone subscriptions per 100 inhabitants (ITU, 2017).

Nigeria can be regarded as a leading nation in terms of finances and banking and a population that engages in many e-payment transactions. Datasets from both the Central Bank of Nigeria and Nigeria Inter-Bank Settlement Systems (NIBSS) have shown that transaction and payments using electronic technology have tremendously increased; e.g., e-payments transactions have reached ATM N23.9 trillion, point of sale (POS) N3.1 trillion, web N5.62 trillion, and e-bill pay N1.1 trillion (Fadoju et al., 2018).

Chapter 2. Literature Review

2.1 Corporate Governance

The banking and financial sector has been experiencing challenges in sustaining and regulating the industry to avoid instances of falling into a financial crisis (de Haan & Vlahu, 2016). Nevertheless, the way banks are been governed has been identified as one of the major contributing factors to some financial crisis (Kirkpatrick, 2009). Accordingly, governments have taken the initiative of bringing in measures that can improve corporate governance of banks at the board of director's level (Walker, 2009). It is important to analyze, understand, and share knowledge of modern banking corporate governance especially with the recent changes of technological adoption, digital transformation, and new services innovations. These new features have introduced new ways that have changed how governance differs from the old years of the financial and banking industry (de Haan & Vlahu, 2016).

Jensen and Meckling, (1976) stated that considering the “principal-agent theory”, managers are entirely expected to protect the interest of the firm owners because they are privy to more information regarding the firm performance. Therefore, there is the necessity to have a certain system to which these managers are evaluated, monitored, and controlled for the benefit of the business from the investor's side.

In any financial and banking institutions, the Board of Directors

representing the shareholders have become the main instrument to govern the corporation and also ensure that the firm is operated in the interest of all shareholders (de Haan & Vlahu, 2016). The board of directors acts as an advisory board that guides the managers through setting up the key business and strategic mission of the firm. Adams & Mehran (2012) stated that with the board of directors as outside monitors, there will be effective monitoring of the firm's management since they are less beholden to management. They are also expected to contribute to reducing problems that the management is facing (Adams, 2010).

Besides having the board of directors, Dewatripont and Tirole, (1994) also contributed that "regulators" are important stakeholders that have a monitoring role specifically to protect depositors in banks and financial institutions. These regulators ensure that the government's laws and regulatory standards are followed mainly to achieve good governance. Some of the standards enforced by these regulatory bodies include Information Technology Governance (ITG) Standards.

2.2 IT Governance: Definitions

Weill & Ross (2004) became the pioneers to document IT governance as a book thereby defining it "as specifying the decision rights and accountability framework to encourage desirable behavior in using Information technology. IT governance is not about making specific IT decisions, management does that - but rather determines who systematically

makes and contributes to those decisions”. The IT Governance Institute (ITGI) defines IT governance as “a structure of relationships and processes to control the enterprise in order to achieve the enterprise’s goal by adding value while balancing risk versus return over IT and its processes” (ITGI, 2003). IT governance can also be viewed as an important part of enterprise governance that focuses on the type of leadership that is laid in an organization, thereby making it an essential concern for both the board of directors and the senior executive management (ITGI, 2003). This has guaranteed that organizations can make IT a sustainable and necessary part of its main objectives and strategies (Büntgen, Joshi, De Haes, & Van Grembergen, 2014).

Major contributions of literature from De Haes & Van Grembergen, (2009) and Mohamed (2012) stated that IT governance “is an integral part of corporate governance and addresses the definition and implementation of processes, structures and relational mechanisms in the organization that enable both business and IT people to execute their responsibilities in support of business/IT alignment and the creation of business value from IT-enabled investments”. This definition is also supported by the work of Héroux & Fortin (2016, 2018a, 2018b) where IT governance is defined as “governance is considered a subset of corporate governance”. Both Lunardi, Maçada, & Becker, (2014) and Pereira & Mira da Silva, (2012) also supported the definition of IT governance as a subset of corporate

governance, while Bradley et al. (2012) and Mohamed (2012) agreed that IT governance helps in risk management with regards to IT losses and helps focus on the value IT can deliver to the organizations.

Webb, Pollard, & Ridley, (2006) came up with another different view of how IT governance is defined i.e. “ITG reflects a movement away from IT managers or Chief Information Officers (CIOs) retaining control of, and responsibility for, IT to a position where the control of, and accountability for, IT related decisions rests at the highest levels of the organizations and encompasses business and technology considerations“.

Considering all the definitions above, this research work will contribute to the definition of IT governance “as a sub-set and integral part of corporate governance that helps in managing risk from technology related losses, which determines if a value is created”.

IT Governance

As a subset of corporate governance, Information technology has become an important platform that the entire financial and banking sector relies on for both its internal business management as well as service delivery to their customers (Lunardi, Becker, et al., 2014; Pereira & da Silva, 2012; Webb et al., 2006). IT standards are obligated and regulated within the banking industry. The adoption of IT governance (ITG) as part of the banking corporate governance has become a norm in management. Most banks now

days focus on a unique and specific way of adopting ITG, thus leading banks to structure its ITG mechanisms in such a way it ensures that both business visions and aligned strategies are interpreted into the IT investments (Borja, Kim, Yoon, & Hwang, 2018). Since the Board of Directors is delegated with the responsibility of corporate governance, IT governance as a subset of corporate governance it is specified to concentrate in making decisions to deliver IT services. Standards of IT governance guides the way IT frameworks will be followed to experience improved decision making, enforcement and evaluation processes across the entire organization (CBN, 2015).

Both the studies of Haes (2006) and De Haes & Van Grembergen, (2009) contributed to the literature of IT governance. Besides specifying that IT governance can be viewed a major part of corporate governance, their work showed that IT governance will be gaining grounds within both the professional and the academic world. Recently, there are a lot of academic contributions in the field of IT governance. Example of this contributions are the work of Héroux & Fortin, (2018a) showed how IT governance can be influential in executive management diversity.

New contributions like the work of Joshi, Bollen, Hassink, De Haes, & Van Grembergen, (2018) worked on the relationship between maturity of IT governance and disclosure of firms. A comprehensive literature review from Wilkin & Chenhall, (2010) produced a paper on IT governance that was

centered on taxonomy of accounting information system. This work extensively covered the domains of IT governance i.e. strategic alignment, risk management, resource management, with value delivery and performance measurements from the perspective of accounting information system and lastly suggested future research works that can be carried out in the field.

In terms of qualitative researches, Prettigun et al (2012) results showed that only 7 percent of articles did their research on empirical studies and 93 percent were all conceptual papers within the IT governance research domain. Furthermore, their results showed that most of these works were done in developing countries, indicating that regulatory bodies in these places are forcing firms to abide by the rules that enforce the adoption of IT governance.

With laws like the Sarbanes Oxley Act, IT became a critical success factor for succeeding in modern business. Attributing to its impact on controls this has safeguard corporate assets from misappropriation and corruption (Trites, 2004). Raghupathi, (2007) pointed out that these laws compel chief executive officers (CEOs) and chief financial officers (CFOs) to use IT to monitor information and also require the chief information officer (CIO of similar position) to provide information periodically and on an accurate bases. This has now created an environment where firms now use IT governance for monitoring and controlling compliance to laws and

regulations, furthermore any bridge on laws could render firms to serious consequences of bridging laws that concerns IT privacy and safety (Buckby & Best, 2007; Hardy, 2006).

Since IT governance has become an integral part of most organizations, Heroux and Fortin, (2016) suggested it has become a very important ingredient that can add to improve the chances of innovation. It also shows that IT capability and knowledge is required from the board of directors to the executive management level which is the needed to provide quality decisions that are strategically related to the organizations. Borja et. al., (2018) study shows that IT governance has effective influence on both product and process innovation.

2.3 Service Innovation

The growth and demand for more services within the last decade have constituted a large part of the provision of employment and also a good substantial output within the industrialized nations (Miles, 2009). Ryu and Lee, (2018) showed that service innovation creates “*changes in various dimensions related to the characteristics of service itself*”. Gadrey, Gallouj, & Weinstein, (1995) explained what it means to produce service a “*is to organize a solution to a problem (a treatment, an operation) which does not principally involve supplying a good. It is to place a bundle of capabilities and competencies (human, technological, organizational) at the disposal of a client and to organize a solution, which may be given to varying degrees of*

precision".

Coombs and Miles (2000) stated that there are three different perspectives of how service innovation can be studied i.e. assimilation, demarcation, and synthesis. The assimilation studies evaluated service innovation by using traditional researches (without any change of modification) that were meant for production innovation (Evangelista, 2000; Miozzo & Soete, 2001). According to their perception, the service is becoming more capital intensive and dependent on technology (Faïz Gallouj & Savona, 2009). The second part is the demarcation standpoint which views service innovation to have different characteristics when compared to product innovation (Coombs & Miles, 2000). The demarcation approach considers that studies in innovation are not specifically identifying services and the important contribution services make to production (Gadrey et al., 1995). This led to the contributions of Drejer (2004) and Hipp & Grupp (2005) who specified that the exceptionality of service that needs customer integration, organizational knowledge, and the non-technological aspects of the organization to produce outputs and process which are intangible for innovation to accommodate services.

The synthesis viewpoint is the third approach where some researchers are against both assimilation and demarcation approaches to service innovation (Coombs & Miles, 2000; Faïz Gallouj & Savona, 2009). Here, innovation is viewed as a combination of both services and manufacturing offering an

integrative outlook that is not controlled by the use of technology (Coombs & Miles, 2000). Finally, other neo-Schumpeterians like Toivonen & Tuominen (2009) have views that these service innovations can spring up economic development which is more viable than the earlier solutions.

A major work and contribution by den Hertog (2000) suggested that service innovation is sometimes limited to changes that occur base on features of the service product. As such, innovation is regularly matched with new designs features like product distribution, client interaction, control of quality, and assurances. These new designs have been observed to have differences, since product services are changed, therefore offering a new service might be different from the existing one that is presently been used. Then the channel of offering this new service will require a different approach to the existing one. This led to a proposal to analyze the different diversity of innovations in a much deeper structure resulting in the introduction of the “*four-dimensional model of service innovation*”.

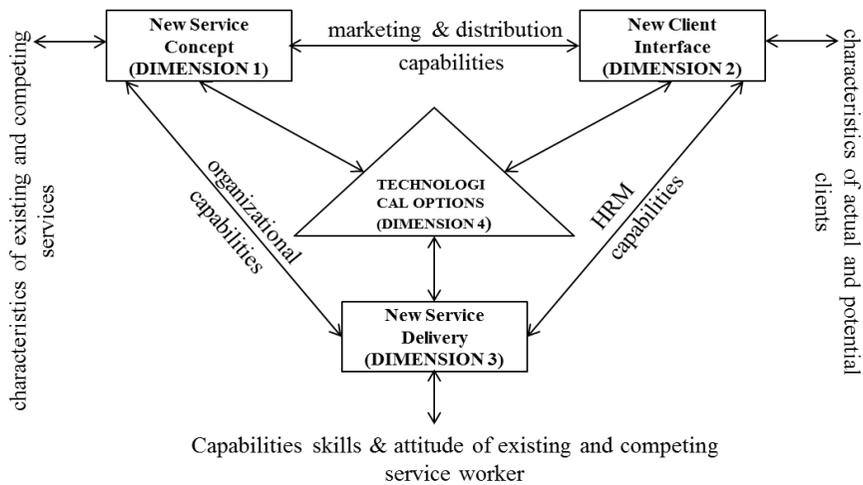


Figure 2 A four-dimensional model of service innovation (den Hertog, 2000)

The model consists of four (4) dimensions that covered different aspects of service innovations. These dimensions are new service concept, new client interface, new Service delivery, and new technology. Even though the model is conceptual it is has been found to cover all aspects of service innovation especially meeting the practical development of services that are new. This should covers policies that guide them towards policy makers and entrepreneurs that is needed to deliver these services (Den Hertog & Bilderbeek, 1999).

With increase development of service innovations literature, den Hertog, van der Aa, & de Jong, (2010) expanded the above four dimension model to a more elaborative conceptual framework that manages service innovation through a dynamic six service innovation capabilities that can be applied in

realizing new service solutions and experiences. These six dynamic capabilities added two (2) more concepts (i.e. new business partner and new revenue model) that can be used to define, assess, and categorize service innovation.

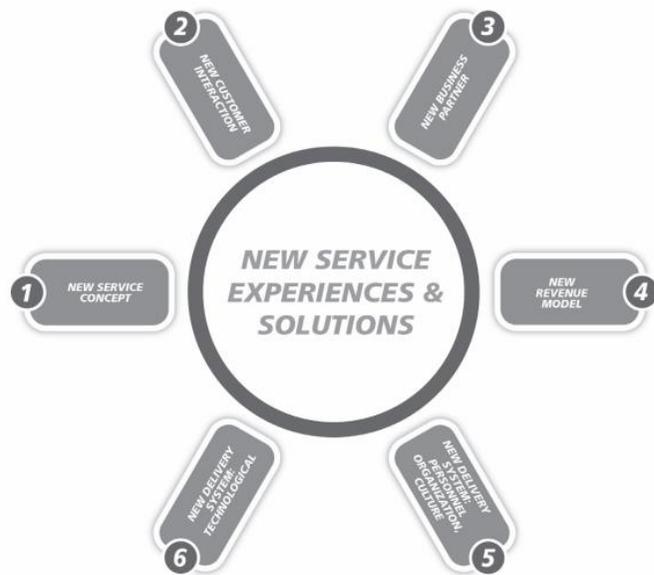


Figure 3 Six dimensions of service innovation (den Hertog et al., 2010)

Taghizadeh, Jayaraman, & Rahman, (2017) defined service innovation as an important aspect of growth that can withstand competition in the midst of shareholders. Now that the service industry is able to achieve high level performance improvement due to application of innovations, then service innovation has become a focus rather than the formal concentration on goods and products (Faiz Gallouj & Savona, 2009). Therefore now innovation strategies are putting emphasis on assigning a clear innovation strategy that

is fully deployed and communicated successfully on services within the organization. This has resulted in devising service innovation processes for deciding, applying and capturing new ideas that will give organizations that competitive advantage (Taghizadeh et al., 2017).

2.4 Mobile Banking in Nigeria

Commercial banks in Nigeria constitute an important element of the financial sector. As they innovate and render banking and financial services like savings, payment applications, and credit facilities which is reaching only a few percentages of the country's population (Efobi et al., 2014). In terms of access to physical cash payment services, Nigeria has been found to be left behind when compared to other African countries like South Africa and Kenya where there is 46 percent of the population uses mobile payment services (Efobi et al., 2014).

The Central Bank of Nigeria (2013) emphasized that Nigeria still requires an extensive outreach of financial and banking services since a considerable number of the adult population is still excluded from accessing these services. As the CBN has taken initiatives to reduce financial exclusion, a payment system that can foster cashless policy are encouraged to use mobile technology to innovate for the provision of these services (Efobi et al., 2014).

The reason for turning on to these mobile technology services, it is

related to the potential to reaching a large number of customers and provides them accessibility at a reduced cost. Baabdullah et al., (2019) stated that mobile banking services are a capable technology that brings significant value to both customers and banks. Tam and Oliveira, (2017) suggested that mobile banking has exceptional qualities from its system and information to services when compared to previous e-banking services. Aboelimged & Gebba, (2013) also supported that mobile banking services have totally changed how users relate to the cyber world and conduct their businesses any place and at any time. With these potentials, the ability to provide connects Nigerians that were excluded from financial and banking access is a possible reality.

Bankole, Bankole & Brown (2011) investigate some of the factors that influence the acceptance of using mobile banking services in Nigeria. Their work suggested that acceptance of a universal pattern of adoption does not work due to cultural differences in different places. Straub, Keil, & Brenner, (1997) also agreed with this point by stating that differences in culture of people tend to have an effect on their behavior and as such affect the adoption and use of technology. Harris et al., (2005) further emphasized on the difference of factors like infrastructures, services offered, marketing strategy, and consumer behavior as an impact on the adoption of the technology. Bankole and Bankole (2017) supported all the views of the researchers above by stating that in Nigeria, ICT innovation for mobile

phone services experiences all these implicating factors.

With the acceptance and use of mobile banking technologies in Nigeria, it is also important to realize that there is a need for these banks to engage in service innovations for improved performance. Lashitew, van Tulder, & Liasse, (2019) highlighted that when adjustments are made to support innovations, the competition will also foster. Previous studies like that of Demircuc-Kunt & Klapper, (2013) stated that there were unsuccessful mobile money innovations in developing countries because each country reveals a different form of adoption of these services. Also, the lack of proper research efforts to investigate these differences has hindered the development of service innovations on their mobile banking services. Fadoju et al., (2018) and David-West, Iheanachor, & Umukoro, (2019a) researches supported this view by revealing that countries with a huge population and a large amount of consumers like Nigeria have been experiencing the lowest acceptance and use of mobile money services even though it has a large number of operators in its market.

Demircuc-Kunt, Klapper, Singer, & Van Oudheusden, (2015) and Choudrie et al., (2018) added that the lack of acceptance and use of the mobile money services have been due to factors like the location of a citizen (i.e. urban or rural settlement) where a majority of the rural settlers were observed to be of low literacy with no jobs that is resulting in their low income. Their recommendations state that financial and banking service

providers must change ways of serving customers since the traditional physical banking system has failed to capture and provide financial and banking services (David-West, Iheanachor, & Umukoro, 2019b).

Chapter 3. Theoretical Framework

In previous years, emphases on innovative researches were predominantly concerned with technological related innovations i.e. products (Drejer, 2004; Evangelista, 2000; Miles, 2000) neglecting innovations that were immaterial. For the development of new innovative services, little scientific knowledge has been developed regarding innovation process (Drejer, 2004; Nijssen, Hillebrand, Vermeulen, & Kemp, 2006). This has resulted in few literatures addressing the development of new services from both researchers that agreed on Schumpeterian and Non Schumpeterian theory.

With innovation becoming increasingly important and needed within the service industry, one sector that is constantly experiencing innovative digital transformation is the financial and banking sector. As services are recognize as private or public, the private ones are considered to have a lot competitive pressure since it deals with service trade, liberalization and deregulations that can allow new competition to grow (Miles, 2000). In order to achieve a competitive edge, service providers must ensure that service quality performances are not declining (Cronin & Taylor, 1994). Consequently, in providing solutions, it is important for innovation in services to become inclusive of new ideas and IT services (Miles, 2009).

Looking at the classic view of services, two distinct periods of service

emergence were recognized i.e. De-industrialization period where innovation was based on manufacturing for economic growth. During this period, services were left behind and technological innovations were geared towards productivity growth. While the recent Post-industrialization period, shows increase demand in services for economic growth. In this period, organizational service innovations are adopted to expand services that are taking and ending the dominance of the manufacturing and automation sector in economic growth contribution (Miles, 2009).

Pavitt (1984) elaborated that there are different service firm patterns e.g. supplier dominated, science based, scaled intensive, special equipment producers and each has a different sectoral pattern of innovation. Miozzo & Soete (2001) suggested that the patterns of their different innovation should be rethought to change the traditional service sector. Castellaci (2008) contributed that services should be viewed past the provider domination. Archibugi (2001) studies showed that the influence of new IT has resulted in changing services and thus growing the service sector. This has raised questions that services should now be considered and treated as a separate sector.

Coombs and Miles (2000) submitted three different schools of thoughts in segmenting operating service innovation research, while other researchers like Drejer (2004) and DeVriess (2006) came up with four segmentation i.e. technologist, assimilation, demarcation and synthesis. From the technologist

approach, Barras's reverse product cycle of can be viewed as the beginning of service innovation research (Barras, 1986, 1990). Linton and Walsh, (2008) and Barras (1990) proposed a change of pattern in the service life cycle where starting with process innovations leads to development of an entirely new service. Barras shared that service innovation that are related to technological capabilities usually gains and progress from IT in general, (Gallouj & Weinstein, 1997). Other researchers like Gallouj (2002) , Pavitt (1984) or Miozzo and Soete (2001) suggested that service innovations can be non-technological e.g. an insurance policy.

The assimilation approach proposed theories and concepts that have background in the manufacturing industry and can be transferred simply into innovation in services (Coombs & Miles, 2000; De Vries, 2006; Drejer, 2004; Miles, 2000; Nijssen et al., 2006). Hughes and Wood (2000), suggested that there is only a small difference between the manufacturing and the service sector. Gounaris & Akamavi (2005) countered this point by stating that these studies developed their analytical frameworks from the manufacturing sector to analyze innovation in services and consideration to distinct features of services.

A demarcation approach establishes a different research segment where scholars focused on the distinctive types of service, hence making it difficult for knowledge to be transferred from the manufacturing to service industry. In this approach, there are boundaries to the differences between

manufacturing and services and different models for both were developed (Gallouj & Weinstein, 1997). Researchers like Gadrey, Gallouj, & Weinstein (1995), Den Hertog (2000) or Djellal and Gallouj (2001) developed service innovation models that concentrated only on demarcation orientation which discloses the distinctive features of services innovation activities. The fourth synthesis approach, determined to combine the manufacturing and innovation in service (Coombs & Miles, 2000; Gallouj & Weinstein, 1997). The synthesis approach offers an integrative method to study innovation of both product and service sectors (Gallouj & Weinstein, 1997).

In line with our study, the guide to use service innovation in increasing financial inclusion was derived from demarcation approach mentioned above. With Djellal and Gallouj (2001) proposing an independent concept of service innovation, its dimensional features can be assessed using improved regression methods that perform better than classical linear regression. DeVriess, (2006) supported this application and added that results of these studies have been cited to show typical effects of the demarcation studies. Therefore, by adopting the demarcation stream of Den Hertog's and Gallouj and Weinstein, service innovations was taken into consideration for better understanding what dimensions and types of service innovation is affected by IT governance mechanisms, service quality performance and Information system success model when there is need to increase user accessibility in the mobile banking sector.

Theory of innovation in services developed by Gallouj and Weinstein (1997) became one of the early contributors in service innovation literature. This theory presented six categories (i.e. radical, incremental, improvement, combinatory, formalisation, and ad hoc innovations) of service innovations to happen in specific or entirely in parts of services.

For this research only two categories i.e. radical and incremental innovations were drawn and used. Another approach that suited our studies is the Den Hertog's four-dimensional (new service concept, new client interface, new service delivery system, and new technology) service innovation were all four dimension were examined. Followed up with an update of six-dimensional model that added two new business partner and revenue model as categories and new service delivery was segmented into technology and personal, organization and culture.

Some research gaps that existed from Den Hertogs (2000) perspective includes how organizations are suppose to arrange their internally oriented service innovations to achieve better performance, thus our application of IT governance mechanims was introduced as a measure. Gallouj and Weinstein (1997) highlighted some existing research gaps in the field of service innovation refering to lack of researches on technology innovation from the service providers side. The third research gap was derived from the existing gaps of success factors of service innovation. Baron et al (2009) explained that there are different views when it come reviewing existing drivers for

developing successful new services. Some researchers viewed different success factors for different service innovation dimensions, while others want to examine the degree of newness. Our study also examined an existing driver of service innovation (i.e. new service delivery-technology in particular) and the IS success model was employed for assessing accessibility and satisfaction.

Finally, conducting this research within the banking industry can be reasonable as most research studies in the field of product and process innovation were broadly conducted, but service innovation researches are few. For example, the study of Damanpour and Gopalakrishnan (2001) worked only product and process innovation in the banking industry and thus leaving a gap of service innovation. Also studies of Gopalakrishnan, Bierly, & Kessler (1999), Gopalakrishnan (2000) and Gopalakrishnan & Bierly (2001) all focused only on product and process innovation in the banking industry and also neglecting investigating service innovation. Therefore, in terms of research opportunities within service innovation literature and with possibilities of progress among reviews that were covered besides those that focused on innovations offering services, we can state the findings of our gaps are relatively void.

Chapter 4. IT Governance Mechanisms: Impact on Service Innovation as a Mediator and Improving Factor for Firm Performance in the Banking Sector

4.1 Introduction

The evolvement of IT Governance as another determinant factor for achieving business and organizational performance is continuously growing across all industries. Most companies have shown increase interest in adopting IT governance, their continuous usage of the process has brought in more attention to the need of how to manage improve on it Lunardi, et al., (2014). With IT governance coming as a subsection of Cooperate governance, this governance process is not only focusing on IT technical operations, but also in strategically driving IT management, controls and services (Hardy, 2006; Ryan R. Peterson, 2004). To realize better performance that can help in succeeding for competitive advantage, IT governance guides on its best practices, standards and processes to ensure an effective IT function that aligns to the organizations business objectives (ITGI, 2006, 2003; Verhoef, 2007). The mechanisms of IT governance facilitates IT decision makers for making policies and regulations that can be implemented with specifications to different applications, likewise monitor

and control how the procedures are applied (Weill & Broadbent, 1998) .

Most researches have shown that organizations that take the decision to adopt and implement good IT governance models have experience more profits on their IT investments when you compare them to their counterparts (Weill & Ross, 2004). In terms of IT governance mechanisms, these decisions have stretched out into structures that consist of committees, processes that looks into IT measurements, budget control and the type of framework required to adopt (G. & De Haes, 2009; Van Grembergen, 2006). While the relational mechanism maintains how these decision makers and the management communicate to achieve strategic development in view of the organization's mission and objectives (Weil and Ross, 2004).

Due to this perspective, within the past few years, a lot of organizations have been reporting success stories of adopting IT governance in the practicing industry. However, there are still gaps of inadequate scientific studies that confirms these success stories within the banking and financial industry (Lunardi, Becker, et al., 2014). Grant, Brown, Uruthirapathy, & Mcknight (2007); Sambamurthy and Zmud (1999); Weil & Ross (2004) have all conducted studies on the IT governance and proposed different types of IT governance. But all of them have recognized structure, process and relational mechanisms as the mechanisms of IT governances (S. De Haes, Huygh, Joshi, & Van Grembergen, 2016). Upon all these works conducted, it is not clear how implementing IT governance mechanisms types will affect

firm performance (Liang, Chiu, Wu, & Straub, 2011). Other works have tried exploring the effect of IT governance on performance. There are some gaps with regards to the particular aspect of IT governance and also these studies have not come to a conclusion if the governance mechanisms leads direct or indirect effect on performance (Lazic, Groth, Schillinger, & Heinzl, 2011; Liang et al., 2011).

Our work here is motivated by the need to more study on how in particular IT governance mechanisms impact firm performance. The implementation of IT governance is geared towards making sure that IT is managed well enough to achieving more profit and improved performance Lunardi, et al., (2014). Conversely, de Reuver & Bouwman, (2012) suggested that governance mechanisms are important to service innovations, showing that these mechanisms are important to achieving innovations. Ryu and Lee, (2018) highlighted the importance of technology in service innovation and how it impacts firm performance, but did not pay any attention to how the organization builds its IT governance to achieve this performance. This work was motivated by the evident need for more investigation into the impact of IT governance mechanisms on service innovation based on how organizations invest funds, resources and human efforts to develop their services, infrastructure, staff training and development for better performance.

Nigeria, with one of the biggest population in the world has taken the

stage in the world as the largest economy in Africa i.e. securing an economic growth of 2.28 percent year-on-year in the third quarter of 2019. When compared to the 2.12 percent growth of the third quarter of 2018, it can be viewed that the country has improved from previous year (Trading Economics, 2020a). Services have continued to realize increase, as GDP from services increased to 6517238.97 NGN Millions in the second quarter of 2019. This has indicated that services in continuously becoming a major GDP contributor (Trading Economics, 2020b). Some of these services are provided by the banking and financial industry, and according the county's central bank, the banking industry improved by 16 percent in the 2019 (CBN, 2019).

With the objective of exploring the effects of IT governance mechanisms on firm performance as an indirect effect, we first investigate how banks in Nigeria adopt IT governance mechanism to match the dynamics changes in mobile banking service innovations. Then we also look at how den Hertog et al., (2010) service innovation dimensions help organizations to realize their better performance within their domains.

This research was carried out among Nigeria's commercial banks listed on the Security Exchange Commission (SEC) stock market and also licensed and regulated by the Central Bank of Nigeria (CBN). In the context, implementation of IT governance mechanisms among these banks refers adopting and using any of the renowned IT governance frameworks e.g.

COBIT, ITIL, TOGAF and PMP. While the adoption of service innovation in stipulates the adopting of the four dimension of Pim den Hertog's model i.e. New Service Concept, New Customer Interface, New Service Delivery and New Technology. Firm Performance focuses on Kaplan and Norton (1996) i.e. mostly based on employee and customer satisfaction and also coupled with innovation at the organization level. Now that performance measurement to strategy can generate feedbacks to its organization as an essential determinant factor to use for effective running of the organization, Therefore, with this research, we intend to contribute to the current literature by analyzing the direct effect of IT governance mechanisms on service innovation and how both the events will lead to improve firm performance.

4.1.1 Research Objective

This study aims to investigate the casual and mediating relationship of IT Governance Mechanisms to service innovation dimensions to firm performance. The results from this research will guide banks in organizing its IT governance structures, processes and relational mechanisms. Also by understanding which of the service innovation dimensions is deemed more significant in relation to IT governance mechanisms, banks can give more priorities to adopting that particular innovation. The second objective of this study is to examine what role service innovation dimensions exert on the relationship between IT governance mechanisms and firm performance.

With results from this study, banking authorities will have empirical

evidence on how to channel the right resources, investment, and expertise on service innovation to achieve performance and competitive advantage.

4.1.2 Research Questions

1. What significant impact does IT governance mechanisms have on the choice of service innovation adoption?
2. What influence does service innovation dimensions have as impacting factors of firm performance?
3. What mediating role do service innovation dimensions exert on the relationship between IT governance mechanisms and firm performance?

4.2 Literature Review

4.2.1 IT Governance Mechanism

Weil and Ross (2005) viewed IT governance mechanism as the system of designing and implementing coordinated governance that is based on decision types taken; how archetypes are mapped out, so that managers of an organization can effectively use IT to achieve better and improved performance. Ali and Green (2005) showed that some variables of IT governance mechanism have proven to have positive significant influence on firm effectiveness. Van Grembergen and De Haes (2009) elaborated more that for an organization to achieve effective IT governance, their Enterprise governance must define their structures, processes and relational mechanisms. This will support the alignment of IT to business for value creation from a

perspective of IT enabled business investment. A review by Almeida & Pereira, (2013) stated that in recent years, IT is available in all organizations and those that run governance effectively are those that have adopted IT governance mechanism. However, Ali & Green (2005), highlighted some gaps where previous studies have not investigated the common understanding concerning how these mechanisms are expected to deliver effective IT governance. Sohal and Fitzpatrick, (2002) also emphasized that these studies did not give consideration to the variations and characteristics of firms and industries that can result in how effective their IT governance emerge.

Therefore, understanding the variables of IT governance mechanism that determines how effective IT governance is to an organization is essential to the success of its IT investments and utilization (part of our investigation). Also the differences in the features of the industries and firms might require different combination of the IT governance mechanism variables thereby showing that IT intensity can be regarded as an essential factor for effective IT governance (Ali & Green, 2005). As pioneers who started exploring IT governance academically, Weil and Ross (2005) explain that enterprises categorize the design of IT governance mechanisms into three main sectors i.e. structures, processes and relational mechanisms:-

4.2.1.1 Structure

According to De Haes & Van Grembergen, (2006) structures of IT governance mechanism comprises of the different IT committees to define

their roles and responsibilities for better performance achievement. The term structure was defined to include units of organizations that prescribe roles and responsibilities for taking decisions with regards to functions of IT management and business alignment (S. De Haes & Van Grembergen, 2009). Webb et al., (2006) and Weill & Ross, (2005) also provided a similar definition by expressing structures of IT governance mechanism to have the tasks of outlining the roles and responsibilities of IT committees. Bianchi and Sousa (2016) definition was more closer to that of Van Grembergen, and De Haes, (2009) stating that according to the intended archetypes of the organization, roles and responsibilities of decision making from the organizational committees are the most noticeable in IT governance mechanisms. Some of the prominent variables of the structure are IT strategy and IT steering committee which are most stated (G. & De Haes, 2009; Webb et al., 2006; Weill & Ross, 2005).

IT steering committees are structures that put together decision makers that are representatives from the board of directors, executive and senior management (S. De Haes & Van Grembergen, 2008). De Haes and Grembergen, (2006) additionally clarified the different functions of the two (2) committees. The IT steering committees manages to oversee IT projects, resource allocation, costs and priorities etc. While the work of IT strategy is to ensure the participation of the board of directors in IT decision matters.

4.2.1.2 Process

De Haes & Grembergen, (2009) explained IT governance process as a practice making decision that is taken strategically through performance, monitoring, and assessing processes, frameworks and tools. Examples of these frameworks are “*Control Objectives for Information and related Technology (COBIT), Information Technology Infrastructure Library (ITIL), and ISO/IEC 27002*” etc.

Levstek, Hoveija and Pucnihar (2018) also defined process in IT governance mechanism as the planning of formal decision making linked with designing the methods of monitoring the ways to which these decisions are implemented and executed in accordance to rules of IT operations. The monitoring of these decisions also provides ideas on how organizations can design proposal in terms of investment, evaluation process, chargeback metrics, architecture exception process and negotiating for service level agreements.

Weil and Ross (2005) identified IT governance processes into different categories based on their monitoring procedures. Alignment processes are used by the management as a method for obtaining general and effective participation in governance decisions. For example, processes in IT investment proposal are used to define steps that are important for reviews and ranking of IT projects. This will also allow project decision makers to determining project funding.

4.2.1.3 Relational Mechanisms

De Haes and Grembergen (2009) explained relational mechanism as an open channel for keeping collaborative relationship between the corporate executives and management (i.e. both business and IT). This process includes communication channels, support, announcements, educational, and training efforts. Most studies on IT governance mechanisms have considered relational mechanisms as an important and paramount factor in achieving IT governance because it helps in supporting and managing business and IT alignment (as long as structures and processes are already implemented properly).

Levstek, Hoveija and Pucnihar (2018) described rational mechanism as a combination of communication practices to circulate policies and principles of IT governance, announcements, open communication channels, and encouragement. This fact was supported by Van Grembergen, De Haes, & Guldentops (2004); De Haes et al. (2013) and Weill & Ross, (2004) where they also added that there are always challenges in firms when it comes to choosing the right communication mechanisms that will lead to achievement of better results.

Yaokumah (2018) suggested that it is important for an organization to align its IT with its core business. This can be achieved through employing the right relational mechanisms that is focusing on effective communication that can help attain strategic dialogue and knowledge sharing with the

organization. Weil and Ross (2005) have also stated that lack of a proper formal communication channels can be viewed as a huge obstacle that can result into difficulties and challenges of implementing IT governance.

4.2.2 Service Innovation Dimensions

Most innovations are considered to as an altered copy of an existing one services and also a combination of some major and minor features of the old existing service. To understand how diverse service innovation resulted, Pim den Hertog (2000) suggested a 4-Dimensional model and later an updated this theoretical framework to a 6 dimensional models for mapping and analysis during adoption. Even though, this suggestion is a theory, it has been proved to have solid empirical evidences to map out service innovation in terms of developing new services and also giving service entrepreneurs a guide template.

Den Hertog et al., (2010) defined “*service innovation is a new service experience or service solution that consists of one or several of the following dimensions: new service concept, new customer interaction, new value system/business partners, new revenue model, new organizational or technological service delivery system*”. Consequently, an organization can be considered to adopt new service as long it picks one of the above dimensions or in multi-dimensional combination as long as value is created to the customers. Most organizations combine these service provisions so that they work together as co-created by both the client and the service provider.

Examples of these dimensions are:-

4.2.2.1 New Service Concept

Frei (2008) defined this concept as new service offering. The idea of this concept is to create value by the service provider in conjunction with their customers. This is usually a new idea or concept of how to offer a solution to a particular problem for the customer. In some instances, there is a combination of many service concepts i.e. to combine features of services that exists individually to become a new service idea (Frei, 2008; Sasser, Schlesinger, & Heskett, 1997) .

4.2.2.2 New Customer Interaction

In this dimension, customers are considered as the main focus. Since, customers contribute a lot to the creation of value, the relationship between customers and service providers is an important issue and this can be regarded as a source of innovation. Other literatures have identified new customer interface as new client interface (Gallouj & Weinstein, 1997; Zeithaml, Bitner, & Gremler, 2003). Most of the innovations that evolved through new customer interface can be viewed as providing solutions for self-services (Kim & Altman, 2020).

4.2.2.3 New Service Delivery System: Personnel, Organization, Culture

Innovation in new service delivery is the attention particularly given to personnel, organization and culture. Heskett (1986) described the idea of

service delivery where an organization is expected to put in structures for servicing the company. This entails putting in the right management, human resources, trainings and expertise so that service providing staffs can perform their jobs appropriately and also in innovative services that can improve performance. This dimension pays more attention to innovations that arise due to human resource and organizational side of the firm. Some examples include organizing trainings, exchange programs and empowering staffs to improve and excel in performing their duties (Norman, 2002). Edvardsson and Enquist (2009) also suggested that transforming ways to motivate employees to guide customers to solve some problems or to institute a good firm culture of how to give services and approach clients. This can be considered as new service delivery innovation since it differentiates how staffs from different companies deliver their services.

4.2.2.4 New Service Delivery System: Technological

The use of technology in provision of services has completely revolutionized how services are adapted in businesses. This dimension observes that ICT is the major (but not predominately) a technological contributor to recent service innovations. Examples of these innovations have transverse to almost every sector thereby creating services such as e-government, e-health, e-banking services. Customizing services to particular individual, self-services, and virtual platforms for executing projects and job considering members in different locations and time zones etc are new

technology delivery services (Segers, den Hertog, & Bouwman, 2007).

4.2.3 Firm Performance

In this research, the consideration to measure firm performance was derived from the perspective of Kaplan and Norton (1992) were they suggested that for a firm to achieve better performance, there is a need to concentrate on both its financial and operational measures of the organization. As previous studies have focused more on the financial performance and this has led to many challenges as gaps. For this reason, decision makers and managers have realized that relying on only financial measures does not address other challenges facing businesses (Enofe, Ekpulu, & Ajala, 2015). In recent years, the involvement of innovative technologies into business activities has contributed to another dimension of measure that needs to be address. Le Bas, Mothe & Nguyen-Thi (2015) stated that there is the need for firms to develop their innovation strategies not only within the technological sector but also how it addresses their business outlook. Through this, firms will be able to combine innovative strategies and how these technologies affect their improvement in firm performance.

4.3 Proposed Research Model and Hypotheses

This study aims to conduct and explanatory study of the causal relationship between IT governance mechanisms, service innovation dimensions and firm performance. The results from this research will guide

banks in organizing its IT governance structures, processes and relational mechanisms, to prioritize which of the service innovation dimensions should be given more consideration when it comes to adoption. Also, a test for mediation was applied to provide explanation concerning the relevance of service innovation adoption and the influence IT governance mechanisms exerts on firm performance.

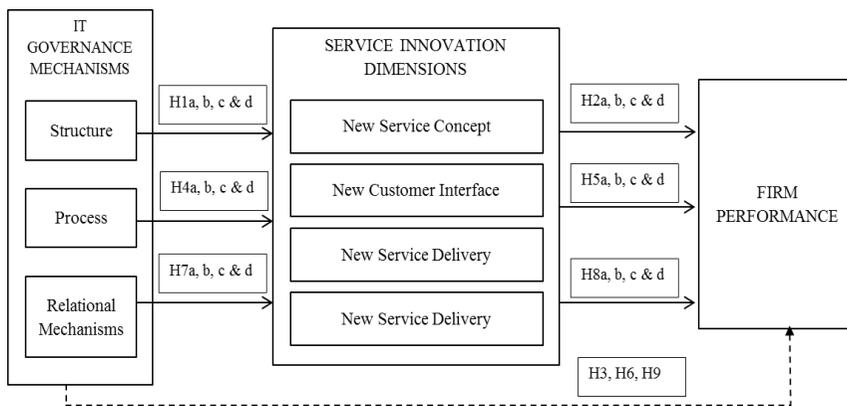


Figure 4 Research Model

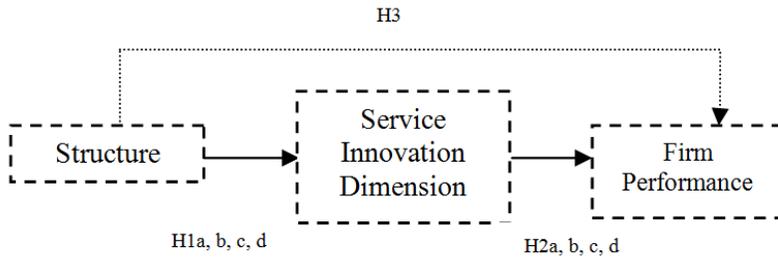
From the above conceptual model, three different models 1, 2 and 3 were developed based on the Structure, Process and Relational Mechanisms. The essentiality of breaking the above general model into three subsectors is to closely and independently look into each mechanism for a more elaborated understanding. Base on this subdivision the following nine hypotheses were developed:

Hypotheses: *Developed based on existing literature adapted from Lunardi et al., (2014),*

Héroux & Fortin (2018b) and Ryu & Lee, (2018). Refer to Table 2 for more details on the adapted variables.

Model 1:

1. **Model 1: H1-2:** *IT Governance Mechanism Structures* have significant influence on *New Service Concept, Customer Interface, Delivery Service and Technology and Firm Performance*.
2. **H3:** *IT Governance Mechanism Structures* has an indirect significant influence on *Firm Performance*.



1st Stage:

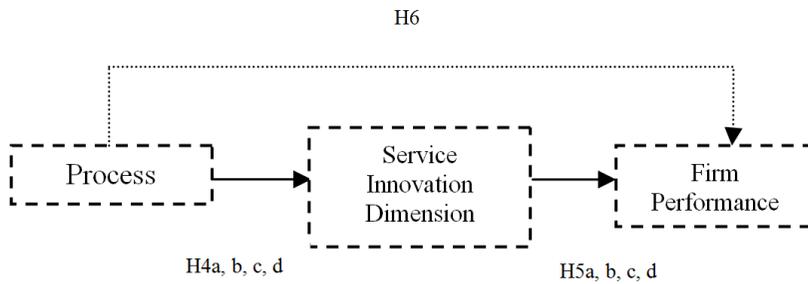
$$\begin{aligned}
 NSC &= \alpha_0 + \alpha_1 STX + \varepsilon_{NSC} \\
 NCI &= \alpha_0 + \alpha_1 STX + \varepsilon_{NCI} \\
 NSD &= \alpha_0 + \alpha_1 STX + \varepsilon_{NSD} \\
 NT &= \alpha_0 + \alpha_1 STX + \varepsilon_{NT}
 \end{aligned}
 \tag{Eq. (1a)}$$

2nd Stage:

$$FP_{STX} = \beta_0 + \beta_1 NSC_{STX} + \beta_2 NCI_{STX} + \beta_3 NSD_{STX} + \beta_4 NT_{STX} + \vartheta_{STX} \quad \text{Eq. (1b)}$$

Model 2:

3. **Model 2: H4-5:** *IT Governance Mechanism Processes have significant influence on New Service Concept, Customer Interface, Delivery Service and Technology.*
4. **H6:** *IT Governance Mechanism Process has an indirect significant influence on Firm Performance.*



1st Stage:

$$\begin{aligned}
 NSC &= \alpha_0 + \alpha_1 PRS + \varepsilon_{NSC} \\
 NCI &= \alpha_0 + \alpha_1 PRS + \varepsilon_{NCI} \\
 NSD &= \alpha_0 + \alpha_1 PRS + \varepsilon_{NSD} \\
 NT &= \alpha_0 + \alpha_1 PRS + \varepsilon_{NT}
 \end{aligned}
 \quad \text{Eq. (2a)}$$

2nd Stage:

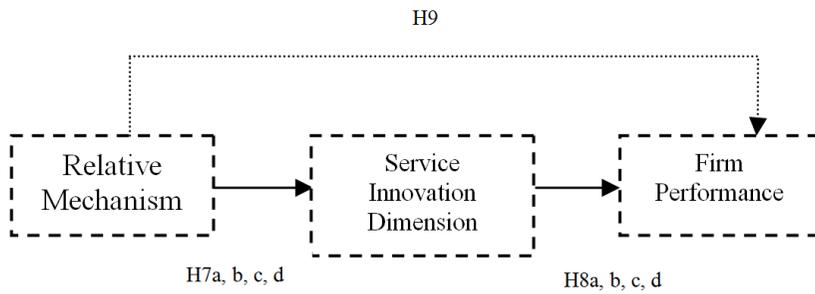
$$FP_{PRS} = \beta_0 + \beta_1 NSC_{PRS} + \beta_2 NCI_{PRS} + \beta_3 NSD_{PRS} + \beta_4 NT_{PRS} + \vartheta_{PRS} \quad \text{Eq. (2b)}$$

Model 3:

5. Model 3: H7-8: IT Governance Mechanism Relational

Mechanisms have significant influence on New Service Concept, Staff Interface, Delivery Service and Technology.

6. H9: IT Governance Mechanism Relational Mechanisms has an indirect significant influence on Firm Performance.



1st Stage:

$$\begin{aligned}
 NSC &= \alpha_0 + \alpha_1 RM + \varepsilon_{NSC} \\
 NCI &= \alpha_0 + \alpha_1 RM + \varepsilon_{NCI} \\
 NSD &= \alpha_0 + \alpha_1 RM + \varepsilon_{NSD} \\
 NT &= \alpha_0 + \alpha_1 RM + \varepsilon_{NT}
 \end{aligned} \quad \text{Eq. (3a)}$$

2nd Stage:

$$FP_{RM} = \beta_0 + \beta_1 NSC_{RM} + \beta_2 NCI_{RM} + \beta_3 NSD_{RM} + \beta_4 NT_{RM} + \vartheta_{RM} \quad \text{Eq. (3b)}$$

Figure 5 Research Model Subdivisions (1, 2 and 3) and Equations

The relationship between our proposed research model and research questions can be linked through the following groupings of our developed hypotheses (see Table 1 below).

Table 1. Hypotheses and Research Questions link (Chapter 4)

Relationship	Research Question 1	Research Question 2	Research Question 3
Hypotheses	H1a, b, c & d H4a, b, c & d H7a, b, c & d	H2a, b, c & d H5a, b, c & d H8a, b, c & d	H3, H6 and H9

Table 1 above explains the relationship between our research questions and our hypotheses. Hypotheses H1, 4 and 7a, b, c & d is supposed to address Research Question 1 which is explaining the relationship of IT governance mechanisms (i.e. structure, process and relational mechanism) to service innovation dimension adoption. Hypotheses H2, 5 and 8a, b, c & d is supposed to address Research Question 2 which is explaining the relationship of service innovation dimension adoption to firm performance.

Hypotheses H3, 6 and 9 addresses Research Question 3 which is examining the indirect relationship between IT governance mechanism to firm performance.

Table 2. Previous Existing Models (Chapter 4)

S/N	Model Variables Measure	Objective	Source
1.	a. Independent Variables: Service Innovation Dimensions b. Dependent Variable: Firm Performance	<i>“The objective of this study was to incorporate empirical studies into the service innovation literature to investigate the different roles of technology in an integrated service innovation framework.”</i>	(Ryu & Lee, 2018)
2.	a. Independent Variables: IT Governance Mechanism and Domains b. Dependent Variable: Effectiveness	<i>“To examine a theoretical model that explains and predicts IT governance effectiveness, linking its domains and mechanisms”.</i>	(Lunardi, Maçada, et al., 2014)
3.	a. Independent Variables: IT Governance, Board IT Competence, Executive Management Competence, Business Alignment b. Dependent Variable: Innovation	<i>“The objective of this study was to examine the means by which IT can contribute to innovation and, more specifically, to what extent these means have an impact on innovation”.</i>	(Héroux & Fortin, 2018b)

4.4 Methodology and Data Collection

Methodology

To evaluate our proposed model, a survey was developed and carried out in Nigeria covering the commercial banking industry (see table 3). A sample questionnaire (see Appendix survey question 1) was designed and adapted from previous literature. The items used in the survey questionnaire were adapted from models of previous researches. For reliability of our new model, the items used for the survey questionnaire were consistent with the sources (see table 2) used from literatures. A five-point Likert scale (5 - 1) were used ranging from “strongly agree to strongly disagree”.

Due to population, diversity and demographic nature of Nigeria, the survey covered three main states in the country i.e. Abuja, Lagos, and Kano. The reason for the selection of these states comes with the fact that they are considered as the administrative capital, economic center, and most populated state respectively. These states have their advantages in contributing to the economic growth of the nation. Selecting the banks in these locations as the sample size becomes necessary because of the available number of banking staff they can deliver. This will also provide the right measure of the population no sampling error with a reliable and good result (Gorondutse & Hilman, 2017; Hilman & Kaliappen, 2014).

To test the items of the questionnaire, a pilot study was carried out on a

sample of 30 respondents. The results obtained provided valid and reliable evidence that the scale and items used in the questionnaire were acceptable to test our proposed model.

Table 3. Descriptive Data

<i>Bank</i>	<i>Frequency</i>	<i>Percentage</i>
Access	9	8.0
FCMB	13	11.6
Fidelity	5	4.7
First	4	3.6
GTB	20	17.8
Jaiz	1	0.9
Keystone	4	3.6
Polaris	20	17.8
Sterling	14	12.4
UBA	1	0.9
Union	3	2.7
Unity	11	9.8
Wema	7	6.2
<i>Total</i>	112	100.0

Data Collection

An offline questionnaire were distributed to IT managers, service delivery managers, service and innovation analysts, service management officers, senior managers, project managers, and customer relation officers within the 18 Nigerian commercial banks.

Our target respondents were banking staff that have been involved in

services provision roles either as a staff, management or decision maker. These respondents became our target informants since our survey provides a good description of IT governance mechanism, service innovation adoption and firm performance. To be consistent with reliability of our data, these respondents we required to individually fill out this survey with respect to their organizations IT governance structures, processes, relational mechanisms, and adoption of service innovation that will increase their firm performance.

After distributing 750 questionnaires to all the 18 banks, only 14 banks were involved in the study as staff of the other four banks were restricted due policy of information non-disclosure. A total number of 222 respondent's questionnaires were received and only 178 respondents were screened and approved to fit the study. Table 3 above shows the descriptive statistics distribution of the respondents were Polaris and GTB Banks having 17.8%, Sterling Bank with 12.4% and FCMB with 11.6% participation rate.

Measurement Model

For a methodology, the study adopted Partial least Square Structural Equation Modeling (PLS-SEM). This selection can be attributed to the complex nature of assessing the research model. (Sarstedt, Ringle, & Hair, 2014) elaborated that PLS is an evolving approach in SEM that has been used in different fields like marketing, management, and management

information system (Ringle, Sarstedt, & Straub, 2012; Ringle, Sarstedt, & Zimmermann, 2011). It is found to become very advantageous for accommodating supplementary complex model structures coupled with its ability to handle heterogeneity (Ringle et al., 2011). Some few more advantages of PLS-SEM are the ability to analyze non-normal data, small sample sizes and also the use of formative indicators (Hair, Risher, Sarstedt, & Ringle, 2019; Ringle et al., 2011; Shmueli et al., 2019).

Measuring Variables

Measurement constructs and items were screened and selected based on their relevance to our study (see Table 2). The questionnaire was developed and validated, through the steps suggested by Koufterous (1999). Structure, process and relative mechanism were selected as the three main constructs that represents IT governance mechanisms. The measuring items representing these 3 constructs were adapted from (S. De Haes & Van Grembergen, 2009). De Haes and Grembergen (2009). Service innovation was viewed from the perspective of den Hertog et al., (2010) and its four dimensions were adapted from Ryu and Lee (2018). Finally firm performance adapted from Ryu and Lee (2018) in consideration to the Kaplan and Norton theory.

Table 4. Definition of Variables (Chapter 3)

Variable	Definition	Source
Structure	“organizational units and roles responsible for making IT	(S. De Haes & Van Grembergen, 2009;

	decisions, such as committees, executive teams, and business/IT relationship managers”	S. De Haes & Grembergen, 2016; Lunardi, Becker, & Maçada, 2009;
Process	“formal processes for ensuring that daily behaviors are consistent with IT policies and provide input back to decisions.”	Lunardi, Maçada, et al., 2014; Van Grembergen, 2006)
New Service Concept	“attaining and sustaining business-IT alignment, mechanisms like announcements, advocates, channels and education efforts .”	(den Hertog, 2000; den Hertog et al., 2010; Ryu & Lee, 2018)
New Staff	“The innovation is often a new idea of how to organize a solution to a problem or a need of a customer.”	
New Service Delivery	“innovations of organizational structure of the service company itself.”	
New Technology	“this dimension pinpoints the observation that ICTs (predominantly, but not exclusively) have enabled numerous service innovations”	(Ryu & Lee, 2018)
Firm Performance	“as a firm’s non-financial performance compared to your competitors”	

4.5 Results Analysis

4.5.1 1st Model Descriptive Statistics

The first part of the results shows the statistical description and Pearson correlation between the variables that were measured during this quantitative

study (see Table 5). Mean and standard deviation (S.D) are viewed as important in describing statistics in terms of interval ratio scale (Sekaran & Bougie, 2013). IT governance mechanism (i.e. structure were observed at Mean = 4.20 and S.D = 0.69) service innovation (ranging from Mean = 4.14 - 4.36 and S.D = 0.66 - 0.75 among all four dimensions) and firm performance was recorded at Mean = 4.11 and S.D = 0.70. This result was found to record new technology dimension to have the lowest S.D of 0.66. The R square fitness of the model was obtain with the range of 0.092 to 0.197 i.e. falling with the acceptable R range of 0 to 1. All the measured variables were recorded within the ranges of high level.

Table 5. Variables Descriptive Statistics (Structure)

Variables	Mean	S.D
Structure	4.20	0.69
New Service Concept	4.14	0.70
New client interface	4.14	0.72
New Service Delivery	4.18	0.75
New Technology	4.36	0.66
Firm Performance	4.11	0.70

4.5.1.1 Collinearity

Multicollinearity can be defined as the relationship between two or more variable i.e. there is no orthogonality between them (Alin, 2010; Farrar & Glauber, 1967; Mansfield & Helms, 1982). Gorondutse & Hilman (2017) also referred to multicollinearity as a statistical assessments were two or

more predicting constructs in regression are highly correlated. The result of our study was assessed for multicollinearity by calculating the Variance Inflated Factor (VIF).

$$VIF_i = \frac{1}{1 - R_i^2} \quad \text{Eq. (4)}$$

Where:

R_i^2 is the multiple R^2 for the regression of X_i on the other covariates

According to Hair et al., (2019) and Hair, Sarstedt, Pieper, & Ringle (2012), their studies showed that there will be no issues with multicollinearity when VIF is less than 5 (Hair, Ringle, & Sarstedt, 2011). Table 4 below illustrates the estimated values of VIF for the constructs in this study, thus indicating that multicollinearity between the ranges of 1.00 to 1.51 was achieved.

Table 6. VIF Values (Structure)

Variables	VIF
Structure	1.51
New Service Concept	1.55
New client interface	1.44
New Service Delivery	1.32
New Technology	1.00

The results from Table 6 above illustrate that there is no multicollinearity between the measured variables since the values of VIF are all less than 5, showing that the rule of thumb was followed (Hair et al., 2011). The result

above has satisfied that the measured constructs of this study has no multicollinearity and thus all the constructs are satisfied for measurement and structural model evaluation.

4.5.2 1st Model Measurement Model

Recent studies from Hair, Risher, Sarstedt, & Ringle (2018);(2012) and Ringle et al., (2011) showed a two-step modeling method (i.e. measurement and structural models) of investigating the quality of items that were used during the measurement and evaluation of a PLS-SEM model. Then this is followed by process of estimating the relationship among the models.

The measurement model was assessed through evaluating the results from our Item Loading (≥ 0.708), Composite Reliability, Convergent and Discriminant Validity (HTMT). Composite reliability was defined as “*the measure for internal consistency in scale items, which is similar to Cronbach’s Alpha*” (Netemeyer, Bearden, & Sharma, 2003).

$$CR = \frac{[\sum_{i=1}^n \lambda_i]^2}{[\sum_{i=1}^n \lambda_i]^2 - [\sum_{i=1}^n \epsilon_i]} \quad \text{Eq. (5)}$$

Where:

“ λ (lambda) is the standardized factor loading for item i and ϵ is the respective error variance for item i . The error variance (ϵ) is estimated based on the value of the standardized loading (λ) as: $\epsilon_i = 1 - \lambda^2_i$.

The item r -square value is the percent of the variance of item i , explained by

the latent variable. It is estimated based on the value of the standardized loading (λ) as: $r^2 = \lambda^2_i = 1 - \epsilon_i$ ” Tenko (1997).

While Philips, Bagozzi, & Yi (1991), Sarstedt et al. (2014), and Shmueli et al., (2019) further explained: “convergent validity or Average Variance Extracted (AVE) as the extent to which the construct converges to explain the variance of its items ranging at ≥ 0.50 ”.

$$AVE = \frac{\sum_i \lambda^2_i}{\sum_i \lambda^2_i - \sum_i Var(\epsilon_i)} \quad \text{Eq. (6)}$$

Where:

λ^2_i = squared loading of items i of a latent variable

$Var(\epsilon_i)$ = squared measurement error of item i

4.5.2.1 Reliability and Validity

Table 7 shows that all values of item loading which were ranging from ≥ 0.708 , i.e. all items satisfying the loading requirement. Composite Reliability results were ranging from 0.792 – 0.847 satisfying the statistical requirement. The Average Extracted Variance (AVE) measures were evaluated between 0.585 – 0.656 i.e. within the threshold range. The result in Table 7 below indicates that reliability and validity have been achieved.

Table 7. Reliability and Validity (Structure)

Variable	Items	Factor Loadings	C.R	AVE
Structure	STX2	0.763	0.847	0.648
	STX3	0.794		
	STX4	0.855		
New Service Concept	NSC3	0.811	0.809	0.585
	NSC4	0.734		
	NSC5	0.748		
New Staff Interface	NSI1	0.797	0.827	0.614
	NSI3	0.778		
	NSI4	0.776		
New Service Delivery	NSD1	0.867	0.792	0.656
	NSD4	0.749		
New Technology	NT2	0.738	0.841	0.570
	NT3	0.799		
	NT4	0.771		
	NT5	0.709		
Firm Performance	FP2	0.759	0.845	0.577
	FP3	0.780		
	FP4	0.767		
	FP5	0.731		

4.5.2.2 Convergent Validity

“Convergent validity is the extent to which the construct converges in order to explain the variance of its items” (Hair et al., 2019). From Table 8 the results below, it can be agreed that Fornell and Larker (discriminant validity) criterion of structures mechanism can be established to an appropriate degree of validity.

Table 8. Convergent Validity (Structures)

	NSC	NSD	NSI	NT	FP	STX
NSC	0.756					
NSD	0.468	0.810				
NSI	0.491	0.452	0.784			
NT	0.383	0.459	0.311	0.755		
FP	0.445	0.609	0.549	0.423	0.760	
STX	0.389	0.444	0.430	0.303	0.330	0.805

4.5.2.3 Discriminant Validity (Heterotrait-Monotrait Ratio HTMT)

Churchill Jr, (1979) and Henseler, Ringle, & Sarstedt, (2014) defined discriminating validity is “*the extent to which constructs are different from one another*”. Fornell & Larcker (1981) and Gefen, Straub, & Boudreau (2000) both agreed that “*the shared variance for all model constructs should not be larger than their AVEs*” while on a contradictory note, Henseler et al. (2014) suggested that the Fornell and Larcker criterion is slightly lacking especially when item loadings of constructs that have minor differences i.e. indicator loadings ranging from 0.65 and 0.85. However, a value of less than 0.85 (< 0.85) was suggested as the threshold for “*Heterotrait-Monotrait (HTMT) ratio of the correlation.*” (Voorhees, Brady, Calantone, & Ramirez, 2016).

Therefore, “*HTMT is defined as the mean value of the item correlations*

across constructs relative to the (geometric) mean of the average correlations for the items measuring the same construct”(Voorhees et al., 2016). When constructs are conceptually very similar, the threshold value is considered less than 0.90 (< 0.90) and for those that are conceptually different, their threshold should be considered less than 0.85 (< 0.85) (Hair et al., 2019; Sarstedt et al., 2014; Shmueli et al., 2019).

Table 9. Discriminant Validity (HTMT) Structures

	NSC	NSD	NSI	NT	FP	STX
NSC						
NSD	0.792					
NSI	0.730	0.778				
NT	0.550	0.757	0.442			
FP	0.635	0.997	0.755	0.558		
STX	0.546	0.715	0.598	0.381	0.442	

Table 9 above indicates the correlation matrix where the diagonal indicators showed the square root of the latent variables AVE. The result shows that in the correlation matrix discriminant validity is achieved. Further assessing the HTMT ratio, the figure below (see Figure 3) shows that our analysis for constructs that are both conceptually very similar and differently distinct. Only NSD→FP relationship has shown not to achieve discriminant validity.

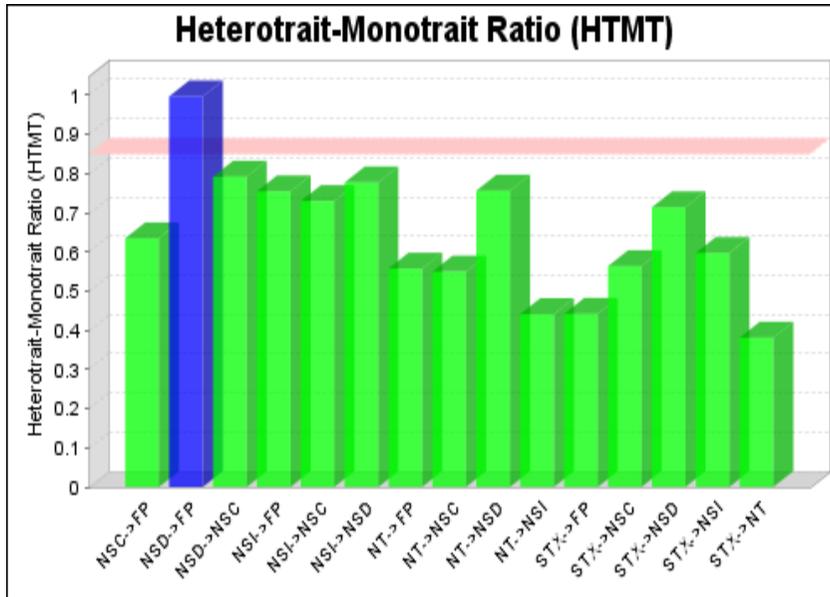


Figure 6. Structure of IT Governance Mechanism HTMT Ratio

4.5.3 1st Model Structural Model

The following results were obtained and analyzed to evaluate the structural model of the 1st Model. Below are the tests for hypothesis for examining the relationships between the studied constructs.

4.5.3.1 Hypotheses Testing

Through the structural modeling analysis, it is possible to examine both the direct and indirect effects between independent and dependent variables. With the possibility to run iterations and conduct estimation using the SmartPLS software package, as recommended by Hair et al., (2012) and Sarstedt et al., (2014) our study analyzed t-values using bootstrapping with an estimated 5000 re-sampling iterations.

Table 10. Hypotheses Testing (Structure)

H3	Relationships	PT	S.D	T Statistics	P – Values	Finding
H1a	<i>STX→NSC</i>	0.389	0.066	5.892	0.000	<i>Supported</i>
H1b	<i>STX→NSI</i>	0.430	0.061	7.253	0.000	<i>Supported</i>
H1c	<i>STX→NSD</i>	0.444	0.065	6.600	0.000	<i>Supported</i>
H1d	<i>STX→NT</i>	0.303	0.081	3.758	0.000	<i>Supported</i>
H2a	<i>NSC→FP</i>	0.070	0.073	0.957	0.339	<i>Rejected</i>
H2b	<i>NSD→FP</i>	0.381	0.069	5.523	0.000	<i>Supported</i>
H2c	<i>NSI→FP</i>	0.303	0.066	4.590	0.000	<i>Supported</i>
H2d	<i>NT→FP</i>	0.128	0.076	1.688	0.092	<i>Rejected</i>

Keys: PT = Path Coefficient; S.D= Standard Deviation

The above Table 10 specifies structure has positive and significant effects on all four service innovation dimensions. The results of their p-value were obtained with the range of 0.000 – 0.339 i.e. p-value falling less than 0.05 which is 95 percent confidence interval that is based on the percentile method and t-statistics above 1.96. Subsequently, two service innovation dimensions (i.e. NSD and NSI i.e. all at 0.000) were found to have a positive and significant impact on firm performance. On the other hand, the other two dimensions (i.e. NSC and NT obtained at 0.339 and 0.092 respectively) were rejected.

4.5.3.2 Total Indirect Effect

Total Indirect Effect of the structure of IT governance mechanism to firm performance indicates a positive and significant effect (Table 11). The T-Statistics value of the results was determined at 8.279 and 0.000 p-values (i.e. greater than 1.96 and less than 0.05 threshold range).

Table 11. Total Indirect Effect (Structures)

Hypothesis	Relationships	S.D	T Statistics	P -Values	Findings
H3	STX→FP	0.044	8.279	0.000	<i>Existing</i>

4.5.4 2nd Model Description Statistics

Table 12 shows the results of the mean and S.D of all the variables measured for the 2nd Model in examining processes of IT governance mechanisms. The variable of process was observed at Mean = 4.20, S.D = 0.72, service innovation dimensions variables Mean were ranging within 4.14 - 4.38 and S.D = 0.68 - 0.74 and firm performance was recorded at a Mean = 4.11 and S.D = 0.70. This result was found to record new technology dimension to have the highest mean at 4.38 and firm performance with the lowest mean of 4.11. The R square fitness of the model was obtained with the range of 0.220 to 0.421 i.e. falling with the acceptable R range of 0 to 1. Nevertheless, all the measured variables were obtained within the required range.

Table 12. Variable Description Statistics (Process)

Variables	Mean	S.D
Process	4.20	0.72
New Service Concept	4.20	0.70
New Client Interface	4.14	0.72
New Service Delivery	4.25	0.74
New Technology	4.38	0.68
Firm Performance	4.11	0.70

4.5.4.1 Collinearity

Table 13 below illustrates the estimated value of the VIF of the constructs in the 2nd Model, hence indicating that multicollinearity between the ranges of 1.000 to 1.646 of VIF was achieved.

Table 13. VIF Values (Process)

Variables	VIF
Process	1.000
New Service Concept	1.605
New Service Delivery	1.646
New client interface	1.422
New Technology	1.345

The results from Table 13 above illustrates that there is no multicollinearity between the measured variables since the values of VIF are all less than 5. Thus, the constructs are satisfied for measurement and structural model evaluation.

4.5.5 2nd Model Measurement Model

The measurement model was assessed through evaluating the results

from our items Loading (≥ 0.708), Composite Reliability, Convergent and Discriminant Validity (HTMT).

4.5.5.1 Reliability and Validity

Table 14 shows that all values of item loading were ranging from ≥ 0.708 , i.e. satisfying the loading requirement. Composite Reliability results are ranging from 0.808 – 0.845. The Average Extracted Variance (AVE) measures were evaluated at 0.586 – 0.687 which also within the threshold range. The result in Table 12 below indicates that both reliability and validity have been achieved.

Table 14. Reliability and Validity (Process)

Variable	Items	Factor Loadings	C.R	AVE
Process	PRS1	0.728	0.809	0.586
	PRS2	0.763		
	PRS6	0.805		
New Service Concept	NSC3	0.769	0.808	0.584
	NSC4	0.727		
	NSC5	0.769		
New Staff Interface	NSI1	0.812	0.828	0.616
	NSI3	0.761		
	NSI4	0.780		
New Service Delivery	NSD1	0.885	0.814	0.687
	NSD3	0.769		
New Technology	NT1	0.775	0.819	0.607
	NT2	0.800		
	NT3	0.750		
	FP2			

Firm Performance	FP3	0.761	0.845	0.577
	FP4	0.785		
	FP5	0.768		
		0.723		

4.5.5.2 Convergent Validity

From Table 15, it can be agreed that Fornell and Larker criterion (discriminant validity) of process mechanism can be established to an appropriate degree of validity.

Table 15. Convergent Validity (Process)

	NSC	NSD	NSI	NT	FP	PRS
NSC	0.764					
NSD	0.531	0.829				
NSI	0.491	0.451	0.785			
NT	0.395	0.470	0.327	0.775		
FP	0.445	0.509	0.548	0.438	0.759	
PRS	0.469	0.589	0.481	0.474	0.385	0.766

4.5.5.3 Discriminant Validity (Heterotrait-Monotrait Ratio HTMT)

Table 16 indicates the correlation matrix where the diagonal indicators showed the square root of the latent variables AVE and the results shows that the correlation matrix is showing discriminant validity is achieved.

Table 16. Discriminant Validity HTMT (Process)

	NSC	NSD	NSI	NT	FP	PRS
NSC						
NSD	0.863					
NSI	0.730	0.725				
NT	0.593	0.754	0.486			
FP	0.635	0.746	0.755	0.603		
PRS	0.706	0.965	0.717	0.694	0.539	

Figure 7 below shows that our analysis for constructs that are conceptually similar and differently distinct. While NSD→NSC and PRS→NSC relationships have no achieve discriminant validity.

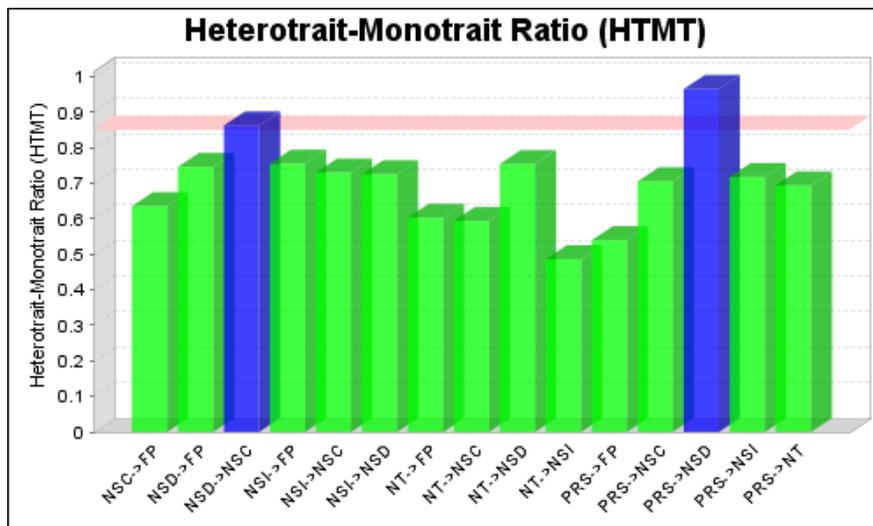


Figure 7. Process of IT Governance Mechanism HTMT Ratio

4.5.6 2nd Model Structural Model

The following results were obtained and analyzed to evaluate the structural model of the 2nd Model. Below are the tests for hypothesis for

examining the relationships between the studied constructs.

4.5.6.1 Hypotheses Testing

Below table are results for hypothesis testing:

Table 17. Hypotheses Testing (Process)

H6	Relationships	PT	S.D	T Statistics	P – Values	Findings
H4a	<i>PRS→NSC</i>	0.466	0.067	6.961	0.000	<i>Supported</i>
H4b	<i>PRS→NSD</i>	0.586	0.072	8.134	0.000	<i>Supported</i>
H4c	<i>PRS→NSI</i>	0.482	0.065	7.422	0.000	<i>Supported</i>
H4d	<i>PRS→NT</i>	0.477	0.079	6.041	0.000	<i>Supported</i>
H5a	<i>NSC→FP</i>	0.085	0.074	1.147	0.252	<i>Rejected</i>
H5b	<i>NSI→FP</i>	0.219	0.087	2.527	0.012	<i>Supported</i>
H5c	<i>NSD→FP</i>	0.347	0.078	4.445	0.000	<i>Supported</i>
H5d	<i>NT→FP</i>	0.189	0.083	2.279	0.023	<i>Supported</i>

Keys: PT = Path Coefficient; S.D= Standard Deviation

The above Table 17 specifies process has positive and significant effects on all four service innovation dimensions. The results of their p-value were obtained with the range of 0.000 – 0.252. Subsequently, three service innovation dimensions (i.e. NSI, NSD and NT i.e. at 0.012, 0.000 and 0.023 respectively) were found to have a positive and significant impact on firm performance. On the other hand, one dimension (i.e. NSC was obtained at 0.252) was rejected.

4.5.6.2 Total Indirect Effect

Total Indirect Effect of processes of IT governance mechanism to firm performance indicates a positive and significant effect (Table 18). The T-Statistics value of the results was determined at 6.135 and 0.000 P-Values (i.e. greater than 1.96 and less than 0.05 threshold range).

Table 18. Total Indirect Effect (Process)

Hypothesis	Relationships	S.D	T Statistics	P - Values	Findings
H6	<i>PRS</i> → <i>FP</i>	0.051	8.345	0.000	<i>Existing</i>

4.5.7 3rd Model Description Statistics

Table 19 shows the results of the Mean and S.D of all the variables measured for the 3rd Model in examining relative mechanism (RM) of IT Governance Mechanisms. Variables of RM were observed at a of Mean = 4.04, S.D = 0.78, service innovation dimensions variables mean were ranging within 4.13 - 4.34, S.D = 0.66 - 0.73 and firm performance was recorded at a Mean = 4.11 and S.D = 0.67 This result was found to record New Technology dimension to have the highest mean at 4.34 and Relational Mechanism with the lowest mean of 4.04 and a S.D of 0.78. The R square fitness of the model was obtained with the range of 0.152 to 0.449 i.e. falling with the acceptable R range of 0 to 1. Nevertheless, all the measured variables were obtained within the required range.

Table 19. Variables Descriptive Statistics (Relational Mechanisms)

Variables	Mean	S.D
Relational Mechanism	4.04	0.78
New Service Concept	4.13	0.70
New client interface	4.14	0.72
New Service Delivery	4.24	0.73
New Technology	4.34	0.66
Firm Performance	4.11	0.67

4.5.7.1 Collinearity

Table 20 below illustrates the estimated values of VIF of the constructs in this study, indicating that multicollinearity between the ranges of 1.000 to 1.652 of VIF was achieved.

Table 20. VIF Values (Relational Mechanism)

Variables	VIF
Relational Mechanism	1.000
New Service Concept	1.526
New Service Delivery	1.652
New client interface	1.457
New Technology	1.358

The results from Table 20 above illustrates that there is no multicollinearity between the measured variables since the values of VIF are all less than 5. Thus, all the constructs are satisfied for measurement and structural model evaluation.

4.5.8 3rd Model Measurement Model

The measurement model was assessed through evaluating the results from our Item Loading (≥ 0.708), Composite Reliability, Convergent (Fornell & Larcker Criterion) and Discriminant Validity (HTMT).

4.5.8.1 Reliability and Validity

Table 21 shows that all values of item loading which were ranging from ≥ 0.708 satisfying the loading requirement. Composite Reliability results were ranging from 0.795 – 0.845 with all loadings satisfying the requirement. The Average Extracted Variance (AVE) measures were evaluated at 0.559 – 0.616 which also within the threshold range. The result in Table 21 below indicates that reliability and validity have been achieved.

Table 21. Reliability and Validity (Relational Mechanism)

Variable	Items	Factor Loadings	C.R	AVE
Relational Mechanism	RM1	0.737	0.835	0.559
	RM2	0.706		
	RM5	0.734		
	RM6	0.809		
New Service Concept	NSC3	0.808	0.809	0.586
	NSC4	0.743		
	NSC5	0.743		
New Staff Interface	NSI1	0.811	0.828	0.616
	NSI3	0.761		
	NSI4	0.781		
New Service Delivery	NSD1	0.805	0.795	0.564
	NSD3	0.712		

Variable	Items	Factor Loadings	C.R	AVE
Relational Mechanism	RM1	0.737	0.835	0.559
	RM2	0.706		
	RM5	0.734		
	RM6	0.809		
	NSD4	0.733		
New Technology	NT2	0.739	0.841	0.570
	NT3	0.816		
	NT4	0.755		
	NT5	0.707		
Firm Performance	FP2	0.762	0.845	0.577
	FP3	0.787		
	FP4	0.767		
	FP5	0.721		

4.5.8.2 Convergent Validity

From the results below (see Table 22) of Convergent Validity (based on Fornell & Larcker Criterion) it can be agreed that the 3rd model for Relational Mechanism of IT governance mechanisms can be established that it has an appropriate degree of reliability and validity.

Table 22. Convergent Validity (Relational Mechanism)

	NSC	NSD	NSI	NT	FP	RM
NSC	0.765					
NSD	0.494	0.751				
NSI	0.489	0.476	0.785			
NT	0.383	0.484	0.316	0.755		

	NSC	NSD	NSI	NT	FP	RM
NSC	0.765					
FP	0.445	0.573	0.548	0.423	0.759	
RM	0.506	0.525	0.390	0.322	0.429	0.748

4.5.8.3 Discriminant Validity (Heterotrait-Monotrait Ratio HTMT)

Table 23 below indicates the correlation matrix where the diagonal indicators showed the square root of the latent variables AVE and the results shows that the correlation matrix is showing discriminant validity is achieved.

Table 23. Discriminant Validity (HTMT) Relational Mechanism

	NSC	NSD	NSI	NT	FP	STX
NSC						
NSD	0.763					
NSI	0.730	0.723				
NT	0.550	0.690	0.442			
FP	0.635	0.801	0.755	0.558		
RM	0.733	0.769	0.554	0.408	0.576	

Figure 8 below shows that all the constructs were observed to have achieved values under the 0.85, thus satisfying discriminant validity.

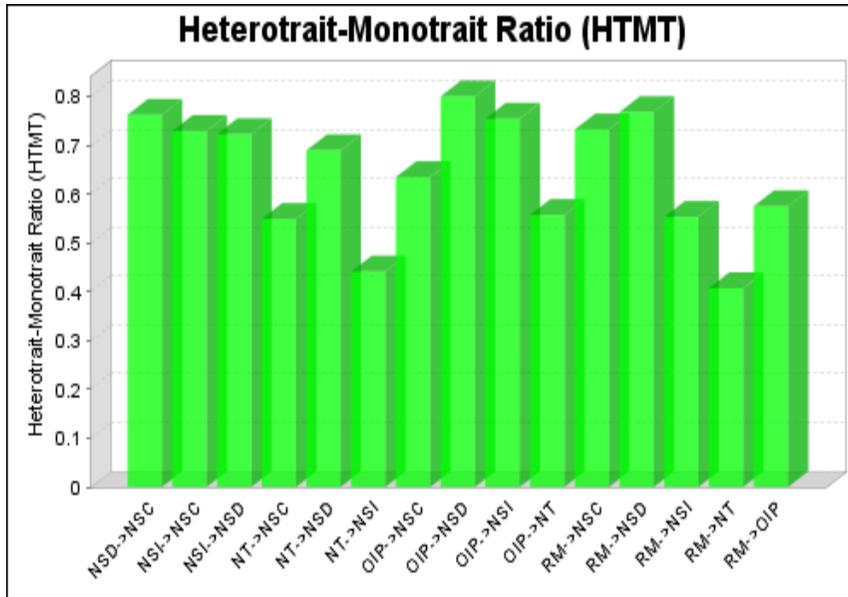


Figure 8. Relation Mechanism of IT Governance Mechanism HTMT Ratio

4.5.9 3rd Model Structural Model

These results obtained will be analyzed to evaluate the structural model of the 3rd model. This will allow for the assessment of the relationships between the 3rd model studied constructs.

4.5.9.1 Hypotheses Testing

Table 24 below table is for confirming of hypothesis testing:-

Table 24. Hypotheses Testing (Relational Mechanism)

H9	Relationships	PT	S.D	T Statistics	P – Values	Findings
H7a	<i>RM→NSC</i>	0.502	0.067	7.503	0.000	<i>Supported</i>
H7b	<i>RM→NSD</i>	0.526	0.073	7.206	0.000	<i>Supported</i>
H7c	<i>RM→NSI</i>	0.388	0.074	5.240	0.000	<i>Supported</i>

H7d	<i>RM→NT</i>	0.323	0.090	3.594	0.000	<i>Supported</i>
H8a	<i>NSC→FP</i>	0.082	0.079	1.044	0.297	<i>Rejected</i>
H8b	<i>NSD→FP</i>	0.314	0.080	3.931	0.000	<i>Supported</i>
H8c	<i>NSI→FP</i>	0.313	0.073	4.283	0.000	<i>Supported</i>
H8d	<i>NT→FP</i>	0.139	0.080	1.742	0.082	<i>Rejected</i>

Keys: PT = Path Coefficient; S.D= Standard Deviation

Table 24 above specifies relational mechanism has positive and significant effects on all four service innovation dimensions. The results of their p-value were obtained with the range of 0.000 – 0.297. Subsequently, two service innovation dimensions (i.e. NSI and NT i.e. at 0.000 and 0.020 respectively) were found to have a positive and significant impact on firm performance. On the other hand, the other two dimensions (i.e. NSC and NSD were obtained at 0.325 and 0.065 respectively) were rejected.

4.5.9.2 Total Indirect Effect

Total Indirect Effect of processes of IT governance mechanism to firm performance indicates a positive and significant effect (Table 25). The T-Statistics value of the results was determined at 6.135 and 0.000 p-Values (i.e. greater than 1.96 and less than 0.050 threshold range).

Table 25. Total Indirect Effect (Relational Mechanism)

Hypothesis	Relationships	S.D	T Statistics	P - Values	Findings
H9	<i>RM→FP</i>	0.058	6.474	0.000	<i>Existing</i>

4.5.9.3 Comparison of Models

From our results above, Model 1 (structure) and Model 3 (relational mechanism) have been observed to have achieved the same properties of hypotheses. Both the two model have rejected the causal relationship of $NSC \rightarrow FP$ and $NT \rightarrow FP$. While on the other Model 3 (Process) was only found to reject $NSC \rightarrow FP$. Thus, it can deduced that Process IT mechanism are well implemented in the banks can be observed for better achievement of firm performance when compared to model 1 and 3 (i.e. structure and relational mechanism respectively).

4.5.10 Mediation Effects of Models 1, 2 and 3

Mediation effect occurs when there are three constructs and the 1st construct is classified as independent variable (i.e. IT governance mechanisms), the 2nd variable as a dependent variable (firm performance) and the 3rd variable as a mediator which intervenes in between the independent and dependent variables (Hair Junior, Hult, Ringle, & Sarstedt, 2014). Mediation effect is assessed to observe any change in the independent variable that is expected to cause change in mediator variable and consequently cause changes in the depended variable (Hair, Hult, Ringle, Sarstedt, & Thiele, 2017).

In this research, our mediator variable is service innovation (with its four dimensions) which is expected to mediate the relationship between IT governance mechanisms and the firm performance. Using the mediating

effect assist in calculating and assessment of both direct and indirect effects of the variables (Carrión, Nitzl, & Roldán, 2017) .

According to Zhao, Lynch Jr, & Chen (2010) mediations can be determined in two steps. Step 1 which is by evaluating the indirect effect side of the variables. Assessing the significance of an indirect effect can be either positive or negative. If positive, then proceed to second step (if negative No mediation effect). Step 2 involves investigates the direct effects which is also assessed in if the significance of direct effect is a positive or negative effect. Assessment of the significance of the direct effect is grouped into direct effect positively (i.e. showing Partial mediation effect) or negatively significant i.e. Full mediation effect (Henseler, 2017).

Tables 26, 27 and 28 below were used to analyze and explain the results obtained from our three sub group the models.

Table 26. Total Indirect Effects of Model 1, 2 and 3

<i>Model 1</i>	<i>Model 2</i>	<i>Model 3</i>
<i>STX</i> → <i>FP</i> = +VE (p-Value 0.000)	<i>PRS</i> → <i>FP</i> = +VE (p-Value 0.000)	<i>RM</i> → <i>FP</i> = +VE (p-Value 0.000)

Keys: Positively significant = Supported; Negatively significant = Rejected

Table 27. Path Coefficients Direct Effects of Model 1, 2 and 3

<i>Model 1</i>	<i>Model 2</i>	<i>Model 3</i>
<i>STX</i> → <i>FP</i> = -VE (p-Value 0.519)	<i>PRS</i> → <i>FP</i> = -VE (p-Value 0.373)	<i>RM</i> → <i>FP</i> = -VE (p-Value 0.227)

Keys: Positively significant = Supported; Negatively significant = Rejected

From Tables 26 and 27 above, the results of this study has shown that the effect of all three models i.e. structure, process and relational mechanism to firm performance is conducted with the help of service innovation dimensions as mediators. This explains that firm performance absorbs both positive and negative effects of IT governance mechanisms. Therefore, service innovation as a mediator can pass or hold back an effect i.e. showing that IT governance mechanisms extract their influence under certain conditions of service innovations. Table 28 below shows a more elaborated specific indirect effects showing that in terms of both structures and relational mechanism of IT governance mechanisms, the two mechanisms extracts its influence on NSI and NT dimensions of service innovation and no influence in terms of NSC and NSD. While process was found to extract influence only on NSI and no influence on NSC, NSD and NT.

Table 28. Specific Indirect Effects

<i>Model 1</i>	<i>Model 2</i>	<i>Model 3</i>
$STX \rightarrow NSC \rightarrow FP = -VE$	$PRS \rightarrow NSC \rightarrow FP = -VE$	$RM \rightarrow NSC \rightarrow FP = -VE$
$STX \rightarrow NSD \rightarrow FP = -VE$	$PRS \rightarrow NSD \rightarrow FP = -VE$	$RM \rightarrow NSD \rightarrow FP = -VE$
$STX \rightarrow NSI \rightarrow FP = +VE$	$PRS \rightarrow NSI \rightarrow FP = +VE$	$RM \rightarrow NSI \rightarrow FP = +VE$
$STX \rightarrow NT \rightarrow FP = +VE$	$PRS \rightarrow NT \rightarrow FP = -VE$	$RM \rightarrow NT \rightarrow FP = +VE$

Keys: Positively significant = Supported; Negatively significant = Rejected

4.6 Discussion

According to the results analysis above and referring to our research questions, our results indicates that the three (3) subdivided models (1, 2 and 3) cause different impacts on IT governance mechanism, service innovation on firm performance.

Considering our 1st research question i.e. examining the significant impact of IT governance mechanism on the choice of service innovations adoption, the results showed that all three aspects of IT governance mechanism have a positive significant impact on all four (4) service innovation dimensions (thus supporting their choice as an innovation process). This results coincides with previous studies of Héroux & Fortin (2018b) who's result also showed a positive significant impact of IT governance on innovation.

The 2nd research question examined the influence of service innovation

dimensions on firm performance. The results from model 1 and 3 (i.e. structure and relational mechanism) indicated the impact of a positive NSD and NSI on firm performance is positively significant. This can be supported by the work of Ryu and Lee (2018) which also experienced a positive impact. The other two dimensions of NSC and NT on firm performance was rejected as a negative impact. This can be attributed to the banks not willing to risk adopting new innovative services due to the high regulatory nature of the sector (Campanella, Della Peruta, & Del Giudice, 2017). While the results of model 2 (i.e. process) was slightly different from model 1 and 3 were only NSC has a negative impact on firm performance.

Lastly for the 3rd research question this work examined the mediating of service innovation dimensions on IT governance mechanisms and firm performance. The results indicated that service innovation exerts a full mediation role. This can also be supported from the works of (Dibrell, Craig, & Neubaum, (2014) were innovativeness fully mediates firm performance.

4.7 Implications

Managerial

This research offers valuable empirical results to board of directors (decision-makers), senior management and regulatory authorities of banks the importance of implementing IT governance mechanisms, and adopting service innovation for an improved firm performance.

The results of this study can guide decision makers and managers on how to use IT governance mechanism for improving service innovation adoption and firm performance. The present structure, process and relational mechanisms of the Nigerian banks are setup well enough to support the adoption of service innovation. This will positively improve the internal banking activities for the staffs and subsequently have some effect of driving improvement in the banking sector. Additionally, regulatory bodies from the government sides can advise banks on practices of implementing IT governance mechanism and new innovations. On the other hand, decision makers and management should focus on improving their new service delivery and staffs interface as these innovations improve performance. While a change and new channel of adopting and implementing new service concepts and new technology is required in the banking sector. As these innovations were rejected to influence performance, their introduction might face challenge of acceptance by the staffs if they have the impression it will affect their job status. Also by regularly updating the CBN IT Blueprint standard, banks can be guided on how to implement IT governance mechanisms. With our results showing rejection of new ideas and technology, the banks and CBN should be encouraged to develop financial innovative services research and development (R&D) centers that should be aligned to work on innovations and its effect on the banking industry and the country's economy. The rejection to adopt new ideas and technology needs to be tackled

especially with the country's new policy on digital economy.

Similarly, our research indicated that service innovation has a mediating effect between IT governance mechanism and firm performance. Showing that a implementing a good structure, process and relational mechanisms can contribute to an innovative wise and improved performance of the banking sector in Nigeria. By shaping the type of service innovation to adopt, banks can create new ideas, client interfaces, delivery, and technology to improve its own organizational value. As such, the finding of this study is important to both policy makers and academicians. To address staffing needs, our results can also guide the banking sector's decision makers and senior management on an appropriate growth and acceptable degree between the types of mechanisms and each of the innovation dimensions. It can be viewed that there is need to look into new client interface and technology as an appropriate measure of adopting new service innovations for use of banking staff.

With the above view, senior management of banks must ensure that IT governance mechanisms are implemented thoroughly to handle new service innovations. This brand of knowledge is essential to the banking industry because it can increase the rate of services adoption and enhance awareness of IT governance mechanisms.

Theoretical

Due to the low output of researches in the field of IT governance mechanism and service innovation within the banking sector of developing countries, the results of this study will contribute value to the upcoming growth of existing literature.

First, it added to the body of knowledge on the experience and awareness of IT governance within the staffs of the banking industry in Nigeria. By investigating the mechanisms in an in-depth manner, the role service innovation as a mediator has shown how it affects firm performance. Drawing from the differences of IT governance mechanisms, banks staffs have also shown different preference on different innovation dimensions. Specifically, all three mechanisms of IT governance were observed to exert same influence on service innovation. All three mechanisms support the adoption of all service innovation dimensions, while service new service ideas and technology. These findings motivates further research of IT governance and innovation within the banking sector, its regulators and customers. Subsequently, it will help in providing insight on how to explore new services and technologies which might have disruptive potentials in the banking industry (e.g. 5G, blockchain and A.I).

4.8 Contributions

By investigating banking staff's perception on how they conduct their internal operations to provide banking services, it is a clear that banking operations depends on IT and innovation. The influence of IT governance mechanisms on adopting a specific service innovation to improve firm performance is positively significant. This assessment was not measured before in previous studies. Relating each particular mechanism (e.g. evaluating structure, process and relational mechanism individually) to each service innovation dimension was not carried out. This research has observed to what extent each of these mechanisms has its influence on service innovation adoption.

By asking the respondents to assess IT governance structure of their bank and its implementation, they were also required to express the choice of service innovation dimension they perceive will improve their internal banking performance. Previous research like Lunardi et al., (2014) only assessed how IT governance mechanisms and its domains have impact on governance effectiveness. But their work did not investigate the mechanism individually in relation to improvement of effectiveness. Another study of Ryu and Lee (2018) carried out a study on service innovation and how it impacts firm performance. This study was carried out in a developed country where new service innovations adoptions are done continuously within diverse industrial sectors. However, our approach in this study focused only

on the banking and financial sector, due to its fast and continuous response to adoption of service innovation. Banks were identified as organizations that rely on IT for their operations and provision of services. Some contributing factors in Nigeria that make banks and financial institutions to adapt to new service innovation and use of IT services is the requirement of the Central Bank of Nigeria that requires all banks (including itself) to comply with the Nigerian Financial Industry IT Standard Blueprint.

The quantitative study of implementing IT governance mechanisms on service innovation for firm performance is quite rare and few especially in developing countries of Sub-Saharan African countries like Nigeria. This has made this study the 1st of its kind to address and examine issues on how the implementation of IT governance mechanisms can indirectly influence firm performance. This work has also empirically provided facts on round which of the IT governance mechanism is influential to both service innovation and firm performance (i.e. as a constructs and also its items).

4.9 Sub-conclusion

In conclusion, our study has answered all three our research question. First, our result has shown structure, process and relational mechanism of IT governance mechanism have significant impact on service innovation dimension. Second, new client interface and service delivery innovations are influencing firm performance, while new service concepts and technology are not. Third, service innovation does exert full mediation effect between IT

governance mechanism and firm performance.

The nature and size of the sample can be expanded for further researches. Attention needs to be taken about generalization of the finding as this study is restricted to Nigeria. The data for the study was drawn after a two months of the survey. The time might be short to source the data that will reflect the results of the study. To identify more information on adopting service innovation a longer period is recommended.

The study adds to the existing literature on mediation role of service innovation dimension in the developing country context. Moreover, the study has added value to present researches on how adopting specific service innovation may lead to improve performance of a firm. Based on present theories, our study will add information and understanding to present researches on the application of IT governance framework and service innovation theory in a new context within the emerging countries (other than studies from developed countries). Thus, this work has confirmed the impact of IT governance mechanism on performance like previous researches (Ali & Green, 2012; Arnaboldi & Rossignoli, 2016; Borja et al., 2018; Chen & Tsou, 2007; S. De Haes & Van Grembergen, 2009; De Reuver & Bouwman, 2012; Lay Hong, Boon Cheong, & Syaiful Rizal, 2016; Prasad, Green, & Heales, 2012) conducted.

Chapter 5. Evaluating the Influence of Service Innovation and SERVPERF Model on Customer Satisfaction: Case Study of Nigerian Mobile Banking Services

5.1 Introduction

In recent years, within both business and the academic research sphere, service innovation has become a center of increased attention (Dotzel, Shankar, & Berry, 2013). This has resulted in growing interest of researches and publications cutting across various research fields (Toivonen & Tuominen, 2009). Ostrom et al., (2010) stated that the notion of service innovation is observed to cover a wide range of sectors which also needs more investigation and improvement. Hagedoorn, (1996) expressed more insight on Schumpeter's research to show that it was one of the pioneer studies to set a definition of service innovation as an acknowledgement to a new service, which explains it as an innovation that is not yet productively presented on the market. Although Coombs and Miles (2000) came up with the theory of service innovation based on perspectives of assimilation, demarcation and synthesis approach. Thereby giving it a segmentation and distinction of how service innovation will be realized better.

Base on the new services that are evolving, it can be viewed that the sense of service quality is required to evaluate and also give these

innovations a template in which they can operate (Sasser et al., 1997). For this study, the “demarcation approach” to service innovation was selected as our focus. When linked to the Barra’s’ Reverse Product Cycle, new product innovation can be viewed in the same matter as a new product which is introduced into a market thereby passes through the phase of refinement. The idea of the refinement is to improve the quality of the service with user friendliness and customer satisfaction (Miles, 2000). Once the product is accepted in the market and competition has become next focus, then the issue of efficiency would have to be measured. At this stage, it is considered as a process innovation i.e. a radical process innovation (Barras, 1986). The combination of the properties of both product and process innovation can now be regarded as service innovation.

Miles (2000) provided a transition from product, process to service innovation selectively in the banking and the financial industry. In the 1960s – 70s, transformation in the retail banking sector started due to incremental process innovations by causing changes like automated transactions and adoption of financial records. Radical process innovations followed in the 1980s, because of the increase of ATMs, financial customers and information systems. The 1990s was no exception to these changes as cashless shopping and home banking emerged. The proliferation of internet and mobile services in the 2000s has brought service innovation to introduce features like online transaction processing, accessing customer data, and provision of

financial information more closely to the customer.

This study will examine how service innovations in the mobile banking (m-banking) industry have impact on service quality performance (SERVPERF) in order of providing the essential customer satisfaction. As most of the services provided for m-banking were services transform from the contemporary retail banking system. These services have provided self-services and introduce more opportunities for financial inclusion of potential new customers, especially in developing nations. An evaluation of these present customers will give authorities an insight of how to improve quality and target specific areas that is experiencing weaknesses and challenges.

5.1.1 Research Objective

The objective of the study is to empirically investigate the influence of mobile banking service innovations on service quality performance to improve the customer satisfaction.

5.1.2 Research Questions

1. What significant influence does service innovation have on dimensions of service quality performance of mobile banking services?
2. What significant impact does service quality performance of mobile banking services have on customer satisfaction?

3. Does service innovation have an indirect impact on customer satisfaction while using mobile banking services?

5.2 Literature Review

5.2.1 Exploitation and Exploration Service Innovation

Based on previous literature, innovation can be grouped into two sectors i.e. those that are based on their closeness to current technology, products and services and those that are close to the existing market and customers (Abernathy & Clark, 1985; Benner & Tushman, 2003; Danneels, 2002; Gadrey et al., 1995; Gallouj & Weinstein, 1997). Exploitative innovations are considered as incremental innovations, these are innovations which are designed to look into the needs of the current markets and customers (Benner & Tushman, 2003; Gallouj & Weinstein, 1997; Jansen, Van Den Bosch, & Volberda, 2006; Sok & O’Cass, 2015). This innovation increases the efficiency of the existing services by also improving the efficiency of the channels through which these services are distributed (Jansen et al., 2006). This will also help in expanding the current skills and knowledge of the establishment and likewise improve their service design capabilities (Benner & Tushman, 2003). As such, exploitative innovations are founded based on knowledge that already exists, skills that are reinforced, with also structures and processes that are already adopted (Lewin, Long, & Carroll, 1999).

On the other hand, explorative innovations were categorized as radical in

nature. The designers of these innovations considered the innovations to look into the future by adapting to developing markets and customers (Danneels, 2002; Gallouj & Weinstein, 1997; Jansen et al., 2006). Explorative innovations capitalize on fading away of existing knowledge, so that it can introduce new and improved ones (McGrath, 2001). Through this procedure, this innovation takes the advantage on introducing new knowledge and skills to leverage its advantage (Levinthal & March, 1993). Because of their radical nature, these innovations propose new designs that will change and create new markets. This innovation also creates new channels of distributing its services (Benner & Tushman, 2003).

5.2.2 Service Quality Performance

Parasuraman, Zeithaml, & Berry, (1985) defined quality as an intangible and unclear aspect of concept. It can also be regarded as a concept that cannot be articulated simply by customers (Takeuchi & Quelch, 1983). As such, measuring and explaining quality has not been an easy task in the academic environment (Monroe & Krishnan, 1983). Nevertheless, the strategic benefit of quality has proven to be an important factor that can contribute to a firm's market share and return on investment (Leong, Hew, Lee, & Ooi, 2015). Previously, researchers were more concentrating on quality within the manufacturing and production industry. With the emergence of the service industry, the importance of how customers judge the type of quality they are getting from services is increasingly rising.

Service quality can lead to customer satisfaction which in return increase in profit and return in investment (Leong et al., 2015). Parasuraman, Zeithaml, and Berry (1988) suggested five main aspects that can be used to measure service quality. These determinants form the Service Quality Model (SERVQUAL). These dimensions are Tangibles, Reliability, Responsiveness, Assurance and Empathy.

Even though SERVQUAL model was widely accepted and used in researches, Cronin and Taylor (1992) suggested an improvement to where they developed the Service Quality Performance Model (SERVPERF). Their argument to introducing this model as an update in measuring service quality was that SERVPERF explains more variations in assessing service quality. This is because there is the need to measure customer's attitude towards a service so that perception can also be measured in addition to performance. They also added that SERVPERF measures service quality better in four service industries i.e. banking, fast food, pest control and dry cleaning. Landrum, Prybutok and Zhang (2007) and Adil, Falah, Al, & Albkour, (2013) also supported this view by approving that SERVPERF is better in measuring service quality in the banking and financial sector.

$$SQ_i = \sum_{j=1}^k P_{ij} \quad \text{Eq. (7)}$$

Where:

SQ_i = *perceived service quality of individual 'i'*

k = *number of attributes/items; P* = *perception of individual 'i' with respect to performance of a service firm on attribute 'j'.*

Tangibles

“Tangibles was defined as the appearance of physical facilities, equipment, personnel and communication materials” Parasuraman, Berry, and Zeithaml (1988). Similarly, “tangibles were also defined as – the physical environment embodied by objects (i.e. interior design) and subjects (i.e. the look of employees)” (Leong et al., 2015). Tangibles have been learned to be of positive and significant influence to customer satisfaction (Aghdaie & Faghani, 2012; Kim & Lee, 2011). Nevertheless, this determinant will be dropped from our assessment observation factor; this is a result of service being defined as an “intangible factor” by Parasuraman, Zeithaml, & Berry (1988), Barney (1991), Drejer (2004) and Hipp & Grupp (2005).

Reliability

Reliability was defined as “the ability to perform the promised service dependably and accurately” (Parasuraman, Berry, & Zeithaml, 1991). Fragoso and Espinoza (2017) also defined reliability as “measures the organization capacity takes to comply with what is promised and by doing so

without error”. Other researchers like Aghdaie & Faghani, (2012) and Lee, Lee, & Yoo, (2000) stated that reliability has a positive and significant effect on customer’s satisfaction. In the banking and financial industry, Amin & Isa, (2008) contributed that reliability should be describe as the consistency of a banks service provision and also how accurate they perform. In terms of the mobile banking sector, reliability is regarded as the banks’ ability to provide mobile banking 24/7, accurately transactions with security, trust and consistent. Therefore, the hypotheses proposed based on this factor are:-

H1a: Service innovation has influence of reliability as a measuring factor of service quality

H2a: There is a significant and positive influence of reliability on customer satisfaction.

Responsiveness

Responsiveness is “the willingness to help customers and provide prompt service” (Parasuraman et al., 1991). Aghdaie & Faghani, (2012) and Lee et al., (2000) both agreed that responsiveness is a positive and significant precursor to customer satisfaction. Within the banking and financial sector, banks are expected to have a prompt response to their customer’s needs. Landrum et al., (2007), Amin & Isa, (2008), and Fragoso & Espinoza (2017) all suggested that banks responsiveness must be immediately taken to provide service assistance to customers that requires it. The hypotheses

developed concerning this factor are:-

H1b: Service innovation has influence of responsiveness as a measuring factor of service quality

H2b: Responsiveness has a significant and positive influence on customer satisfaction.

Assurance

Parasuraman et al., (1991) defined assurance as “the knowledge and courtesy of employees and their ability to convey trust and confidence”. Amin & Isa, (2008) came up with the same definition by defining assurance as “knowledge and courtesy of employees and their ability to inspire trust and confidence”. In the banking sector, Frago and Espinoza (2017) considered assurance as safety as the third most important factor of service quality measurement. Clemes, Gan, Kao, & Choong, (2008) and Yi and La, (2003) both suggested that assurance is a factor that has a positive and significant influence on customer satisfaction. The hypotheses developed concerning assurance are as follows:-

H1c: Service innovation has influence of assurance as a measuring factor of service quality

H2c: Assurance has a significant and positive influence on customer satisfaction.

Empathy

Empathy was defined as “the caring and individualized attention provided to the customer” (Parasuraman et al., 1991). Aghdaie and Faghani, (2012) and Suki, (2014) described empathy as the ability to give individual customers personal attention with regards to their specific needs. As a determinant to service quality, empathy is found to have a positive and significant influence on customer satisfaction (Clemes et al., 2008). Our hypotheses on empathy are:-

H1d: Service innovation has influence of empathy as a measuring factor of service quality

H2d: Empathy has a significant and positive influence on customer satisfaction.

5.2.3 Customer Satisfaction

Customer satisfaction can be defined as the process of meeting the expectation of a customer based on the product or service that is provided (Oliver, 1980). A customer can be considered to be satisfied as long it the services rendered matches or even exceeds their perceived expectation (Amin, 2016). Contrary to this notion, customers are also perceived to be dissatisfied (Fullerton & Taylor, 2015; Sharifi & Esfidani, 2014). In the marketing field, customer satisfaction has been highlighted as both cumulative and transactional (Cronin & Taylor, 1994; Liébana-Cabanillas, Muñoz-Leiva, &

Rejón-Guardia, 2013).

For our research, satisfaction will be viewed as a depended variable from service quality and will be assessed based on mobile banking services provided by Nigerian banks. Some of the previous studies on mobile banking services have assess these qualities based on their relations with service quality performance model (Arcand, PromTep, Brun, & Rajaobelina, 2017; Baabdullah et al., 2019; Efobi et al., 2014). But this is the first work combining assessment of service innovation and service quality performance.

5.3 Proposed Research Model and Hypotheses

This study research model (Figure 10 below) was based on the theory of the service innovation ambidexterity and SERVPERF models, (i.e. the Service Quality Performance Model) are hypnotized on their impact on customer satisfaction. The adoption of two categories of service innovations i.e. exploitative and explorative innovative features were used to examine their effect on service quality performance dimensions. The research model was build based on separate constructs system of service quality performance dimensions i.e. reliability, responsiveness, assurance and empathy as independent variables. Tangibility was dropped from this study since mobile banking service is not a physical object. The impacts of these independent variables were further assessed on customer satisfaction. With this theoretical establishment, nine (H1 – 9) hypotheses were developed.

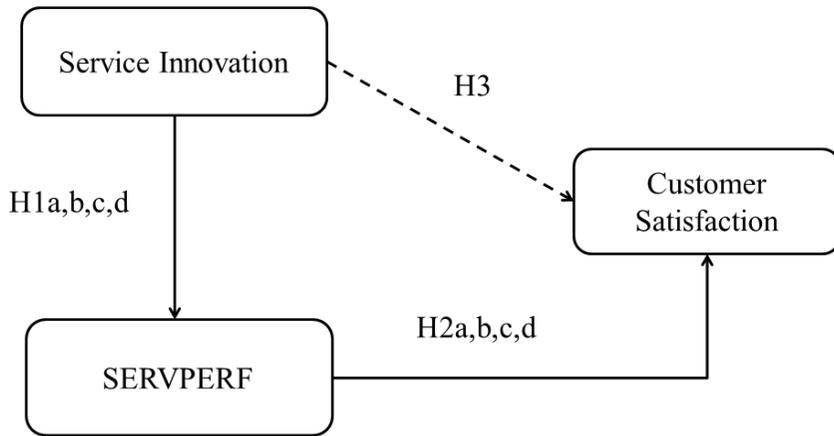


Figure 9. Research Model

The equation to measure our conceptual research model can be calculated as follows:

1st Stage:

$$\begin{aligned}
 Re &= \alpha_0 + \alpha_1 S.I_exploitative_{Re} + \alpha_2 S.I_explorative_{Re} + \varepsilon_{Re} \\
 R &= \alpha_0 + \alpha_1 S.I_exploitative_R + \alpha_2 S.I_explorative_R + \varepsilon_R \\
 A &= \alpha_0 + \alpha_1 S.I_exploitative_A + \alpha_2 S.I_explorative_A + \varepsilon_A \\
 E &= \alpha_0 + \alpha_1 S.I_exploitative_E + \alpha_2 S.I_explorative_E + \varepsilon_E
 \end{aligned}
 \tag{Eq. (8)}$$

2nd Stage:

$$CS = \beta_0 + \beta_1 Re + \beta_2 R + \beta_3 A + \beta_4 E + \gamma_{cs}
 \tag{Eq. (9)}$$

Hypotheses: Developed based on existing literature (adapted from Sok and O’Cass, (2015); Parasuraman et al., (1988); Cronin and Taylor (1994) and Leong et al., (2015)). Refer to Table 30 for more details on the adapted variables.

1. *H1a: Service innovation has influence of reliability as a measuring factor of service quality performance.*
2. *H1b: Service innovation has influence of responsiveness as a measuring factor of service quality performance.*
3. *H1c: Service innovation has influence of assurance as a measuring factor of service quality performance.*
4. *H1d: Service innovation has influence of empathy as a measuring factor of service quality performance.*
5. *H2a: There is a significant and positive influence of reliability on customer satisfaction.*
6. *H2b: Responsiveness has a significant and positive influence on customer satisfaction.*
7. *H2c: Assurance has a significant and positive influence on customer satisfaction.*
8. *H2d: Empathy has a significant and positive influence on customer satisfaction.*
9. *H3: There is a direct significant and positive effect of service innovation on customer satisfaction.*

The relationship between our proposed research model and research questions can be linked through the following groupings of our developed hypotheses (see Table 29 below).

Table 29. Hypotheses and Research Questions link (Chapter 5)

Relationship	Research Question 1	Research Question 2	Research Question 3
Hypotheses	H1a, b, c & d	H2a, b, c & d	H3

Table 29 above explains the relationship between our research questions and our hypotheses. Hypotheses H1a, b, c & d is addressing Research Question 1 examines the relationship between exploitative and explorative service innovation and SERVPERF Model. Hypotheses H2a, b, c & d is addressing Research Question 2 examines the relationship between SERVPERF Model and customer satisfaction. Hypotheses H3 addresses Research Question 3 examining the indirect relationship between exploitative and explorative service innovation to customer satisfaction.

Table 30. Previous Existing Models (Chapter 5)

S/N	Model Variables Measure	Objective	Source
1.	<i>Independent Variables:</i> Exploitative and Explorative Innovation <i>Dependent Variable:</i> Service Quality and Firm Performance	<i>“To investigate the effects of service innovation exploration – exploitation on financial performance through the delivery of quality services”.</i>	(Sok & O’Cass, 2015)
2.	<i>Independent Variables:</i> Tangibility, Reliability,	<i>“To determine the influence of SERVPERF on customer</i>	(Leong et al., 2015).

S/N	Model Variables Measure	Objective	Source
	Responsiveness, Empathy and Assurance <i>Dependent Variable:</i> Customer Satisfaction and Loyalty	<i>satisfaction and customer loyalty among low cost and full service airlines”.</i>	Amin and Isa (2008)
3.	<i>Independent Variables:</i> Tangibility, Reliability, Responsiveness, Empathy and Assurance <i>Dependent Variable:</i> Service Quality	<i>“To examine the relative efficacy of performance-based and perceptions-minus-expectations measures of service quality”.</i>	(Cronin & Taylor, 1994).

5.4 Methodology and Data Collection

Methodology

To evaluate our proposed model, a survey was developed and to be carried out in Nigeria among the customer using mobile banking services. A sample questionnaire (see Appendix survey question 2) was designed and adapted from previous literature. The items used in the survey questionnaire were adapted from models of previous researches. For reliability of our new model, the items used for the survey questionnaire were consistent with the sources (see table 30 above) adopted from literatures. A five-point Likert

scale (5 - 1) were used ranging from “strongly agree to strongly disagree”.

To achieve better sample distribution, Nigeria’s three main states i.e. Abuja, Lagos, and Kano were selected for this study. The reason for the selection of these states comes with the fact that they are considered as the administrative capital, economic center, and most populated state respectively. These states have their advantages in contributing to the economic growth of the nation. Selecting the customers in these locations as the sample size becomes important because of the large pull of customers using mobile banking services. This will also provide the right measure of the population with no sampling error for a reliable and good result (Gorondutse & Hilman, 2017; Hilman & Kaliappen, 2014).

To test the items of the questionnaire, a pilot study was carried out on a sample of 30 customers. The results obtained provided valid and reliable evidence that the scale and items used in the questionnaire were acceptable to test our proposed model.

Data Collection

The survey questionnaire was adapted from previous studies like Amin and Isa (2008) and Leong et al., (2015). Valid research questions were adapted and carefully designed under controlled conditions (i.e. focusing on the banking sector) that were sourced and replicated from previous researches. The survey questions used a “Likert Scale” of 5 – 1 (i.e. from

strongly agreed to strongly disagreed). In conducting the survey, a Google form page was design and also a paper based printed format of the questionnaire were also handed out to mobile banking customers. Two months duration was taken to finally receive the required number of questionnaire replies (after constant weekly reminders).

After a total of 750 questionnaires were distributed (i.e. delivery 40 questionnaires among the 18 commercial banks in Nigeria). For this study, 307 responds were received which is followed with conducting data screening and cleaning, and only 207 respondents i.e. 27.6 percent response rate were deemed to satisfy the valid response of the research. One of the reasons for the low response can be attributed to most bank customers are reluctant to disclose any information regarding their personal banking details due to high rate of cybercrimes.

Measurement Model

Since our quantitative was obtained, the analysis of these data (Table 28 shows the descriptive statistics of the data obtained) is based on numbers representing customer's perception, therefore to evaluate our hypotheses, a SMARTPLS 3.2.9 was employed to conduct a Partial Least Square-Structural Equation Modeling (PLS-SEM) analysis. Because PLS-SEM is a composite-based SEM that is appropriate for exploratory studies (Sarstedt, Ringle, & Hair, 2017; Wold, 1975). Also Hair (2017) stated that PLS-SEM

was designed to conduct estimation for prediction purposes especially for research models that are complex. Henseler et al., (2014) also added that PLS-SEM accommodates small sample size and a non-normalized data.

Measuring Variables

For selecting and measuring our variables, service innovation (exploration and exploitation), SERVPERF model variables and customer satisfaction were adapted from the sources in Table 31 below.

Table 31. Definition of Variables (Chapter 5)

Variable	Definition	Source
Service Innovation (Exploration and Exploitation)	<p>“Exploitative innovations are considered as incremental innovations, these are innovations which are designed to look into the needs of the current markets and customers”</p> <p>“Explorative innovations were categorized as radical in nature. The designers of these innovations considered the innovations to look into the future by adapting to developing markets and customers”</p>	(Jansen et al., 2006; Sok, O’Cass, & O’Cass, 2015)
Reliability	<p>“The service provider’s capability to offer precise and trustworthy services”.</p>	(Cronin & Taylor, 1992, 1994; Leong

Variable	Definition	Source
Responsiveness	“A firm’s readiness to help its customers by providing swift and efficient service performance.”	et al., 2015)
Assurance	“Miscellaneous features that give confidence to customers (i.e. the firm’s particular service knowledge, courteous and trustworthy behavior of employees).”	(Amin & Isa,
Empathy	“The service firm’s willingness to offer each customer with individual service”	2008; Arcand et al., 2017;
Customer Satisfaction	“Defined as an individual’s perception either discontent or pleasure by comparing the perceived performance of a product with respect to one’s expectations”	Baabdullah et al., 2019; Leong et al., 2015)

5.5 Results Analysis

5.5.1 Descriptive Statistics

The result of the study shows the statistical description between the variables that were measured during this quantitative study (see Table 32). Mean and standard deviation (S.D) are viewed as important in describing statistics in terms of interval ratio scale (Sekaran & Bougie, 2013). Table 32 shows the results of the mean and S.D of all the variables measured in this study. Service Innovation was observed at a Mean = 3.76 and S.D = 1.03 and

Service Quality dimensions were recorded with Reliability (Mean = 3.34 and S.D = 1.16), Responsiveness (Mean = 3.41 and S.D = 1.08), Assurance (Mean = 3.67 and S.D = 1.00) and Empathy (Mean = 3.39 and S.D = 1.03) and Customer satisfaction as depended variable was observed at Mean = 3.76 and S.D = 1.00. This result was found to record both service innovation and customer satisfaction to have the highest mean and Reliability with the lowest mean with also the highest S.D at 1.16. The R square fitness of the model was obtained with the range of 0.159 to 0.223 i.e. falling with the acceptable R range of 0 to 1. All the measured variables were recorded within the ranges of high level.

Table 32. Variables Descriptive Statistics (Service Quality)

Variables	Mean	S.D
Service Innovation	3.76	1.03
Reliability	3.34	1.16
Responsiveness	3.41	1.08
Assurance	3.67	1.00
Empathy	3.39	1.03
Customer Satisfaction	3.76	1.00

5.5.2 Collinearity

Multicollinearity is defined as the relationship between two or more variable i.e. there is no orthogonality between them (Alin, 2010; Farrar & Glauber, 1967; Mansfield & Helms, 1982). Gorondutse & Hilman, (2017) also referred to multicollinearity as statistical assessments were two or more

predicting constructs in regression are highly correlated. The result of our study was assessed for multicollinearity from calculations of Value and Variance Inflated Factor (VIF). Hair, Risher, Sarstedt, & Ringle (2019) and Hair et al., (2012) both studies showed that there were no issues with multicollinearity if the VIF is less than 5 (< 5). Table 33 below illustrates the estimated values of VIF of the constructs in this study, indicating that multicollinearity between the ranges of 1.000 to 1.842 was achieved.

Table 33. VIF Values (Service Quality)

Variables	VIF
Service Innovation	1.000
Reliability	1.326
Responsiveness	1.671
Assurance	1.842
Empathy	1.831

The results from Table 33 above, the values obtained illustrates that there is no multicollinearity between the measured variables since the values of VIF are all less than 5, showing that the rule of thumb was followed (Hair et al., 2011). As such this has satisfied that the measured constructs of this study and thus all the constructs are satisfied for measurement and structural model evaluation.

For the analysis of our data, PLS-SEM was employed. To evaluate the measurement and structural model, Hair et al., (2019; 2012); Shmueli et al. (2019) and Ringle et al. (2011) all showed a two-step modeling method (i.e.

measurement and structural models) of investigating the quality of items that were used during the measurement and evaluation. Then this was followed by process of estimating the relationship among the models.

The method of obtaining results was improved for researchers, since (Wold, 1975) developed PLS-SEM as a solution to statistically provide solutions for a different types of researches. Chin (2010) also supported the idea of using PLS-SEM to analyze researches that have reflective and explanatory measurements. The use of SmartPLS software as an analysis tool was employed to assess for reliability, validity, bootstrapping (for investigation effects) and multicollinearity of our developed model (Ringle, Wende, & Will, 2005).

5.5.3 Measurement Model

The measurement model was assessed through evaluating the results from our Item Loading (≥ 0.708), Composite Reliability, Convergent and Discriminant Validity (HTMT). Composite reliability with a threshold rate of 0.70 and Average Variance Extracted (AVE) ranged at ≥ 0.50 .

5.5.3.1 Reliability and Validity

Table 34 shows that all values of item loading which were ranging from ≥ 0.708 , i.e. all items satisfying the loading requirement. Composite Reliability results were ranging from 0.812 – 0.867 satisfying the requirement. The Average Extracted Variance (AVE) measures were evaluated at 0.534 – 0.618 which also within the threshold range. The result

in Table 34 below indicates that reliability and validity have been achieved.

Table 34. Reliability and Validity (Service Quality)

Variable	Items	Factor Loadings	C.R	AVE
Service Innovation	SIE3	0.726	0.821	0.534
	SIE4	0.731		
	SIE5	0.764		
	SIE7	0.701		
Reliability	Re3	0.734	0.827	0.616
	Re4	0.858		
	Re5	0.758		
Responsiveness	R2	0.750	0.812	0.591
	R3	0.790		
	R5	0.765		
Assurance	A2	0.797	0.829	0.618
	A3	0.760		
	A4	0.801		
Empathy	E2	0.742	0.829	0.548
	E3	0.727		
	E4	0.772		
Customer Satisfaction	C1	0.795	0.867	0.567
	C2	0.747		
	C3	0.729		
	C4	0.732		
	C5	0.750		

5.5.3.2 Convergent Validity

From the results below (see Table 35) of Convergent Validity (based on Fornell & Larcker Criterion) it can be agreed that all the variables of the model are valid for measurement model analysis.

Table 35. Convergent Validity (Service Quality)

	A	C	E	R	Re	SIE
A	0.786					
C	0.672	0.753				
E	0.627	0.584	0.741			
R	0.515	0.507	0.539	0.769		
Re	0.369	0.386	0.341	0.459	0.785	
SIE	0.423	0.409	0.399	0.472	0.427	0.731

5.5.3.3 Discriminant Validity (Heterotrait-Monotrait Ratio HTMT)

Churchill Jr, (1979) and Henseler, Ringle, & Sarstedt, (2014) defined discriminating validity is “*the extent to which constructs are different from one another*”. Fornell & Larcker (1981) and Gefen, Straub, & Boudreau (2000) both agreed that “*the shared variance for all model constructs should not be larger than their AVEs*” while on a contradictory note, Henseler et al. (2014) suggested that the Fornell and Larcker criterion is slightly lacking especially when item loadings of constructs that have minor differences i.e. indicator loadings ranging from 0.65 and 0.85. However, a value of less than 0.85 (< 0.85) was suggested as the threshold for “*Heterotrait-Monotrait (HTMT) ratio of the correlation.*” (Voorhees et al., 2016).

Therefore, “*HTMT is defined as the mean value of the item correlations across constructs relative to the (geometric) mean of the average correlations for the items measuring the same construct*”(Voorhees et al.,

2016). When constructs are conceptually very similar, the threshold value is considered less than 0.90 (< 0.90) and for those that are conceptually different, their threshold should be considered less than 0.85 (< 0.85) (Hair et al., 2019; Sarstedt et al., 2014; Shmueli et al., 2019).

Table 36. Discriminant Validity (HTMT) Service Quality

	A	C	E	R	Re	SIE
A						
C	0.893					
E	0.887	0.759				
R	0.770	0.698	0.784			
Re	0.566	0.509	0.484	0.679		
SIE	0.593	0.536	0.555	0.686	0.593	

Table 36 above indicates the correlation matrix where the diagonal indicators showed the square root of the latent variables AVE. The result shows that most variables have achieved discriminant validity. By assessing the HTMT ratio, the figure below (see Figure 11) shows that our analysis for constructs that are both conceptually very similar and differently distinct. Only C→A and E→A relationships have shown not to achieve discriminant validity.

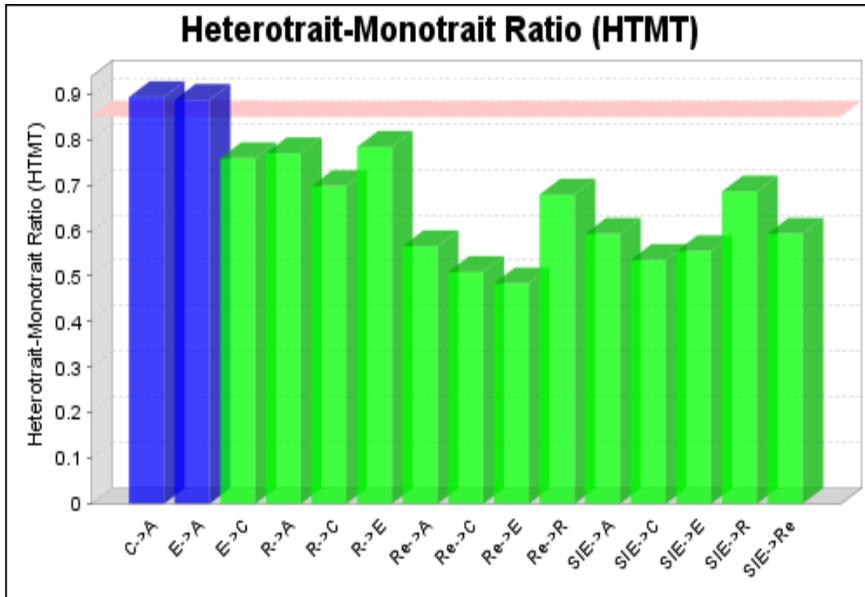


Figure 10. Service Innovation to SERVPERF HTMT Ratio

5.5.4 Structural Model

The following results were obtained and analyzed to evaluate the structural model of the research model. Below are the tests for hypothesis which will allow for examining the relationships between the studied constructs.

5.5.4.1 Hypotheses Testing

Through the structural modeling analysis, it is possible to examine both the direct and indirect effects between independent and dependent variables. With the possibility to run iterations and conduct estimation using the SmartPLS software package, as recommended by Hair et al., (2012) and Sarstedt et al., (2014) our study also analyzed the t-values using bootstrapping with an estimated 5000 re-sampling iterations within the

standard deviation distribution range so that it can function as proxy for the parameters within the standard statistical error range.

Table 37. Hypotheses Testing (Service Quality)

H	Relationships	PT	S.D	T Statistics	P – Values	Findings
H1a	<i>SIE→A</i>	0.426	0.045	9.480	0.000	<i>Supported</i>
H1b	<i>SIE→E</i>	0.396	0.044	9.014	0.000	<i>Supported</i>
H1c	<i>SIE→R</i>	0.467	0.037	12.629	0.000	<i>Supported</i>
H1d	<i>SIE→Re</i>	0.425	0.043	9.901	0.000	<i>Supported</i>
H2a	<i>A→C</i>	0.441	0.054	8.159	0.000	<i>Supported</i>
H2b	<i>E→C</i>	0.210	0.059	3.564	0.000	<i>Supported</i>
H2c	<i>R→C</i>	0.131	0.060	2.175	0.030	<i>Supported</i>
H2d	<i>Re→C</i>	0.080	0.045	1.778	0.076	<i>Rejected</i>

Keys: PT = Path Coefficient; S.D= Standard Deviation

The above Table 37 specifies seven of the hypotheses have positive and significant effects on all four service quality performance variables. The results of their p-value were obtained with the range of 0.000 – 0.076 i.e. with seven p-values falling less than 0.05 which is 95 percent confidence interval. Lastly, one of the hypothesis was found to have negative significance to customer satisfaction i.e. *Re→C* was rejected.

5.5.4.2 Total Indirect Effect

Total Indirect Effect of the service innovation to customer satisfaction is positive with significant effect (Table 38). The T-Statistics value of the results was determined at 9.654 and 0.000 p-values (i.e. greater than 1.96

and less than 0.050 threshold range).

Table 38. Total Indirect Effect

Hypothesis	Relationships	S.D	T Statistics	P – Values	Findings
H	SIE→CS	0.038	9.654	0.000	<i>Existing</i>

5.6 Discussion

Our first research question examines the significant influence of service innovation (exploitative and explorative) on service quality performance of mobile banking services. The results shows that service innovation has a positive impact on the service quality performance which coincides with previous studies of Lin (2013) which also showed a positive significant impact of service innovation on service quality.

The 2nd research question examined the impact of service quality performance of mobile banking services on customer satisfaction. The results indicated assurance, empathy and reliability have positive significant impact on customer satisfaction. This can be supported by the works of Leong et al., (2015) and Amin and Isa (2008) which also experienced a positive impact. Only responsiveness variable was rejected as a negative impact. This can be attributed to issues and challenges of service provision from the providers (Ozili, 2018).

The 3rd research question of this work examined how service innovation has an indirect impact on customer satisfaction while using mobile banking

services. The result in Table 38 showed that there exists an indirect relationship between service innovation and customer satisfaction. This indirect existence can be supported to also exist in works of Lin (2013).

5.7 Implications

From a theoretical perspective, this study has added to the current literature in regards to the influence of service innovation i.e. from both exploitation and exploration to service quality model (i.e. SERVPERF) and customer satisfaction of the services provided over mobile technology in the banking industry. This research is among the pioneers of studies to investigate the impact of service innovation on customer satisfaction from an indirect and a direct effect perception. Furthermore, this study is among the first to test the effect of SERVPERF quality model on evaluation of customers satisfaction. The model was established to a robust channel to assess quality of financial innovation services. Hence, the conceptual model designed for this research can be applied as a reference for future works that might concerned the assessment of innovation, quality and how users perceived the services they receive.

Our research empirical findings have shown that the results obtained can contribute to decision makers of banks especially those managers concerned with mobile banking services. This information can provide them with important information about the quality of innovative services they provide. With both exploitative and explorative service innovations have a positive

impact on service quality performance, the management and decision makers can try combining both innovations based on need assessment. For a sector that requires an overhaul, an explorative innovation can be adopted, while in incremental case an exploitative innovation adoption should be arranged.

The dimension of responsiveness as an impacting factor to customer satisfaction was rejected. Even though, customers value responsiveness while using mobile banking services, the notion of the services responsiveness might be seen from both the banks and the telecommunication service provider perspective. The banking management should ensure upgrade in the quality of response time of mobile banking services. Decision regarding responsiveness must be address in collaboration with all other stakeholders that participate in service provision. A standard quality rate should be adopt by all parties to all stakeholders provide the rate of service quality in terms of responsiveness. With an assessment on the issue of responsiveness carried out and fixed immediately. Also a feedback procedure on necessary actions regarding responsiveness for the customers is important. So far, this will show them how they are valued and also remedy any deficiencies with regards to the banks attention on situations.

For a bank to be competitive, it is supposed to provide quality services that are assured and reliable to their customers. Assurance, empathy and reliability are quality dimensions that are imperative for any mobile banking service provider, therefore ensuring that the present quality status quo is kept and

improved for customer's satisfaction. Finally, a periodical monitoring and evaluation must be achieved so that customers will be assured that the services they use is fully reliable, assured and respond to their need continuously.

5.8 Contributions

Empirical studies on service innovations and its impact on quality with the views of customer's satisfaction is limited within the present literature environment. This study presents an evaluation of how service quality serves as a mediator between service innovation and customer satisfaction. Previous studies that were carried out only focused on service quality, customer satisfaction and loyalty of products and the manufacturing industry. Due to the proliferation of new innovative services and the way these services are changing the business ecosystem, service innovation needs to assess to how it can produce satisfied customers especially within the banking industry.

The sample of data used in this research focused on customers that utilized mobile technology to engage in financial services. The effect of service quality have produce a positive significant impact on customer satisfaction with only tangibility been dropped as a dimension, since services are considered as intangible provisions.

This research is the first empirical work in Nigeria (Sub Saharan Africa) that addresses how banks should adopt the notion of service innovation

(exploitation and exploration), use SERVPERF model to assess quality in order to provide satisfaction to its customers.

5.9 Sub-conclusion

The objective of this study was to examine the influence of service innovation on customer satisfaction. The results obtained after our data analysis have shown that service innovation has a positive and significant influence on the dimensions of SERVPERF model. Likewise, the SERVPERF dimensions were found to have a positive and significant effect on customer satisfaction with only the exception of the responsiveness dimension which is negatively significant.

Our study approached to sampling of Nigerian mobile banking users. The sampling of the study was taken from the three major cities of Nigeria i.e. Abuja, Kano and Lagos this might have slight influence the issue of generalizability of the whole population of the country. As the adoption of technology is more famous within the young age bracket, the majority of the respondents are the educated, young and also working class employers. Therefore, the sample might dismiss other groups e.g. the old, illiterates, and high income mobile banking users.

This result of our study showed that responsiveness has a negative impact on customer satisfaction of mobile banking services. The lack of impact of this variable might be attributed to other service providers like the

telecommunications companies and the inter-bank payment companies like the Nigerian Interbank Settlement System. The inabilities of these companies to deliver services accordingly are perceived as the banks fault. The lack of information from these service providers from the respondent's perspective might slightly affect the result.

Finally, this study has determined that service innovation in relationship to service quality performance is essential in delivering mobile banking services. It has shown that it can play a center role in ensuring that the combination of service innovations (radical or incremental) adoption must confer to quality so that customers are satisfied.

Chapter 6. Investigating Factors Impacting User Accessibility and Satisfaction in Mobile Banking Service Delivery: A SEM-ANN Hybrid Predictive Analysis Approach

6.1 Introduction

The proliferation of internet into all sectors our daily activities has changed the financial and banking sector by aiding banks to adopt digital transformation that has helped changed how they internally conduct execute their banking processes (BCBS, 2018). As such, banks have in addition to using information technology (IT) only for their internal processes, they have also adopted new and innovative means in providing access to financial services such as internet banking (Amin, 2016). One of the successes of utilizing IT and service innovation in the banking sector is its ability to eliminate servicing hours in delivering financial services to its customers. Service delivery innovations like automate teller machines (ATMs), Internet, telephone and mobile banking have dispense the traditional banking business hours to provide a 24/7 financial availability to its customers.

The Financial Times and also the Central Bank of Nigeria (CBN) both recognized that there are over 60 million unbanked Nigerians (Efobi et al., 2014; Financial Times, 2018). While on the other hand, the Nigerian Communications Commission reported that the country has over 185 million

active mobile line subscribers (i.e. indicating 97.45% Teledensity percentage) (NCC, 2020). In this regard, to reduce the rate of these unbanked citizens, the CBN's revised National Financial Inclusion Strategy (NFIS) has sought out to make mobile banking a pillar to delivering financial services to these unbanked citizens (CBN, 2018). As such, the unbanked Nigerians perform financial and banking services like opening accounts, transactions, paying bills and loan applications through new and innovative financial services such as social media banking and USSD.

With initiatives to surge financial inclusion in countries like Nigeria, the CBN's NFIS main target is to help reduce the growing poverty rate in the country. The importance of using the combination of mobile technology and innovative financial services is to increase financial inclusion for economic growth among individuals, businesses and the government (Ozili, 2018). Thus, by providing new service delivery innovative channels, financial services and inclusion can contribute to citizens, banks, financial providers, government accessibility to financial services (Efobi et al., 2014). The benefits of these new innovative service delivery channels are making available and accessible services at a trusted and reduced and affordable cost (Efobi et al., 2014; Ozili, 2018) .

Moreover, due to its availability and ease to use, mobile banking has become a successful financial service delivery channel and quite a large number of customers in Nigeria have accepted and adopted the use of this

technology and its services for daily individual and business routines (Ozili, 2018). Despite the availability of mobile banking services, there are still prevailing gaps and contradiction between the availability of these financial services and its user accessibility and satisfaction, especially in terms of bridging the gap of financial inclusion (Bankole & Bankole, 2017). Ozili (2018) highlighted that precaution needs to be taken not to equate availability with accessibility. It can be assumed that if there is need to increase financial inclusion, and then more accessibility of services is needed. Because this can improve the unbanked chances of acquiring basic financial services that are cheap for citizens that are poor and of low income and upon all placing these services on mobile phones make these citizens have access to banks.

Presently, banks have been innovating with mobile banking service so that they can reach out to an abundant number of customers (Lee & Chung, 2009). By increasing new service delivery of mobile banking services, customers and new potential users will take the advantage of utilizing mobile banking services since it produces value with regards to no effort in use, flexible use at any place and time, affordable cost and trusted security. However, with all these benefits, current literature suggests that researches have not focused on examining how the service price, trust and quality which are determinants of using mobile banking services affects user accessibility and satisfaction.

The objective of this research work to first examine the causal relationship between Quality, Price and Trust as influencing factors of user

accessibility and satisfaction in order to find ways to increase financial inclusion. Secondly, it seeks to investigate issues related to service price payment and trust as factors that might influence accessibility and satisfaction. Third, is to examine the success of mobile banking based on DeLone and McLean Model.

Investigating innovative service delivery on mobile banking will increase our comprehension of the way how the above determinants impact customers and thus provide a chance to provide ways to increase new customers. This study is expected to provide some mobile banking accessibility and satisfaction guidelines and strategies based on the service delivery technology applied by the banks, so as to explore ways of increase financial inclusion.

This chapter is organized as follows: 2.0 Literature Review, 3.0 Research Model and Hypothesis, 4.0 Research Methodology, 5.0 Results and Discussion, 6.0 Sub-Conclusion, 7.0 Contribution and 8.0 Implications.

6.1.1 Research Objective

To investigate, evaluate and make predictive analysis of the causal relationship (i.e. both linear and nonlinear relationships) between IS success qualities (i.e. system. Information and service), Price Value and Trust as influencing factors of user accessibility and satisfaction to achieve more financial inclusion.

6.1.2 Research Questions

1. What significant influence does IS success qualities, price value and trust have on user accessibility and satisfaction for achieving more financial inclusion?
2. What significant impact does user accessibility have on a customer satisfaction?
3. Among the three (3) proposed methodologies of predictive accuracy (i.e. PLSpredict, ANN and SEM-ANN) which of the approach can fit our proposed model and show accuracy in predicting user accessibility and customer satisfactions?

6.1.3 Research methodology

The methodological approach for this study will be explored using a hybrid of SEM and Artificial Neural Network (i.e. SEM-ANN). From the initial stage, our data was analyzed in two different steps i.e. involving PLS-SEM method with the SmartPLS 3.2.8 software (Hair et al., 2019; Ringle et al., 2012). With the advantage of PLS-SEM having the variance composite base SEM, its application in different fields of business and social sciences has proven it wide range of acceptance and importance in causal relationship analysis (Henseler, 2017). Both the measurement and structural model were assessed to understand the relationships among observed data and latent variable and also representing how these latent variables are related (Hair Junior et al., 2014). This first stage will only permit us to derive the linear

relationship of our model. Classifying PLS-SEM as a conventional linear regression technique, it is considered to over simplify how complex the process of human decision-making is interpreted (Chong & Bai, 2014; Tan, Ooi, Leong, & Lin, 2014) .

To mitigate this limitation, a second stage analysis is carried out using Artificial Neural Networks (ANN). With ANN been represented based on a structure of a human brain, its main benefit is the possibility to identify relationships that are non-linear and non-compensatory (Leong et al., 2015; Lai-ying Ying Leong, Hew, Tan, & Ooi, 2013). Both the works of Chong & Bai,(2014) and Sim (2014) emphasized on how ANN models have the capability to adapt and become highly robust so that it delivers accurate predictions, better than linear regression models. Although, Leong et al., (2015) and Liébana-Cabanillas, Marinković, & Kalinić, (2017) both agreed that when it comes to investigating causal relationship and hypothesis testing, ANN's approach is not suited. Thus, with our proposed hybrid approach of SEM-ANN, the two models can complement each other by reducing their limitations and improving their combined strength.. After the structural model analysis of the SEM is derived, an ANN model will be applied to rank the impact of predictors that are only significantly obtained for the SEM.

In this research work, neural networks were will be modeled on Tensorflow using python with a consideration given to both all data (from our original conceptual model to test only for ANN capability) and also for

the selected significant predictors obtained from SEM. For this study, four ANN models were investigated with a training dataset of 90 percent and testing set of 10 percent in calculating the Root Mean Square Error (average) of both data sets.

6.2 Literature Review

6.2.1 Service Delivery Innovation

Nowadays, researchers are interested in rethinking different channels of managing service innovation. Both Hertog (2000) and Miles (2009) agreed innovation in services are regarded when services have a relationship between service concepts, client interface, delivery practices and new technologies.

Service delivery is concerned with how an organization structures itself so as to provide a required service (Heskett, 1986). From the organizational side, the right management is assigned to provide its worker all they require to develop and offer services that are innovation to the customer. Service delivery innovations can start at the human resource of an organization and leads all the way to the customer (den Hertog, 2000). Edvardsson and Enquist, (2009) also stated that service delivery is not only from a retail side but also extends to motivating customers to become involved in the innovation process. Sampson & Froehle (2006), Teboul (2006), Vargo & Lusch, (2006) and Barrett, Davidson, & Vargo (2015) based service delivery as a resource co-produced and resourced processed based.

Sampson & Froehle, (2006), added the customer as stakeholder who has an important role in services delivery, since they provide the inputs of the delivery process. Teboul (2006) also viewed customers as agents that interact during service transactions and thus making them an integral part of the service delivery process.

Due to recent dynamic changes in technological world, have resulted to where banks are becoming more innovative and also putting large amount of investment in technology that can increase and improve their service delivery system. As banks are depending more on technology, service innovations is becoming a driving force for the changes within the banking industry (YuSheng & Ibrahim, 2019). Song, Song, & Di Benedetto (2009) integrated service innovation model and service quality to address issues of new service systems. The study showed that service delivery innovation captures aspects of service quality which links it to service performance and also improves how to provide better service management.

6.2.2 DeLone and McLean Model

A decade later after publishing the first IS success model, it was followed up by an updated that includes some changes e.g. the introduction of service quality and intention of use and net benefits were also featured as dependent variables (Delone & McLean, 2003). The model was further updated to remove individual and organizational impact and replace it with net benefits (Petter, DeLone, & McLean, 2013) . Previous researches conducted in the

fields of digital innovation, transformation, services, and disruption have evaluated their success using the DeLone and McLean's model (Skog, Wimelius, & Sandberg, 2018) . Manandhar, Kim, & Hwang, (2015) also expressed the DeLone and McLean model as a complete model for analyzing online services and how successful the model will be used to asses IS from a developing country perspective.

In terms of assessment of accessibility, Mustafa & Kar, (2019) used the DeLone and McLean model to evaluate system quality and use accessibility as a measure. By considering accessibility as a criteria needed to for digital services to function properly, therefore service delivery should be achieved with no physical limits hindering it. On the other hand, failure of this service delivery causes systems failure and results into inaccessibility.

The IS success model was also adopt and used to investigate mobile banking users satisfaction (Lee & Chung, 2009). The service quality of mobile banking services has a positive impact on satisfaction, thus an impact on satisfaction will also positively influence how these services are used. The model has also proved that there is a close interrelation between user satisfaction and use, even though in a process logic, use is expected to derived before user satisfaction (Baabdullah et al., 2019).

Boateng, Asongu, Akamavi, & Tchamyu, (2018) on the other hand suggested that it is important to share information regarding access to

financial services (e.g. credit) so that it can be facilitated by those in needed, this showing information quality is important to user satisfaction and accessibility. From the African perspective, Kusi and Opoku-Mensah, (2018) research showed that the kind of information available about finance services helps in moderating the price paid for the services. Ibrahim & Alagidede, (2017) stated that there are advantages of sharing information regarding access to financial services most especially in countries with English speaking countries than the French speaking countries.

Based on previous literature, any positive impact of system quality, information quality on mobile Banking service on satisfaction and accessibility can be recognized and included as factors that determine a customer's use and access of mobile banking services.

6.2.2.1 System Quality

With regards to mobile banking, customers have no direct association with the services system. Therefore, quality in terms of system in mobile banking can be viewed as an electronic storefront that can bring about the use of services on the mobile phones (Gao & Waechter, 2017).

Both DeLone & McLean, (1992) and Sharma, Gaur, Saddikuti, & Rastogi, (2017) considers the system to have quality features like prompt response time, reliable, stable and a good user interface. The deficiency of any of the aforementioned features might cause a user to have difficulties in

using the device and this will result in low user's intention to use. There by judging the ability of the service provider to deliver quality service (Dwivedi, Kapoor, Williams, & Williams, 2013). In most instances, customer satisfaction is rated based on worthy performance of the system. The experience of the user on this performance is expected to positively lead to their satisfaction and this directs users to continue using the system (Zhou, 2013).

Bhattacharjee (2001) also highlighted that there is a relation between user experience and a good performing system i.e. it a good performing system positively influences user experience. Based on the above literature support, it can be suggested that when there is a good and functional system quality, there are high chances users will have more accessibility and also be satisfied.

6.2.2.2 Information Quality

Sharma et al., (2017) and Veeramootoo, Nunkoo, & Dwivedi, (2018) explained that Information quality is expected to deliver on time, accurate, sufficient and be of relevant importance. Akter, D'Ambra, & Ray, (2013) further elaborated that quality of information is described as a contributing factor that impacts the attitude of customers with regards to how they use the technology. As such, Urbach, Smolnik, & Riempp, (2010) have considered information quality as the leading influencing factor for mobile banking intention of use. Zhou (2013) emphasized that lack of worthy

information quality increases the exertion of information segmentation which subsequently leads to additional difficulty in operations. Also the deficiency of good information quality results into decline in customer satisfaction as their expectation of reaching the right and accessible information of using mobile banking services is limited. Based on these previous literature supports, it is suggested that when good and quality information is provided by the banks, there are high chances users will have more accessibility and also be satisfied.

6.2.2.3 Service Quality

Delone & McLean, (2003) and Veeramootoo, Nunkoo, & Dwivedi, (2018) viewed service quality as the quality sustenance that is provided by the IS and IT support team to their customers or clients. Besides a product (i.e. device e.g. mobile phone) currently there are services mostly rendered on these products. There are emphases to focus on service quality, due to its significance as a measure of success and effectiveness in ensuring that quality of services are maintained at an accessible rate and satisfying the customers (Pitt, Watson, & Kavan, 1995).

With mobile financial services been provided over mobile technology and the mobile phones are the physical channels to access these services, therefore their usability and knowledge of their service quality is essential to user accessibility and satisfaction (Gefen, 2002). Hence, when users experience decrease in accessibility, reliability and slow response, service

quality can be rated as an unsatisfied factor to the customers (Kuo, Wu, & Deng, 2009) .

Previous researchers have also stated that the service providers should ensure that staff providing services must be very well trained, listen to customer's issues and challenges, and address their problems. This has been found to enhance access to services, intention of use and finally and cause customer satisfaction. When banks pay attention to mobile banking service quality, results have shown an increase in customer satisfaction is experience (Amin & Isa, 2008), thus more new customers are willing to adopt its usage as access to these are assured.

6.2.2.1 Price Value and Trust

Price value

Venkatesh, Thong, & Xu, (2012) defined price value as customers' rational tradeoff concerning the benefits of using an application(s) and the monetary cost been paid to use the services. To use services offered on technology, customers usually compare the price value they pay for both the technology and also the discounts they will realize in the future when they continue using the services on the technology (Alalwan, Dwivedi, & Rana, 2017; Baabdullah, 2018). Hence, Laukkanen & Lauronen, (2005) stated that this process of using this technology will add to the customer's level of using

the services provided by the technology most especially when discounts are awarded.

Nevertheless, from the perspective of mobile banking services, some customers might reject to continue using the banking services on mobile technology when service providers increase the charges price value (Njenga & Ndlovu, 2012). As such, service user might change their usage to a new innovative service with an easier and affordable price value, thus indicating that price value is a good factor determining how continuously a customer uses a service, consequently increasing their rate of access to that service (Alalwan et al., 2017). The net benefit derived from using a service should be more than the price value paid by the customer; this will allow the customer to continue using the service and also increases their access rate (Lee, Park, Chung, & Blakeney, 2012). This suggests that when customers are charged high price values, this will render them unable to make payment of these services and subsequently reduce the rate at which they access these services. Based on this price value can influence user accessibility and satisfaction.

Trust

The evaluation of customer's trust is expected to be centered on the confidentiality of mobile banking service providers to accomplish the intended services to be brought to a successful issue (Shim, Kim & Altman,

2016). Due to increase in the rate of cybercrimes, there have been issues with trust related to security and privacy (Noor, Anwar, Altman & Rashid, 2020). This is generating a lot of customer's risks concerns in engaging mobile banking services (Chong, 2013b).

With mobile phones as devices for channeling digital financial services, customers have concerns related to security confidentiality of not only the services they conduct through the phones, but also private information stored on their individual devices (Oliveira, Faria, Thomas, & Popovič, 2014; Slade, Dwivedi, Piercy, & Williams, 2015). Hence, to keep the current customers to continue using mobile banking service is important for both continues usage and granting new user access to financial services (Baabdullah et al., 2019; Slade et al., 2015).

Following the stated fact from these past literature, trust can be viewed as an important variable increase intention of use, accessibility and satisfaction amid mobile banking customers.

6.2.2.2 User Accessibility

Páez, Gertes Mercado, Farber, Morency, & Roorda, (2010) defined accessibility as an essential factor that plays a vital role in enabling how to understand the user's ability to partake fully in day-to-day life activities. Provision of accessibility helps in curtailing exclusion issues and promotes progress in terms of realizing better understanding of how individuals can

access facilities. In another definition by ISO 9241-171 (ISO, 2008) accessibility is regarded as a usability of a service, by individuals and it provided to them an inclusive variety of capabilities. Therefore, accessibility revolves around issues that provide the biggest possible variety of services to its users.

Burgess and Pande, (2004) suggested that the absences of accessibility to financial services can be attributed as one of the major reasons why poor people remain in poverty conditions. Hassan and Alamgir, (2002) supported this view by stating that the extent of poverty is ascribed that poor citizens are ‘systematically disorganized’ by relationships in their environment which is political, economic and social centered.

According to Aterido, Beck, & Iacovone, (2013) access to financial services is different to use of financial services and individuals that have access to financial services might not be using them owing to some reasons that might reasons that are sociocultural to that particular community. Sometimes not using this services are due to high cost of these services, and these cuts them off accessibility to these services.

Since mobile banking is a category of digital financial services (Ozili, 2018), previous researches like Hu & Zheng, (2016) defined digital finance as any innovation any organization offers in order provide access to financial applications to the general public over the internet. Ozili, (2018) stated that

financial inclusion and digital finance are important to users of financial services, government, financial providers and the economy. Therefore, an increase in accessibility to finances to the low income individuals decreases the cost at which banks and other financial companies provide services.

Despite the current improvement in digital financial innovativeness, accessibility and use of financial services has fail to reach vast segments of the population which shows there is an existing gap between availability and accessible used services (G20 Summit, 2013). Gomber, Koch, & Siering, (2017) explored what digital finance encompasses e.g. software's related to finance, service delivery that allows customers to interact and communicate to achieve financial services. This can be attributed that digital finance covers technology, services and products that ensures customer and other stakeholders have access financial services over the internet. Based on researches above, it can viewed that digital finance like mobile banking services are essential to providing access to financial services and other factors like price paid to use these services and the trust customers have on the services can influences a user's accessibility.

6.2.2.3 Customer Satisfaction

The idea of measuring customer's satisfaction started some few decades back. Customer satisfaction has been characterized as a measure of the difference between the expectation of a customer before paying for a service and the customer evaluates the services after use (Oliver, 1980). Johnson,

Gustafsson, Andreassen, Lervik, & Cha, (2001) suggest that the service sectors have different views of how customer satisfaction is viewed. They identify that some customers see it from the perspective of transaction-specific concept while others view it as a cumulative concept. Therefore, with banking as a service sector, it can be supported to operate on a transaction-specific concept. Although Johnson et al., (2001) suggested that customer satisfaction should be viewed from the angle of cumulative concept and operation, while other authors support more of viewing it from the perspective of transactional specific concept.

6.2.3 Mobile Banking Technologies and Services

Based on previous literature, mobile banking service deliveries can be categorized into different sectors i.e. based on the services these technologies offer and how banks have also adopted already existing technologies and utilize them to provide banking services to reach out to large number of customers and pay less on hosting all these services as a financial inclusion procedure (Krugel, 2007).

Mobile Banking Applications (app)

Pousttchi & Schurig, (2004) Mobile banking application is a program application that is downloaded over the internet and install on a mobile phone to all a user access financial services over mobile phones. Mobile banking applications are expected to fulfill the needs and expectation of a

customer and complete a transaction performed. Hu, Li, and Hu (2008) highlighted that new mobile banking applications provide contents that are new and innovative.

Mobile banking applications have features that includes that are information technology and also applications that are meant for commercial services (Alavi & Ahuja, 2016) . The app has provided 24 hours banking services to customers and also gives them an opportunity to become bankable with no constraints to location (Kourouthanassis & Giaglis, 2012) . With the following advantages, mobile banking applications have removed the limitations of access to banking services (Alavi & Ahuja, 2016).

Sampaio, Ladeira, & Santini, (2017) state that the use and adoption of mobile banking applications in experiencing continuous growth and is expected to exceed two billion users by the year 2030. Likewise, there are has been increase surge in the number of complains with regards to services utilized over mobile banking apps. These complain have become a focus to adjustment, so that banks can achieve more customer satisfaction that can build trust and loyalty.

Short Message Service Banking

Short Message Services (SMS) has be an effective technological service that has been adopted and used in a reached considerable large number as a mobile communications service (Peevers, Douglas, & Jack, 2008). Even

though the number of SMS messages has reduced by half (i.e. from 6 trillion to 3 trillion) from 2016, it is still considered an important mobile communication services (ITU, 2018). This can be attributed to new social network services that are rapidly changing almost all sectors in the world. Sillence & Baber, (2004) stated that SMS messages are mostly used as a one-2-one communication channel commonly among friends, but later businesses (e.g. the banking sector) have realized the huge potential of using SMS for deploying services and also for communication to individual communication with customers.

SMS banking services has been a huge success throughout the world, most especially in Asian and Africa (e.g. India and Kenya). Its popularity in these two particular continents is due to use of low cost mobile phones because of the socio-economic status and also lack of extensive internet infrastructure (BBC, 2004). Almost all banks in developing countries have adopted SMS banking services to provide information and notifications (Shaikh & Karjaluoto, 2015) . Because SMS depends only on normal Global System for Mobile Communications (GSM) networks, its ease of for delivery of financial services to consumers has been successful.

Unstructured Supplementary Service Data (USSD)

The USSD was originally designed for maintaining and testing features. This allows engineers of mobile network operators (MNO) to transmit and

receive messages over GSM networks in such a way that services are not disrupted for the customers (YA & Yewande, 2020) . It was later adopted by telecom services providers for prepaid airtime and checking of airtime balance (Perlman, 2017).

USSD is a mobile financial services interface that is highly patronized in developing world. Its ease of use has resulted in adoption go services since it there is no requirement for downloading, installing an application with no need for internet connection. These few qualities has transform USSD mobile as a platform for universal access to mobile financial services. Presently USSD is been regarded as the 3rd universal app in mobile financial services (Thusi & Maduku, 2020).

Perlman, (2017) suggested some advantages of USSD are its ease of adaptability to all GSM phones, it's fast, easily accessible and response time is reliable. Several of its drawbacks include technical limitations that have been happening due to increase on failures of transactions. There is lack of enough security with USSD services and accessibility might be blocked, controlled or made excessively by service providers as a result of bottlenecks created due to competition.

Social Networking (Social Media) Banking

Bohlin, Shaikh, & Hanafizadeh, (2018) defined Social network banking as the delivery of financial and banking services to consumers over social

networking platforms that are accessible through mobile phones or tablets. These days, social media has evolved as a platform for general public use i.e. both for people that have and do not have any IT skills. Its attraction to provide free services has drawn billions of users worldwide. Besides, social media platforms have utilizes the internet to provide their services and this has changed the world's business ecosystem. These platforms are found to be quite popular most especially among the new millennial generation (Parusheva, 2017; Rezayat, 2017).

Okeke, (2018) and Parusheva, (2017) expressed that the worlds banking industry has become conscious of the importance of social media because of the influence and extend it can reach customers. This has enable banks to reach out to customers far beyond the traditional or early digital banking system. Presently, banks have extensively engaged social media as a channel for marketing, customer relationships and service support, although only a few have started offering transactional banking services.

Bohlin et al., (2018) highlighted the attributed some advantages of social networking banking to additional banking services that are accessibility, easy to use, reduction in payment charges, opportunity to recruit new customers while retaining old ones, convenience of access anywhere and anytime. Parusheva, (2017) expressed that there are some transaction security issues ascribed to social networking banking. This research work stated that to bank customers security is a very important issue for them to trust the

transactions they can conduct via social networking banking services. In essence, these banks have taken security initiatives that uses an out band authentication using a onetime SMS password send to the customer’s mobile phone. Some of the security initiatives have built confidence and most importantly trust to use the social networking banking services.

6.3 Proposed Research Model and Hypotheses

The research model of this study (see Figure 12 below) was based on the theory of the IS success model, (i.e. the DeLone and McLean updated 2003 Model). Price value and Trust were evaluate as contributing variable that can predict user accessibility and its impact on customer satisfaction. The research model was build based on separate constructs system, information, service quality, price value and trust and their impact on user accessibility and customer satisfaction. With this theoretical establishment, nine (H1 – 9) hypotheses were developed.

Two equations were measure from our conceptual research model the equations were calculated as follows:

$$UA = \alpha_0 + \alpha_1 SQ + \alpha_2 IQ + \alpha_3 SRQ + \alpha_4 PT + \chi_{UA} \quad \text{Eq. (10)}$$

$$CS = \beta_0 + \beta_1 SQ + \beta_2 IQ + \beta_3 SRQ + \beta_4 PT + \delta_{CS} \quad \text{Eq. (11)}$$

Hypothesis: *Developed based on existing literature (adapted from Lee and Chung, 2009 and Venkatesh et al. (2012); Shareef, Baabdullah, Dutta,*

Kumar, & Dwivedi (2018). Refer to Table 30 for more details on the adapted variables.

1. H1 and H2: System quality of mobile banking service delivery will positively contribute to User Accessibility and customer satisfaction.

2. H3 and H4: Information quality of mobile banking service delivery will positively contribute to User Accessibility and customer satisfaction.

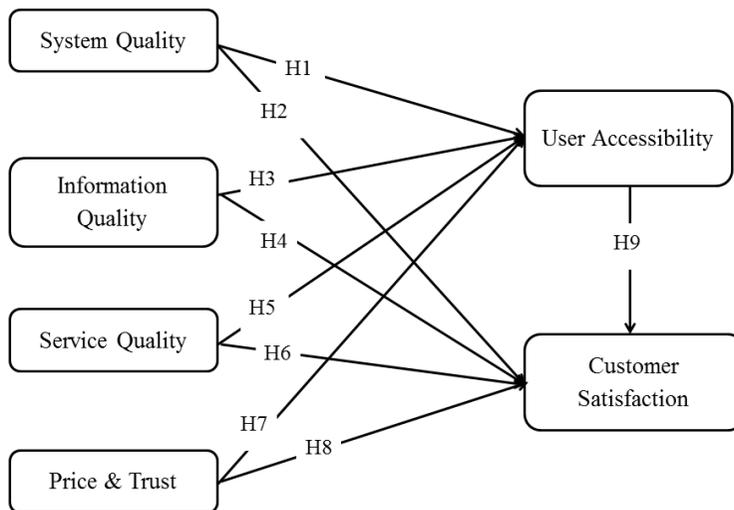


Figure 11. Research Model

3. H5 and H6: Service quality of mobile banking service delivery will positively contribute to User Accessibility and customer satisfaction.

4. H7 and H8: The payment charges price and trust of mobile banking service delivery will positively contribute to User Accessibility and customer satisfaction.

5. *H9: User accessibility to mobile banking service delivery will positively contribute to customer satisfaction.*

The relationship between our proposed research model and research questions can be linked through the following groupings of our developed hypotheses (see Table 39 below).

Table 39. Hypotheses and Research Questions link (Chapter 6)

Relationship	Research Question 1	Research Question 2	Research Question 3
Hypotheses	H1 – 8	H9	6.5.6

Table 39 above explains the relationship between our research questions and our hypotheses. Hypotheses H1 - 8 is addressing Research Question 1 which examines the relationship of system, information, service quality, price and trust to user accessibility and customer satisfaction. Hypotheses H9 is addressing Research Question 2 which examines the relationship between user accessibility and customer satisfaction. Hypotheses H3 addresses Research Question 3 examines the predictive accuracy of the above hypotheses.

Table 40. Previous Existing Models (Chapter 6)

S/N	Model Variables Measure	Objective	Source
1.	<p><i>Independent Variables:</i> System, Information and Interface Design Quality</p> <p><i>Dependent Variable:</i> Trust and Customer Satisfaction</p>	<p><i>“Based on DeLone and McLean’s Model, to assess how these three external quality factors can impact satisfaction and trust”</i></p>	(Lee & Chung, 2009).
2.	<p><i>Independent Variables:</i> Perceived Awareness, Availability of Resources, Computer – Self Efficacy, Perceived Ability to Use, Multilingual Option, Perceived Information, Trust, Quality, Functional Benefits Image</p> <p><i>Dependent Variable:</i> Mobile Banking Adoption</p>	<p><i>“To address consumers’ intentions to select mobile banking service delivery channel from behavioral, technological, social, cultural, and organizational perspectives for the three distinct stages like static, interaction, and transaction service. To investigate consumers’ behavioral intentions to adopt mobile banking at the three distinct service stages”.</i></p>	(Shareef et al., 2018)

S/N	Model Variables Measure	Objective	Source
3.	<p><i>Independent Variables:</i> System, Information and Service Quality</p> <p><i>Dependent Variable:</i> Customer Satisfaction and Net Benefits</p>	<p><i>“DeLone & McLean Information Systems Success Model can be adapted to the measurement challenges of the new e-commerce world”.</i></p>	(Delone & Mclean, 2004)

6.4 Methodology and Data Collection

Methodology

To evaluate our proposed model, a survey was developed and to be carried out in Nigeria among the customer using mobile banking services. A sample questionnaire (see Appendix survey question 2) was designed and adapted from previous literature. The items used in the survey questionnaire were adapted from models of previous researches. For reliability of our new model, the items used for the survey questionnaire were consistent with the sources (see table 40 above) adopted from literatures. A five-point Likert scale (5 - 1) were used ranging from “strongly agree to strongly disagree”.

To achieve better sample distribution, Nigeria’s three main states i.e. Abuja, Lagos, and Kano were selected for this study. The reason for the selection of these states comes with the fact that they are considered as the administrative capital, economic center, and most populated state

respectively. These states have their advantages in contributing to the economic growth of the nation. Selecting the customers in these locations as the sample size becomes important because of the large pull of customers using mobile banking services. This will also provide the right measure of the population with no sampling error for a reliable and good result (Gorondutse & Hilman, 2017; Hilman & Kaliappen, 2014).

To test the items of the questionnaire, a pilot study was carried out on a sample of 30 customers. The results obtained provided valid and reliable evidence that the scale and items used in the questionnaire were acceptable to test our proposed model.

Data Collection

The survey questionnaire was adapted from previous studies like Delone & Mclean (2004), Venkatesh et al (2012), Shareef et al., (2018), ISO (2008), Oliver (1980) and Leong et al., (2015). Valid research questions were adapted and carefully designed under controlled conditions (i.e. focusing on the banking sector) that were sourced and replicated from previous researches. The survey questions used a “Likert Scale” of 5 – 1 (i.e. from strongly agreed to strongly disagreed). In conducting the survey, a Google form page was design and also a paper based printed format of the questionnaire were also handed out to mobile banking customers. Two months duration was taken to finally receive the required number of

questionnaire replies (after constant weekly reminders).

After conducting data screening and cleaning, only 333 respondents i.e. 44.4 percent response rate were obtained which satisfies a valid response rate of the research. One of the main reasons for the high responses to almost 50% might be the COVID-19 lockdown imposed (during the data collection period) in Nigeria most especially in the three main cities of Abuja, Lagos and Kano where these data collection too place.

Measuring Variables

Based on the DeLone and McLean IS success model, below are the variables (in Table 41) that were measured as independent to evaluate their effects and influence on the two dependent variables.

Table 41 Definition of Measuring Variables (Chapter 6)

Variable	Definition	Source
System Quality	“in the Internet environment, measures the desired characteristics of an e-commerce system. Usability, availability, reliability, adaptability, and response time (e.g., download time) are examples of qualities that are valued by users of an e-commerce system”.	(Delone & Mclean, 2004)
Information	“captures the e-commerce content issue.	

Variable	Definition	Source
Quality	Web content should be personalized, complete, relevant, easy to understand, and secure if prospective buyers or suppliers are to initiate transactions via the Internet and return to a site on a regular basis”.	(Venkatesh et al., 2012)
Service Quality	“the overall support delivered by the service provider, applies regardless of whether the support is delivered by the IS department or a new organizational unit or is outsourced to an Internet service provider. This dimension is more important in an ecommerce environment than ever before, because the users are now customers rather than employees, and therefore, poor user support will translate into lost customers and lost sales.”	(Shareef et al., 2018)
Price and Trust	<p>“Price value is defined as “the consumers’ cognitive trade-off between the perceived benefits of the applications and the monetary cost for using them”.</p> <p>“Trust is the degree to which users have attitudinal confidence for reliability, credibility, safety, and integrity of mobile banking system from the technical, organizational, social, and</p>	(ISO, 2008)

Variable	Definition	Source
User Accessibility	political standpoints and also from the effective, efficient, prompt, and sympathetic customer service response, if required” “accessibility is regarded as a usability of a service, by individuals and it provided to them an inclusive variety of capabilities”	(Oliver, 1980)
Customer Satisfaction	“defined as a measure of the difference between the expectation of a customer before paying for a service and the customer evaluates the services after use”	

6.5 Results Analysis

6.5.1 Descriptive Statistics

The result of the study shows the statistical description and person correlation between the variables that were measured during this quantitative study (see Table 42). Mean and standard deviation (S.D) are viewed as important in describing statistics in terms of interval ratio scale (Sekaran & Bougie, 2013). Table 36 shows the results of the average mean and S.D of all the variables measured in the study. The IS success dimensions average were recorded at Information Quality (Mean = 4.08 and S.D = 0.76), Price and Trust (Mean = 3.84 and S.D = 0.79), System Quality (Mean = 4.15 and S.D

= 0.72) and Service Quality (Mean = 3.70 and S.D = 0.94). User Accessibility and Customer satisfaction are depended variables were observed at Mean = 4.17 and S.D = 0.65 and Mean = 4.15 and S.D = 0.69 respectively. Our result has shown user accessibility and customer satisfaction have the highest mean distribution and Service Quality and Price & Trust have the highest S.D. The R square fitness of the model was obtained at 0.592 for CS and UA was observed at 0.418 i.e. both falling with the acceptable R range of 0 to 1. All the measured variables were recorded within the ranges of high level.

Table 42. Variables Descriptive Statistics (Accessibility and Satisfaction)

Variables	Mean	S.D
Customer Satisfaction	4.15	0.69
Information Quality	4.08	0.76
Price and Trust	3.95	0.77
System Quality	4.15	0.72
User Accessibility	4.17	0.65
Service Quality	3.70	0.94

6.5.2 Collinearity

The result of our study was assessed for multicollinearity from calculations of Value and Variance Inflated Factor (VIF). Hair et al. (2019, 2012) both studies showed that there might be no issues with multicollinearity if the VIF is less than 5 (< 5) (Hair et al., 2011). Table 37 below illustrates the estimated values of VIF of the constructs in this study,

indicating that multicollinearity between the ranges of 1.000 to 1.842 was achieved. For this study, there are two dependent variables which will result in two different values of Collinearity for both outputs.

Table 43. VIF Values (Accessibility and Satisfaction)

Variables	VIF
User Accessibility	1.00
Information Quality	1.382
Price and Trust	1.907
System Quality	1.640
Service Quality	1.961
Customer Satisfaction	1.00
Information Quality	1.413
Price and Trust	2.040
System Quality	1.670
Service Quality	1.719

The results from Table 43 above illustrate that there is no multicollinearity between the measured variables since the values of VIF are all less than a value of 5.

6.5.3 Measurement Model

The measurement model was assessed were done on path loading (≥ 0.708), Composite Reliability, Convergent and Discriminant Validity (HTMT). Composite reliability with a threshold rate of 0.70 and Average Variance Extracted (AVE) ranged at ≥ 0.50 .

6.5.3.1 Reliability and Validity

Table 44 shows that all values of item loading which were ranging from ≥ 0.708 , i.e. all items satisfying the loading requirement. Composite Reliability results were ranging from 0.812 – 0.867 satisfying the requirement. The Average Extracted Variance (AVE) measures were evaluated at 0.534 – 0.618 which also within the threshold range. The result in Table 44 below indicates that reliability and validity have been achieved.

Table 44. Reliability and Validity (Accessibility and Satisfaction)

Variable	Items	Factor Loadings	C.R	AVE
Customer Satisfaction	CS1	0.775	0.906	0.658
	CS2	0.774		
	CS3	0.865		
	CS4	0.833		
	CS5	0.806		
Information Quality	IQ1	0.794	0.857	0.600
	IQ2	0.751		
	IQ3	0.778		
	IQ4	0.774		
Price and Trust	PT2	0.764	0.876	0.638
	PT3	0.792		
	PT4	0.820		
	PT5	0.817		
System Quality	SQ2	0.863	0.830	0.620
	SQ3	0.768		
	SQ5	0.725		
Service Quality	SQR2	0.768	0.846	0.580
	SRQ3	0.738		

Variable	Items	Factor Loadings	C.R	AVE
Customer Satisfaction	CS1	0.775	0.906	0.658
	CS2	0.774		
	CS3	0.865		
	CS4	0.833		
	CS5	0.806		
	SRQ4	0.718		
	SRQ5	0.818		
User Accessibility	UA4	0.869	0.839	0.723
	UA5	0.831		

6.5.3.2 Convergent Validity

From the results below (see Table 45) of Convergent Validity (based on Fornell & Larcker Criterion) it can be agreed that all the variables of the model are to an appropriate degree have achieved both reliability and validity.

Table 45. Convergent Validity (Accessibility and Satisfaction)

	CS	IQ	PT	SQ	SRQ	UA
CS	0.811					
IQ	0.424	0.774				
PT	0.710	0.428	0.799			
SQ	0.536	0.467	0.519	0.787		
SRQ	0.610	0.423	0.651	0.544	0.761	
UA	0.602	0.421	0.568	0.475	0.561	0.850

6.5.3.3 Discriminant Validity (Heterotrait-Monotrait Ratio HTMT)

(Hair et al., 2019) suggested that the Fornell and Larcker criterion is

slightly lacking especially when item loadings of constructs have only minor differences i.e. indicator loadings ranging from 0.65 and 0.85. However, both that a value of less than 0.85 (< 0.85) and (Voorhees et al., 2016) suggested the “*Heterotrait-Monotrait (HTMT) ratio of the correlations.*” Therefore, “*HTMT is defined as the mean value of the item correlations across constructs relative to the (geometric) mean of the average correlations for the items measuring the same construct*” (Voorhees et al., 2016). When constructs are conceptually very similar, the threshold value is considered less than 0.90 (< 0.90) and for those that are conceptually different, their threshold should be considered less than 0.85 (< 0.85) (Sarstedt et al., 2014; Shmueli et al., 2019).

Table 46. Discriminant Validity (HTMT) Accessibility and Satisfaction

	CS	IQ	PT	SQ	SRQ	UA
CS						
IQ	0.506					
PT	0.842	0.530				
SQ	0.691	0.631	0.682			
SRQ	0.721	0.543	0.809	0.732		
UA	0.826	0.593	0.799	0.718	0.764	

Table 46 above indicates the correlation matrix where the diagonal indicators showed the square root of the latent variables AVE and the results shows that the correlation matrix is showing discriminant validity is achieved. By assessing the HTMT ratio, the figure below (see Figure 12)

shows that our analysis for constructs that are both conceptually very similar and differently distinct.

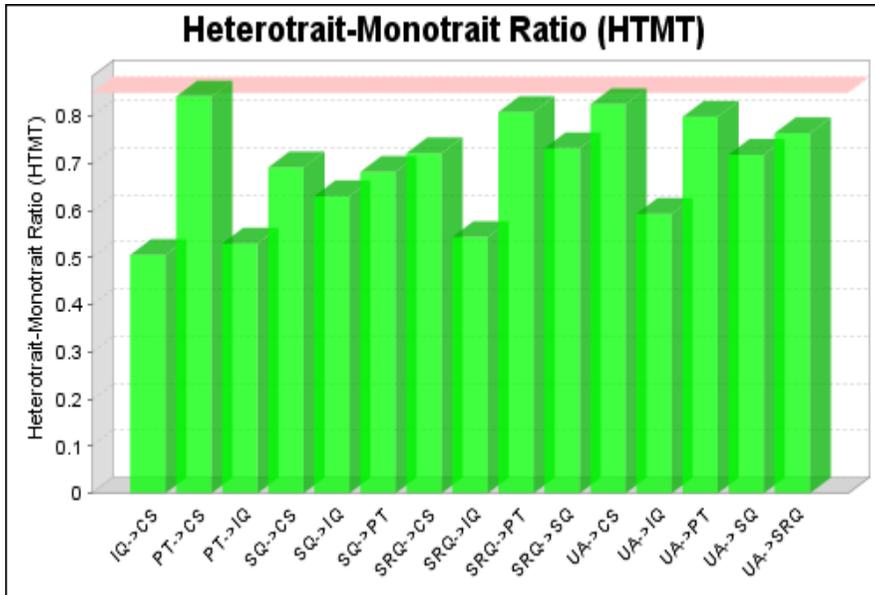


Figure 12. IS success model to Accessibility and Satisfaction HTMT Ratio

6.5.4 Structural Model

The following results were obtained and analyzed to evaluate the structural model of the research model. Below are the tests for hypothesis which will allow for examining the relationships between the studied constructs.

6.5.4.1 Hypotheses Testing

As recommended by (Hair et al., 2012; Sarstedt et al., 2014) our study analyzed t-values using bootstrapping with an estimated 5000 re-sampling iterations recurring. The selection of 5000 re-sampling is based on suggested

work of (Hair et al., 2012; Sarstedt et al., 2014; Shmueli et al., 2019) were the studies showed that selecting this value will ensure that all model parameters abides by experimental sampling sharing nature and is within the standard deviation distribution range so that it can function as proxy for the parameters for standard statistical error.

Table 47. Hypotheses Testing (Accessibility and Satisfaction)

H	Relationships	PT	S.D	T Statistics	P – Values	Findings
H1	$SQ \rightarrow UA$	0.130	0.058	2.258	0.024	<i>Supported</i>
H2	$SQ \rightarrow CS$	0.130	0.059	2.201	0.028	<i>Supported</i>
H3	$IQ \rightarrow UA$	0.418	0.052	8.048	0.000	<i>Supported</i>
H4	$IQ \rightarrow CS$	0.040	0.054	0.716	0.474	<i>Rejected</i>
H5	$SRQ \rightarrow UA$	0.253	0.054	4.681	0.000	<i>Supported</i>
H6	$SRQ \rightarrow CS$	0.130	0.059	2.201	0.028	<i>Supported</i>
H7	$PT \rightarrow UA$	0.278	0.057	4.877	0.000	<i>Supported</i>
H8	$PT \rightarrow CS$	0.418	0.052	8.048	0.000	<i>Supported</i>
H9	$UA \rightarrow CS$	0.213	0.052	4.098	0.000	<i>Supported</i>

Keys: PT = Path Coefficient; S.D= Standard Deviation

The above Table 47 specifies eight of the hypotheses have positive and significant effects on all three variable of IS success model (i.e. system, information and service quality) with price-trust to have influence on user accessibility and customer satisfaction. With only the rejection of information quality should that it has impact customer satisfaction ($IQ \rightarrow CS$ with a T-Value and P-Value of 0.716 and 0.474). The results of their p-value were obtained with the range of 0.000 – 0.028 i.e. with eight p-values falling

less than 0.05 which is 95 percent confidence interval that is based on the percentile method.

6.5.5 Predictive Analysis Using PLSpredict

Partial least square (PLS) was used as a “causal-predictive” method of SEM. It was intended to overcome the usual contrast estimated between prediction and explanation (Shmueli et al., 2019). Since PLS-SEM normally does predictive analysis, its model evaluation depends on metrics that assess explanatory power of path modeling (Hair, Black, Babin, Anderson, & Tatham, 2006).

PLSpredict was founded on the idea dividing the sample dataset into two separate samples i.e. training sample and the holdout samples (Shmueli et al., 2019). Both samples are used for model parameters estimation and also for calculating the predictive strength of the model (Danks, Ray, & Shmueli, 2017). Shmueli et al., (2019) highlighted that in PLSpredict, to predict the value of a dependent variable there is the need to use the values of the independent variables items. The values of the items in the holdout sample are used to apply to the estimated model that is used for the training sample, and the result of the prediction of the dependent variable will be indicated. As Sarstedt, Ringle, & Hair (2017) stated that PLS-SEM will generate out-of-sample results, likewise PLSpredict uses holdout-of-sample base procedure that generates both case level prediction on the items and its variable.

Shmueli et al., (2019) presented PLSpredict as a prediction oriented model for evaluation in PLS-SEM, there are some important choices when using the prediction model. First, the amount of folds to be used, second the repetition count and third is selecting of method of quantifying the amount of prediction error in RMSE. PLSpredict is established on the idea of k-fold cross validation where the dataset is segmented into k equal sizes. This followed with a combination of k-1 subsets of a single training sample that is expected to predict the remaining of the k-10 subsets (i.e. Holdout sample).

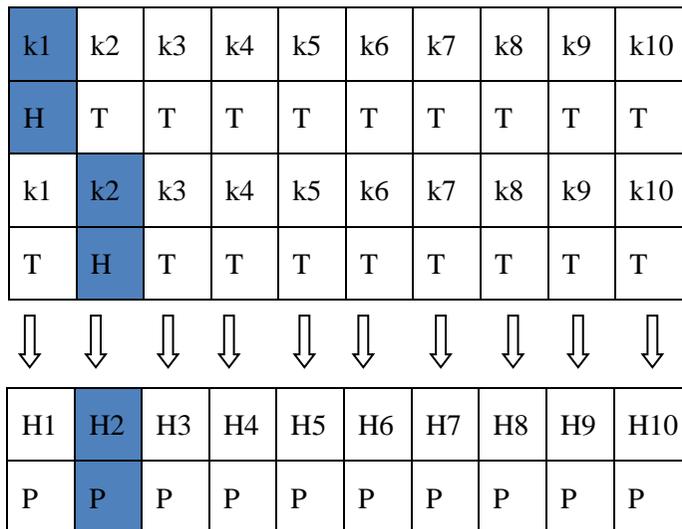


Figure 13. k-fold cross validation with K= 10-fold (H=Holdout; T=Training; P=Predicted)

With k1 as the first subset i.e. Holdout 1 omitted from the analysis and the model is assessed with the training data (i.e k2 to k10). The next combination goes with the selection of k2 as the Holdout while k1 to k10 as the training data. Therefore, in each selection of Holdout sample it is

expected to have a predicted value that is based on a model. The accuracy of these derived predictions were summarized into prediction statistics. In order to assess the predictive error, a Root Means Square Error (RMSE) was used since it gives the difference between predictions and the actual observations and a square root of the values is taken. The second step of chose r number of the repetition depends on different previous literatures. Vanwinckelen and Blockeel, (2012) suggested a 1 run, while Shmueli et al., (2019) suggested 10 repetitions as an appropriate number.

Lastly, RMSE is mostly selected in predictions errors because of its highly symmetrical distribution. Using the RMSE, for different categories of prediction was estimated where PLS-SEM is greater than normal linear regression model (LM). These categories are:

1. For none of the items; indicating predictive relevance is not obtained.
2. For a minority of items; Low predictive power
3. For majority of items; Medium predictive power
4. For all items; High predictive power

6.5.5.1 Results of PLSpredict

Based on the PLSpredict steps above, a predictive analysis was carried out after the measurement and structural model analysis above. For our analysis, Shmueli et al., (2019) three important choices were followed for the prediction orientation. A 10-fold cross-validation was selected, followed

by chosen 10 repetitions, and a RMSE was used to assess the difference between the PLS-SEM and LM. Table 15 below shows the results of our dependent variables after prediction analysis. The class of our prediction analysis will be categorized under the third class of majority items been predictable i.e. we are obtained a medium predictive power.

Table 48. PLSpredict Assessment of Manifest Variable

Items	PLS-SEM		LM RMSE	PLS-SEM – LM RMSE
	RMSE	Q ² predict		
CS2	0.505	0.283	0.514	-0.009
CS5	0.562	0.303	0.569	-0.007
CS1	0.557	0.334	0.567	- 0.010
CS4	0.576	0.406	0.604	-0.028
CS3	0.570	0.450	0.587	-0.017
UA4	0.558	0.360	0.550	0.008
UA5	0.546	0.204	0.537	0.009

Our focus of analysis on the conceptual model is targeted towards our two dependent variables i.e. UA and CS (this was done through estimating the items that describe these variables). By checking the item values of the Q²predict, which should be greater than zero (Q²predict>0), our results indicates that all our PLS-SEM Q²predict values were above zero. Next we take the difference of the RMSE of the PLS-SEM and LV. The results of the

differences were all CS found to be of negative values and UA were positive, thus indicating PLS-SEM analysis has low prediction errors for CS and high predictive values for UA. Thus, CS is found to have predictive accuracy than UA. Therefore, analyzing the same dataset with other predictive models like Artificial Neural Networks might generate improved predictive accuracy.

6.5.6 Predictive Analysis Using Artificial Neural Networks

Haykin, (1994) defined ANN as “a massively parallel distributed processor made up of simple processing units, which has a natural propensity for storing experiential knowledge and making it available for use”, while Palmer, Montano, & Sesé, (2006) defined ANN to be “made up of a large number of simple processing elements known as nodes or neurons”. Both research works agreed that ANN as an artificial intelligence tool outclasses linear regression models in terms of prediction (Leong et al., 2015). Research works like Leong et al., (2015) added that ANN has no need for multivariate assumptions e.g. linearity, homoscedasticity and normality to be achieved.

Even though SEM is used to examine causal relationship and test for hypothesis, the model has not been combine with other artificial intelligence algorithms to generate a hybrid model for better result analysis (Wong, Law, Yau, & Ngan, 2011). As already mentioned, SEM only determines the linear relationships and in some cases it tries to oversimplify difficulties especially those related to processes of decision-making in humans. To address this

limitation, ANN ability to detect both non-linear and compensatory relationships allows it to learn both complex linear and non-linear relationships between IS success model variables i.e. system, information, service and price/trust and their capability to have influence on user accessibility and customer satisfaction.

Traditional regression models usually accept that an underperformance of a predictor can be compensated by improving other predictors (e.g. an underperformance of system quality towards user accessibility and customer satisfaction can be compensated by improving other qualities of the IS success model). Nevertheless, the use of compensatory model in IS success model might not be applicable since all other variables of the model standalone towards influencing accessibility and satisfaction. But through finding the non-linear relationships, ANN is given an opportunity to also analyze non-compensatory effects of IS success model on accessibility and satisfaction. In addition to this ANN will produce more accurate predictions to traditional regression models (Chong, 2013b, 2013a; Lai Ying Leong, Hew, Tan, & Ooi, 2013; Zhang & Zhou, 2006). Due to its “black box” nature this has resulted into disadvantages of ANN thus making it not suitable for over-simplifying complexities of decision-making processes (Tan et al., 2014).

In this study, after using PLS-SEM analysis to derive the significant determinants (i.e. deriving causal relationships and hypothesis testing) the determinants will be the input variables during the second stage of the ANN

examination. For the ANN analysis, a Feed Forward Back Propagation (FFBP) algorithm of multilayer perceptron (MLP) was selected due to the nature of multiple input variables. An MLP is categorized into three different layers i.e. input, hidden and output.

For better performance, and to avoid over fitting our datasets, a 10 fold cross validation was employed, followed by a data division of 90:10 for training and testing respectively. With respect to three hidden layer generation was allowed and an epoch of 30 was fixed due to limitation of our dataset.

A dimension is needed to measure the accuracy of the ANN model; a Root Mean Square of Errors (RMSE) was selected and calculated. The importance of using a RMSE is that it gets the difference between the predicted and expected value which then squared. Besides not having any unit, if it decreases, then it shows the model is good and fitted, therefore it can view that a low RMSE values is what is desired. The RMSE will indicate the predictive nature and also the accuracy of our proposed model.

6.5.6.1 Predictive Comparison between ANN and SEM-ANN

The prediction and analysis of the variables were conducted on regression of an artificial neural network (ANN) models and a hybrid SEM-ANN. These two models were compared and evaluated based on their performance of our observed variables. The evaluation and efficiency of each model were assessed in ways of benchmark the run experiments based

on our developed conceptual model. A 10 k-fold cross-validation and resampling techniques were applied to derive the estimated of the performances of the prediction accuracy of the ANN model which consist of ALL the items of the original conceptual model. This was compared to hybrid SEM-ANN model which identifies only the SELECTED variables with item loadings of good properties i.e. ≥ 0.708 as required (Hair et al., 2019).

To further complete the hybrid SEM-ANN model, only hypothesis that have are significantly impacting the depending variables were SELECTED (the case of Information Quality as the only variable that is not impacting customer satisfaction was dropped). Predictive accuracy was estimated for the training dataset which was set at 90 percent and compared to testing dataset placed at 10 percent (i.e. 90:10) and a calculated Rooted Mean Square Error and (RMSE) was derived for comparison.

Table 49. Ten-fold Cross Validation of ANN (ALL) and SEM-ANN (SELECTED) Models

K- fold C.V	ALL Training (RMSE)	K- fold C.V	SELECTED Training (RMSE)
k= 0	0.39418184757232666	k= 0	0.42028674483299255
k= 1	0.31529684114456420	k= 1	0.29986751079559326
k= 2	0.49110329151153564	k= 2	0.28258335590362550
k= 3	0.40114369988441470	k= 3	0.26094383001327515
k= 4	0.49883209276199943	k= 4	0.53676491975784300
k= 5	0.42454987764358520	k= 5	0.29510831832885740

k= 6	0.55160713195800780	k= 6	0.30028286576271057
k= 7	0.44422322516729740	k= 7	0.28987395763397217
k= 8	0.34890896081944400	k= 8	0.28426247835159300
k= 9	0.46602696180343630	k= 9	0.24623724818229675
Average:	0.43(+/- 0.07)	Average:	0.32(+/- 0.08)
Training RMSE ALL:	0.43	Training RMSE SELECTED:	0.32
Testing RMSE ALL:	0.5559915560341551	Testing RMSE SELECTED:	0.5408542993700967

Based on the results obtained above (see Table 49), it can be derived that four different models will be evaluated and analyzed. The results of the 10 k-fold cross validation for both ANN (ALL) and SEM-ANN (SELECTED) models show that the ANN (ALL) model training RMSE was estimated at 0.43 while the SEM-ANN (SELECTED) RMSE was estimated at 0.32. These values indicate that even though the ANN model alone is capable of handling the linear and non-linear compensatory and non-compensatory regression, but the SEM-ANN model shows to have lower RMSE values. For the RMSE testing was estimated for ANN (ALL) at 0.56 and SEM-ANN (SELECTED) was obtained at 0.54. The SELECTED model was found to a better RMSE since it is lower than ANN, thus showing that the selection of the features done by SEM (i.e. through the item loadings and hypotheses) out performs the ANN (ALL) model.

The difference between the training and test of the ANN and SEM-AMM

models were -0.13 and -0.21 respectively (see Table 43 below). Here it can be viewed that ANN has less difference and is more closer to zero which shows that it is less over fitting with high testing error while SEM-ANN with -0.21 is a little more over fitting lower testing error. This shows that our model is still a bit more complex, which shows that it is better to separate of two dependent variables for a better analysis (hence generating our next two SELECTED models for UA and CS estimation) .

Table 50. RMSE Average for ALL and SELECTED Training and Testing.

RMSE(AVE)	TRAINING	TESTING	DIFFERENCE
ALL:	0.43	0.56	-0.13
SELECTED:	0.33	0.54	-0.21

6.5.6.2 Predictive Analysis of SELECTED UA and CS

With the above prediction estimation, it was concluded that our next level of analysis will be concentrated with only the SEM-ANN model since its prediction accuracy performs better to the ANN model. Considering our two dependent variables (i.e. UA and CS) two models were built to address the hypotheses from the SEM structural model. For this estimation only the information quality variable was dropped while assessing CS since it was experienced to have insignificant impact on CS (see Table 51 below).

Table 51. Ten-fold Cross Validation of (UA) and (CS) of SELECTED Models

k- fold C.V	UA Training (RMSE)	k- fold C.V	CS Training (RMSE)
k= 0	0.37956240773200990	k= 0	0.29768502712249756
k= 1	0.59005099534988400	k= 1	0.73298132419586180
k= 2	0.29113864898681640	k= 2	0.28696784377098083
k= 3	0.27525752782821655	k= 3	0.29476350545883180
k= 4	0.28232091665267944	k= 4	0.29599544405937195
k= 5	0.38486689329147300	k= 5	0.21473957598209380
k= 6	0.30924525856971740	k= 6	0.37689521908760070
k= 7	0.36894530057907104	k= 7	0.28649610280990600
k= 8	0.28816622495651245	k= 8	0.44126498699188230
k= 9	0.28983372449874880	k= 9	0.27490475773811340
Average:	0.35(+/- 0.09)	Average:	0.35(+/- 0.14)
Training RMSE UA:	0.35	Training RMSE CS:	0.35
Testing RMSE UA:	0.38293145062765344	Testing RMSE CS:	0.4386944236982468

Table 52 below shows that with regards to the output variables, UA experienced an average training RMSE value of 0.35 and testing value of

0.38 (i.e. a difference of -0.03). The CS output observed an average RMSE values at 0.35 for training and 0.43 (i.e. a difference of -0.05). This result indicates that UA has lower testing error with better prediction accuracy.

Table 52. RMSE Average for UA and CS SELECTED Training and Testing.

RMSE(AVE)	TRAINING	TESTING	DIFFERENCE
UA	0.35	0.38	- 0.03
CS	0.35	0.43	- 0.05

The performance of our SELECTED model for prediction was better and can be validated based on our estimated RMSE versus the number of epochs. As it is shown in Figure 14 below, the graph shows the loss function (i.e. the prediction error of the ANN which is calculated in gradients that are used to update the weights of the ANN). The graph showed that with an increase in the number of epochs the RMSE starts to decrease for both the training and the loss function. The best performance of the optimization between the training and the loss function started around 15 numbers of epochs which is of RMSE below 0.5. This is showing after 10 epochs the loss function and the training set are flattened (i.e. RMSE =loss function) which shows that it is the best position to converge.

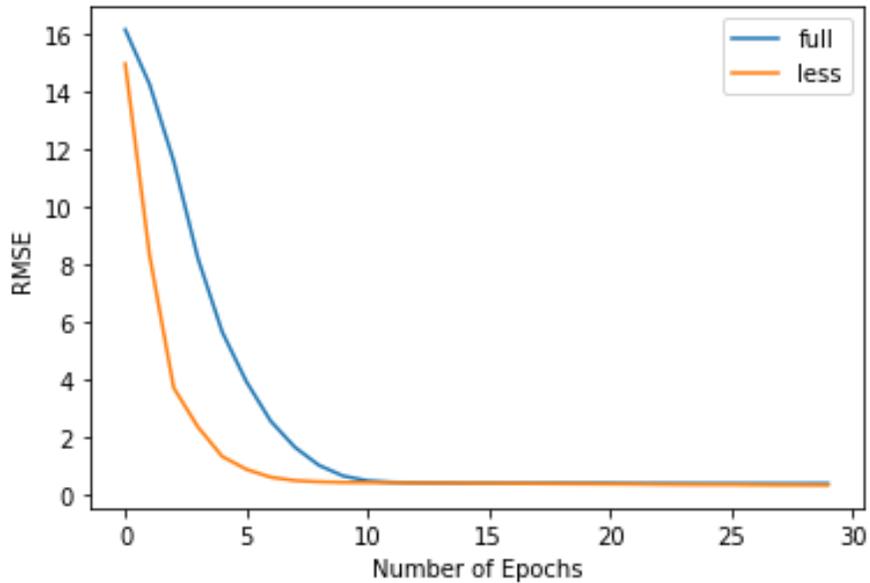


Figure 14. Predictive Performance RMSE vs. No. of Epoch

6.5.6.3 Comparison with Previous studies Model

Previous studies like Chong (2013b); Tan et al., (2014); Leong et al., (2015); Foo, Lee, Tan, & Ooi (2018); Hew et al., (2019); Abubakar et al., (2019) all developed a SEM-ANN hybrid approach model so as to replace the regression analysis conducted by SEM alone. As a base line, these studies used a multilayer perceptron (MLP) i.e. based on FFBP algorithm. In relation to the data use, a 10 fold cross validation was adopted (due to small size of the data) where 90 percent training and 10 percent testing was assigned to avoid over fitting. RMSE was used a measurement for predictive accuracy. With this specification as a baseline, our study also applied the same technical specification and further improved this baseline so as to achieve our novelty.

The difference of our model and the existing ones can be recognized to the variations in the number of hidden layer neurons applied to the model and also the selection of the activation function. A sigmoid (logistic or soft) function was mostly selected as activation function i.e. a neuron that defines the final output of an input of one or more neurons (Abubakar et al., 2019; Chong, 2013b; Foo et al., 2018; Hew et al., 2019; Leong et al., 2015; Tan et al., 2014). Tanaka (2020) suggested the use of Rectifier Linear Unit (ReLU) to perform better than the sigmoid activation function. ReLU function was selected for its piecewise function properties and its less computational demand than the sigmoid. Also for the selection of the number of hidden layer neurons, Leong et al., (2015); Tan et al., (2014) and Foo, Lee, Tan, & Ooi (2018) used an auto-generation process, Chong (2013b) used 5 hidden layers while Abubakar et al., (2019) and Hew et al., (2019) used 3 and 4 respectively. The selection of the hidden layer neurons were in consideration to the datasets ranging from 140 to 216. With a dataset of 333 respondents, our study selected three (3) hidden layer neurons so as to be within the range of the previous research.

The prediction analysis used by previous studies only focused on conducting SEM the followed by ANN. This can be attributed to the previous works having only one output layer (Abubakar et al., 2019; Foo et al., 2018; Hew et al., 2019). Another difference with our study is observing to different dependent variable (UA and CS) which separate. Due to the

single output layer of the previous studies, the ANN inputs were from ‘all’ the variables good loading performance of greater than or equals 0.708 (≥ 0.708). With our altered two dependent variables, three (3) different stages of analysis were applied:-

1. Combine Features: - “All” existing items of the model were used for analysis and test in ANN without been applied to any selective feature of SEM. This can be regarded as all combine features as combine inputs.
2. Selective Features:- this followed the SEM-ANN procedure like previous researches to conduct “feature selection” in SEM and applied in ANN for accurate prediction. Thus, forming the combine feature and selected inputs.
3. Separated Features:- from the selected features of the SEM, the feature that determines each dependent variable were only selected to also determine separate dependent outputs (i.e. UA and CS, see table 45 and 46).

The above classification is the first work that made this separate categorization of feature selection process.

Lastly, even though our SEM-ANN followed the similar baseline design adopted by previous research work, our model used a different architecture in terms of activation function, different number of hidden layers neurons; our dataset is higher than all the previous studies with two (2) dependent

variables and finally a 3 stage feature selection categorization to derive different predictive results for each dependent variable. With the novelty of the above points, in fairness to the previous researchers, this work has slightly modified their baseline hybrid SEM-ANN methodology to show improvement in accommodating more than one dependent variable for predictive accuracy.

6.6 Discussion

Our first research question examines the significant influence of IS success qualities, price value and trust on user accessibility and satisfaction.

The results show that SQ, IQ, SRQ and PT have a positive impact on the user accessibility while SQ, SRQ and PT have a positive impact on the customer satisfaction. The above result can be supported from previous works of Lee & Chung (2009). While IQ also showed a negative significant impact of customer satisfaction showing that customers are having challenges.

The 2nd research question examined the significant impact of user accessibility have on a customer satisfaction. Our results showed user accessibility has a significant influence on customer satisfaction. This can be supported by the work of Ahmad & Al-Zu'bi, (2011) which also experienced a positive impact on customer satisfaction in the e-banking sector.

The 3rd research question of this work examined how proposed methodologies of predictive accuracy (i.e. PLSpredict, ANN and SEM-ANN)

to determine which of the approach can fit our proposed model and show accuracy in predicting user accessibility and customer satisfactions. The results showed that the SEM-ANN model have better predictive accuracy of user accessibility and customer satisfaction as dependent variables. The results of our modified model supported the results of our baseline adopted works like Hew et al., (2019); Foo et al., (2018) and Abubakar et al., (2019).

6.7 Implications

Theoretical Implications

From the perspective of theory base, this study can be regarded to have added knowledge on literature in terms of factors of IS success qualities, price value and trusts on user accessibility and customer satisfaction with respect to service delivery innovations in the mobile banking sector. The study is among the first works that examines the influential effects of IS success models qualities, price and trust with the application of SEM-ANN hybrid approach to determine both user accessibility and customer satisfaction.

Furthermore, the modified hybrid model is the first to be tested on customer's perceptions concerning their access and satisfaction to innovative mobile banking services. This was found to have good predictive accuracy and can be used as a replacement to traditional regression methods. Our designed conceptual model can further be studied academically as a reference to both new and old researchers that are interested in application of artificial

intelligence in Information Systems of the mobile banking sector.

Managerial implications

The empirical result of the study is expected to make contributions to the management, decision and policymakers from banks, financial innovative firms and banking regulators. The results of this study will provide them with information that is essential to the quality, price charges and security they provide to their current customers. Among all the variables, only Information quality was found to be not significant in determining satisfaction. This can be attributed to the low amount of Information provided to the customer's in terms of failed transactions, payment services and customers Information after use of mobile banking services.

Additional effort is required by all Nigerian banks to ensure that the quality of Information they provide with regards to mobile banking service Information are accurate, complete, relevant, precise and mostly importantly timely provided to the customers. Abiding by the CBN's IT Standard Blueprint, employing the ISO 9000 standards for measuring quality goals that banks should make sure to manage and monitor as continuous improvement activities.

The provisions of reliable and quality services are among the most important factors that all stakeholders involve in mobile banking service delivery should address. As banks are the second most regulated sector in the

world (i.e. after Health), they are also bound to deliver banking services that are subject to evaluation by their customers. This is essential because the satisfaction and accessibility of the present customers will determine inclusion of the large unbanked population. This will build confidence to the financially excluded population to adopt and use of innovative financial services. Therefore, it is important for the banking industry and the regulators to understand that lack of the Information quality might lead to continuous decrease in the number of unbanked. New measures of providing quality Information should be explored. Both the banks and regulators are required to take obligatory actions to lessen that will increase access to quality Information for continuous improvement.

Even though the results of this study showed that system, Information, service qualities, the charge price for transaction and trust on the banking security systems have significant effect on user accessibility, there is still more room for improvement. Continuous monitoring, evaluation and assessment should become a regulatory policy by the regulators so as to ensure the quality of these services are always checked, sustained and maintained continuously.

6.8 Contributions

Recent studies in Information Systems are using artificial neural networks to replacing traditional regression methods. This study aimed at investigating how the provisions of IS success qualities, price value and trust are

determining factors to user accessibility and customer satisfaction. As previous studies use only regression methods like SEM, the ability to uncover and also assessed both the linear and non-linear regression studies is increasing the academic environment. As a result of this exposure, determining the success of service delivery innovations to ensure they increase accessibility and satisfaction will benefit new policies (e.g. the 2015 cybercrime act) and decision-making processes. This can deliver an increase in the number of people that will have access to banking and financial services and this is what this research has addressed.

With a focus on the present customers that are using different mobile banking services e.g. mobile app, USSD code, SMS banking to delivery access to financial services is becoming a focus of research in making sure these services are more accessible. The inclusion of price value and trust as determining variable to IS success model is new but also essential especially to Nigeria. Due to growing poverty and cybercrime (especially internet banking frauds) rate, a lot of potential new customers have reservations on the price charge for the services and also trust on security issues (Wada & Odulaja, 2012).

The contribution of this study will highlight to banks how important it is for them to understand the perception of their current customers and make the necessary innovations and make the right decisions on qualities, price and security that new customers will have confidence and worthy enough to make

them join the digital financial world.

6.9 Sub-conclusion

The objective of our study is to investigate, evaluate and also make some accurate prediction of the causal relationships of the variable of IS success qualities, price value and trust on dependent variables user accessibility and customer satisfaction. The utilization of the hybrid SEM-ANN model allowed us to assess features like linear, non-linear, compensatory and non-compensatory characteristics of the independent variables over the dependent variables. An initial PLS-SEM was run to derived results of measurement and structural models where only Information Quality was observed to have no significant impact to customer satisfaction.

The second phase of our analysis to determine our predictive accuracy was carried out by developing four models in two groups. The first group assessed the performance of the predictive accuracy between ANN (using all the initial variables of our study) and a SELECTED (using the derived item loading of ≥ 0.708 and only hypotheses that are significantly impacting our dependent variables). The results obtained proved that SEM-ANN performed better than the ANN model as the RMSE of the SEM-ANN where lower proving the predictive accuracy was better.

This research show that all IS success quality variables, price and trusts are influencing factors that play important roles in determining how banks can

elevate their innovative service delivery processes so that an increase in user accessibility and customer satisfaction can be experienced so that more adults in Nigeria can have access to financial services that are of sound qualities, trusted and affordable.

The study showed that using a hybrid model of SEM-ANN will provide more information that covers both the linear and non-linear features of IS success qualities, price and trust rather than only assessing the linear features. This has also shown that the predictive nature of these variables can be better obtained if we use the hybrid assessment model.

The sampling of the study was taken from the three major cities of Abuja, Kano and Lagos. This might have a slight influence on the issue of generalizing the sample obtained to the whole population of the country. This can be seen as a limitation to the study. Thus, a cross-sectional survey approach was used for the survey and hence the effect of time was not examined.

This result of our study showed that information quality is a negative impacting factor on customer satisfaction of mobile banking service delivery. The negative impact of this variable might be attributed to a lack of regulatory laws compelling the banks to provide quality that will satisfy customers. The variables observed in our IS success model included all three qualities, other variables like perceived usefulness and performance expectancy might have produced improved results. These limitations might have some slight effect on

our study.

Chapter 7. Conclusion

7.1 Summary

The goal of this research work is to examine how we can utilize innovative financial service on mobile phones to increase financial inclusion in Nigeria. As a country with over 200 population and 56% of adult population, over 60% of these adult population are unbanked. While on the other hand, the number of mobile phone has exceeded 186 million subscriptions and a teledensity penetration of 97.5 percent. As such, this research examine the possibilities of how banks can use new innovative financial services that can place on mobile phones so as to give more chance every mobile phone subscriber to have access to quality mobile banking services. To assess this work, this research work focused on three different works that when combined they can address this pending problem by deriving empirical results that can provide potential solutions that can be used for both theoretical and managerial implications. In order to arrive at our results, the sample data used for the analysis of all three the studies was collected differently via surveys. The first data collection was centered on bank staff while the second and third data collections were centered on mobile banking customers. The bank staff responders were IT managers, service delivery managers, service and innovation analysts, service management officers, senior managers, project managers, and customer relation officers. Whereas the responders of the second and third studies

were customers that frequently engage in use of mobile banking services for their daily financial activities.

In total for the first and second study, 750 questionnaires were distributed. For the first study, 178 valid responses were used achieving 23.73 percent response rate. This was considered well enough for our analysis and also compared to previous studies that have experience difficulties in getting banking professionals to participate due to their time and banking policy of non-information disclosure. The second study 207 valid responses were sourced back i.e. amounting to 27.50 percent of the response rate which is also good enough for the studies. The third study survey was conducted online, due to the pandemic lockdown in Nigeria. A total of 363 responses were gotten and 333 were screened and cleared for analysis. When compared to the normal 750 questionnaires distributed, it can deduce that it covered 44.40 percent of the responses which is good enough for our studies. To arrive at our results, the study employed a structural equation modeling (SEM) in combination of other methods. Our first study used a SEM with mediation effect; the second only used SEM while the third used a hybrid model of SEM and artificial neural networks (SEM-ANN).

The first study examined how IT governance mechanisms (i.e. structure, process and relational mechanisms) have effects on service innovation dimensions adoption (new service concept, new client interface, new service delivery and technology). Also it assessed how the following services

innovations dimensions have influence on firm performance. For better analysis, the conceptual developed model of this research work was further divided into three sub models. Starting the analysis with structure model, the effect of IT governance structures and relational mechanism were significantly impacting all four dimensions of service innovation and also firm performance indirectly.

On the other hand, new service concept and new technology are the only dimensions having a negative impact on firm performance. As for IT governance processes, it was significantly impacting service innovation dimensions, and only on new service concept was again found to reject any significant on firm performance. Indirectly, all three mechanisms were impacting firm performance with consideration to service innovation as a mediator. Finally, service innovation was found to have full mediation existence between IT governance mechanisms and firm performance.

The second study investigated the influence of explorative and exploitative service innovations on service quality performance (SERPERFV) variables and how it determines customer satisfaction. Based on the need to balance ambidexterity, banks need to start looking into adopting both service innovation concepts. Nevertheless, to achieve both creativity and efficiency a good quality assessment of the mobile banking services provided is need. That will determine the sort of impact these service innovations have on quality and how this resonates to customer

satisfaction. Tangible was dropped as a measurement variable from the SERVPREFV dimensions, due to the nature of banking satisfying an intangible service. The measurement model requirement showed that all standard parameters were satisfied to proceed for the structural model assessment. Our results showed that all the explorative and exploitative service innovations have influence on service quality and likewise service quality dimensions have significant influence on customer satisfaction with only responsiveness having to be observed to have no significant impact on customer satisfaction. Finally, a significant indirect effect exists from explorative and exploitative service innovations to customer satisfaction.

The third study evaluated and predicted Information System (IS) success qualities (i.e. system, information and service qualities), price values (paid for services) and trust as influencing variable that can result into increase of user accessibility and customer satisfaction in financial inclusion. In the research work, a hybrid model of SEM-ANN was applied to make predictions. The first of the analysis used SEM to for measurement and structural model. The second analysis conducted an assessment of the conceptual model using ANN as a substitution to traditional linear regression method. This was done to bridge the deficiency of linear regressions models inability to detect non-linear relationships. A comparison of the ANN analysis was done with the hybrid SEM-ANN model that used selected proven hypothesis from the SEM structural model (where only Information

Quality was found to have no significance to customer satisfaction). A Root Means Square Error (RMSE) was calculated for both models and the RMSE of the SEM-ANN was found to be lesser than then ANN model, thus proving its better in predictive accuracy. Thus, these results showed that customers were not satisfied with the quality of information of mobile banking services provided by the servicing banks.

7.2 Contributions

It is essential to state the three key contributing points of this research work. First is with regards to the geographical and developing region; second is due to the research gaps from previous studies; and third, in terms of the development of new theoretical models to improve the field of research. Lastly the novelty of the study can also be considered as contribution to the body of knowledge.

With regards to Nigeria's geographical location in the sub-Saharan Africa, only a few studies are carried out on services innovations. As developing countries, innovation has not been a strong factor that is contributing to the regions national development. Countries within this region lag behind in innovations as they only take and use what the developed has used for a long run. Besides, some countries in the sub-Saharan regions still lack strong policy and regulatory requirements that guides innovations. Although, a country like Nigeria can be viewed to be performing quite good when compared to other counterparts in the region. As a result of some the

challenges and issues of falling banking sector in Nigeria and the sub-Saharan region, the banking sector have been mandated to adopt IT governance to help in guiding the banks with issues like the service innovation adoption. This study is one of the first to conduct empirical investigation that looked into service innovation, IT governance mechanism, service quality, and IS success qualities as determinants of firm performance, customer satisfaction and user accessibility to increase financial inclusion of mobile banking services.

With respect to our second contribution due to research gaps, previous studies have not examined the collective understanding of the circumstance and effect of IT governance mechanisms on innovations so as to deliver improve firm performance. Other works only focused on the aspect of service innovation and its impact on firm performance. While filling this gap, our study introduced IT governance mechanism and service innovation to achieve firm performance. Another research gap in terms of previous studies was only the assessment of the service quality performance to impact customer satisfaction, no study examined how service innovations impacts quality and subsequently customer satisfaction. However, there is also need to measure service delivery innovation on terms of IS success so as to examine the present user accessibility and satisfaction. This will allow both the banks and policy makers to acquire empirical results that can help them in taking the right decisions.

Lastly, the novelty of the research work has shown to be the first study to address the above there existing gaps that were investigated as our three main objectives of our research. In terms of the new theoretical models developed, this study has added a new field to the field of service innovations. These theoretical models can be further assessment into other service sectors that are different from the banking and financial industry.

7.3 Policy Implications

To jointly discuss the policy implications of this study, there is the need to highlight how the 2018 National Financial Inclusion Strategy (Revised) recognizes innovation as an imperative figure that is needed to build the foundation of creating an enabling environment to encourage financial inclusion in Nigeria. Also the strategy is mandated to examine enhanced financial innovative ways to provide more access to Nigerians. This strategy has started influencing banks to internally examine if their governance is designed to accommodate the government's financial inclusion vision. Nigeria's recent National Digital Economy Policy and Strategy 2020 – 2030, the government in conjunction with the private sector has taken initiatives to transform the country's into a leading digital economy frontier. This transformation is also founded on entrepreneurship and digital innovation perspective which is expected to create value and prosperity. The government has already set out channels for achieving financial inclusion, but there is no implementation and research approaches from the private

banking side. These approaches are supposed to support banks to internally organize themselves to meet these policies, provides quality and accessible services. Based on these openings, our research was carried to fill in these gaps.

From the first empirical study, the following submissions concerning the impact of IT governance mechanism and service innovation for firm performance and its policy implications might be realized: our result showed all three components of IT governance mechanism have influence on service innovation. This can be an important source to ensure that service innovation is integrated and inserted into policies for development of Service Innovation Strategy Committee and the inclusion of this committee into the CBN IT Standard Blueprint. With the standard blueprint recognizing IT steering, IT Strategy, and Project Management committees, it is important to insert this service innovation committee so as to foster banks to formally understand the importance of service applications and its necessity in upholding innovation. By linking this policy to the CBN's regulatory framework, banks can take the appropriate regulatory risks in innovation aspects. This regulation can suggest the extent a bank can go in adopting innovative services without compromising laws and affecting present regulations that govern the required internal operations of the banks. Although, the policy should cover the appropriate regulatory framework so that innovation can succeed without interference, it should also ensure that

banks who achieved service innovations for increasing financial inclusion development are granted incentives.

Another way to achieve the digital economy roadmap in Nigeria is to support the government with reliable data that is backed by empirical evidence. Therefore, a policy for the establishment a Service Innovation Research Institute will provide direct support to both the government and also the private banking institutions. The information to be generated from the institute can help government align the digital economy strategy with other already establish ICT and telecommunications roadmap. With the emergence of new financial institutions e.g. financial technology companies (Fintech) and Digital Banks (only), will spring up with different kinds of risks e.g. operational, strategic, compliance and cyber will become a challenge to the regulators. For this reason, Service Innovation Research Institute should be mandated to investigate and identified the risks associated with the kind of services these new financial institutions will face. Also ensuring that the risks associated between the current banking sectors and the expected new coming ones are fully understood, evaluated and monitored.

From the second empirical study of combining exploitative and explorative service innovation and its impact on service quality performance for customer satisfaction. Some propositions can be suggested so that an improvement in customer satisfaction policy of the banking industry can be

achieved. To achieve the digital economy vision, some amendments are needed not only in the banking regulatory sector but also the ICT industry that supports the services that are provided in the banking industry. Currently, policies that promote service innovations are needed to substitute policies that regulate highly technological innovations. Also to succeed with the financial inclusion strategy, there is the need to promote open innovation initiatives that involves user participation (to some extent) in providing new services.

In view of the importance of customer satisfaction, the government needs new policy to elevate the priority of the customer. Presently, customer complaints are only regarded as medium priority, but practically the banks have downgrades these complaints to low priority. Our result in evidence showing customers are not satisfied with the responsive nature of mobile banking services they receive. The appropriate authorities need to establish a National Customer Satisfaction Index Organization. The agency will be mandated to measure customer satisfaction of different innovative services and products.

Like in other countries, the agency will ensure there is improvement in service quality competition among firms, companies, and industries so that people's life can also be improved. By promoting the customer satisfaction index, promoting innovation at different layer of the service quality performance model will be required. High level priority of demand in terms

of reliability, responsiveness, and assurance is needed for services in the mobile banking sector. Other measurement variables can be determined as low or medium priority base on their demand.

Third, the results of IS success qualities, price value and trust have influence on user accessibility and customer satisfaction. The application of SEM-ANN as a robust model suggested that user accessibility should consider these qualities as determinant factors. In achieving more accessibility, there is the need for innovative service delivery to consider the different variables of the IS success model, the price at which transactions are paid and its trustworthiness. This result showed that customers are not satisfied with the quality of information that is provided by the banks. So, government policies that support the disclosure of rating information quality are needed. For the government to drive its new digital economy strategy to success, more citizens need to be included for accessing financial services. Policies that guarantee the quality of information are likely to help increase additional accessibility as customers will develop more confidence with information regarding their funds and transactions. In addition, there is the need for a promotional policy from the Nigeria Inter-Bank Settlement System (NIBSS) which can encourage customers launch complains regarding lack of access and dissatisfaction of services. Lastly, for any bank that has been providing accessible services that are recognize to increase financial inclusion and operates within the regulatory sandbox of the

regulatory should be offered incentives as an encouragement.

The above three policy implications suggested for each study can be summarized into categories creating a new policy that establishes service innovation strategy committee that can in cooperated into CBN's financial inclusion plan and the IT Standard Blueprint. This is followed by establishing a Service Innovation Research Institute that can investigate present and emerging services (e.g. blockchain crypto currencies and use of artificial intelligence) in the banking industry and beyond. Second, to protect the present customers and the future ones, Nigeria requires a National Customer Satisfaction Index organization to specifically deal with service quality challenges. Third, laying promotional policies from the NIBSS to ensure and support accessible service provision.

The financial and banking industry in constantly experiencing changes due to innovative services that are been supported by technological breakthroughs. The increase in breakthroughs like the mobile technology sector is becoming scalable to adapt digital financial services that can be accessed in almost everywhere there is a presence of telecommunication network. With this, studying service innovation in coupled with mobile technology in banking industry should be leverage to delivery financial services to anyone holding mobile phones.

7.4 Limitations and Future Research

As suggested by previous literature, survey instrument was the method for data collection. There were some difficulties in data collect especially for the first study that was evaluating questionnaire answers from the banking professionals. Some of the Nigerian banks have policies of hindering their staff from disclosing any information related to the banking management. To some extent, some the banks even consider it a bridge of company policy if a staff fills in any questionnaire without getting clearance from senior management. This has resulted to only 14 of the 18 Nigerian commercial banks staff to only participate in this study. This could be viewed to have produced some bias results as there can be different perception and experience about the IT governance mechanisms in the different banks were not considered in this study.

Also in evaluation of the IT mechanism in the first paper, only the top rate variables that explained the mechanism were used for evaluation purposes. As previous literature stated that these variables are the more important to explain these variable, likewise there are other weak variables that might be weak but also influential. Their lack of inclusion into the assessment might generate some bias in the study. Future research can consider a general test that includes these weak variables for assessment.

Future researchers can start exploring the use of SEM-ANN to replace the traditional linear regression methods. The SEM approach will filter the

positive significant hypotheses that can be further assessed for prediction and accuracy. While the predictive analytic approach of ANN will provide the possibility of uncovering non-linear assessment that these traditional linear regressions methods lack.

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Appendix 1

Department of Technology Management, Economics and Policy
International I.T Policy Program
Faculty of Engineering
Seoul National University
Seoul, South Korea

Dear Sir/Madam,

I am a PhD student of the above department conducting a research on the topic “**The Impact of IT Governance Mechanisms on Service Innovation for achieving Firm Performance**”. Kindly spare part of your time to respond to the questionnaire attached.

This survey has been design to investigate the perception of banking staff with regard to their banks IT governance mechanism, service innovation to achieve firm performance. The data collected by this survey might help the Nigerian Banking Industry to develop a better approach to IT governance and service innovation adoption that will improve their performance.

All the response given in this respect will be regarded as strictly confidential and for the purpose of this research only.

Thank you.

Yours faithfully,

Abdullahi Garba Ali

Kindly answer the following questions:

State Your Bank:

Gender: M / F

Age: 18-25; 26-40; 40-above

Education: None; Primary; Secondary School; Undergrads; Postgrads

Marital Status: Single; Married; Divorced; Others

Instructions: Tick the number that corresponds to your choice, using the following scale: SD = Strongly Disagree; DA= Disagree; N=Neutral; A=Agree; and SA=Strongly Agree. Thank you for taking your time to participate in this survey.

Chapter 4 Questionnaire

Variables	Measurement Items					
	Structure	SD	DA	N	A	SA
STX1	We have a well organize IT Structure in our bank?	1	2	3	4	5
STX2	Our IT Steering Committee (at an Executive/Senior Management level) oversees IT	1	2	3	4	5

	practice, strategies and policies.					
STX3	IT project implementation team manages and give priorities to IT projects?	1	2	3	4	5
STX4	Our IT strategy committee provides strategic direction and the alignment of IT and business issues?	1	2	3	4	5
STX5	Chief Information Officer (or similar position) report's IT related matters to a Senior Executive/Management or to directly the CEO?	1	2	3	4	5
STX6	Our IT and e-Service security and risk officers comply with CBN standards?	1	2	3	4	5
STX7	Our bank integrates IT and business together?	1	2	3	4	5
	Process	SD	DA	N	A	SA
PRS1	Our bank defines and	1	2	3	4	5

	updates its IT Strategic processes.					
PRS2	Our bank does IT Budgeting and Auditing Control?	1	2	3	4	5
PRS3	We exercise IT standards, governance and control?	1	2	3	4	5
PRS4	We effectively comply with Service Level Agreements reach with IT service providers?	1	2	3	4	5
PRS5	IT performance is very well measured?	1	2	3	4	5
PRS6	We apply processes and methodologies to govern and manage IT projects?	1	2	3	4	5
PRS7	Our bank gives priority to IT Investments and projects performance?	1	2	3	4	5
	Relational Mechanisms	SD	DA	N	A	SA
RM1	Our banks aligns IT vision	1	2	3	4	5

	with its business strategy.					
RM2	IT and business staff complements each other within the same unit (office or branch).	1	2	3	4	5
RM3	Senior Management gives good examples as leaders.	1	2	3	4	5
RM4	Sometimes Business and IT senior management have informal meetings with the staff?	1	2	3	4	5
RM5	Both business and IT are audited by auditors.	1	2	3	4	5
RM6	Corporate internal communication is use to address general IT issues.	1	2	3	4	5
RM7	Cross training are conducted between IT and Business staff.	1	2	3	4	5
	New Service Concept	SD	DA	N	A	SA
NSC1	Our bank adopts new service ideas or solutions that	1	2	3	4	5

	can improve performance.					
NSC2	New ideas or solutions to addresses staff needs and problems at work are implemented.	1	2	3	4	5
NSC3	We develop new services for creating value towards organizational performance.	1	2	3	4	5
NSC4	Our bank combines existing and new services for better performance?	1	2	3	4	5
NSC5	Training and awareness programs are conducted after adopting new services.	1	2	3	4	5
	New Staffing Interface	SD	DA	N	A	SA
NSI1	Our bank adopts new staffing interface to improve staff performance?	1	2	3	4	5
NSI2	Staffs have roles in creating value for organizational	1	2	3	4	5

	performance?					
NSI3	Our bank has the capacity to implement new staffing interface?	1	2	3	4	5
NSI4	Management supports staff to participate in service production and delivery?	1	2	3	4	5
NSI5	New ways of communicating with staffs are implemented (e.g. using social media).	1	2	3	4	5
	New Service Delivery	SD	DA	N	A	SA
NSD1	Our bank adopts new service delivery methods.	1	2	3	4	5
NSD2	Implementing new service delivery solutions require organizational restructuring for better performance.	1	2	3	4	5
NSD3	When new service delivery methods are adopted, they are	1	2	3	4	5

	shared from HQs to all branches?					
NSD4	Adopting a new service delivery channel that simplifies staff work?	1	2	3	4	5
NSD5	New service deliveries are effective in improving service quality.	1	2	3	4	5
	New Technology	SD	DA	N	A	SA
NT1	Our bank adopts new Technology to improve performance.	1	2	3	4	5
NT2	New technology helps in transforming services for better performance.	1	2	3	4	5
NT3	New technologies are used for an effective and efficient service delivery.	1	2	3	4	5
NT4	New technologies are used in facilitating communication	1	2	3	4	5

	and cooperation between staff and management.					
NT5	New technologies are used for improving service quality.	1	2	3	4	5
	Firm Performance	SD	DA	N	A	SA
OIP1	Our bank has been able to adopt new services for staff satisfaction?	1	2	3	4	5
OIP2	There is improvement in staff related experiences with service innovations?	1	2	3	4	5
OIP3	There are improvements in capabilities of innovating service for organizational performance.	1	2	3	4	5
OIP4	There are improvements in performance due to new service delivery to clients.	1	2	3	4	5
OIP5	Our bank adopts technology to improve responsiveness to	1	2	3	4	5

	staff needs?					
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Chapter 5 Questionnaire

Variables	Measurement Items					
	Service Innovation	SD	DA	N	A	SA
SIE1	To what extent can you rate the old Mobile banking services?	1	2	3	4	5
SIE2	To what extent can you rate the new Mobile banking services?	1	2	3	4	5
SIE3	To what degree is your Mobile banking service introducing new service features?	1	2	3	4	5
SIE4	To what extent are the Mobile banking services opening up new opportunities e.g., transactions, payments,	1	2	3	4	5

	and other services?					
SIE5	What level can you rate your Mobile banking services for introducing new technologies e.g., QR Payment, Token Payment and text payment (USSD code)?	1	2	3	4	5
SIE6	To what degree can you rate improvements in the current Mobile banking service?	1	2	3	4	5
SIE7	To what level is your Mobile banking services easy to use?	1	2	3	4	5
SIE8	To what degree are your Mobile banking services reducing your expenses e.g. transportation, time and service charges.	1	2	3	4	5
	Service Quality					

	Tangibles:	SD	DA	N	A	SA
T1	Learning how to use services on Mobile banking is easy.	1	2	3	4	5
T2	I prefer Mobile banking to other banking services.	1	2	3	4	5
T3	My overall use of M-banking is easy?	1	2	3	4	5
T4	Mobile banking improves my work, business and life efficiency?	1	2	3	4	5
T5	Mobile banking services allows me to easily and quickly access banking information.	1	2	3	4	5
T6	My overall rating of mobile banking is useful.	1	2	3	4	5
	Reliability:	SD	DA	N	A	SA
Rel1	Mobile banking services fulfill its intended usage for	1	2	3	4	5

	transactions, bill payment and others?					
Re2	Customer care responds to M-banking problems immediately?	1	2	3	4	5
Re3	I depend on Mobile banking service for my transactions.	1	2	3	4	5
Re4	Within 24 hours, my Mobile-banking service is available, open and working.	1	2	3	4	5
Re5	Our Mobile banking services is maintained error free.	1	2	3	4	5
	Responsiveness:	SD	DA	N	A	SA
R1	Our Mobile banking platform informs customers of new services.	1	2	3	4	5
R2	Our Mobile banking platform informs customers	1	2	3	4	5

	on updates and maintenance schedule.					
R3	Customer gets fast response on their Mobile banking issues.	1	2	3	4	5
R4	Our M-banking customer care is willing to help on issues?	1	2	3	4	5
R5	Mobile banking staffs are available for customers' needs.	1	2	3	4	5
	Assurance:	SD	DA	N	A	SA
A1	The level of our Mobile banking service staffs behavior and attitude gives us confidence as customers?	1	2	3	4	5
A2	The services provided on the M-banking app are safe for customer use.	1	2	3	4	5
A3	As a customer I trust	1	2	3	4	5

	Mobile banking services.					
A4	Our Mobile banking staffs are consistently polite to customers.	1	2	3	4	5
A5	Staffs that are responsible for M-banking services have good experience and knowledge.	1	2	3	4	5
	Empathy:	SD	DA	N	A	SA
E1	As a customer, individual attention is given to me when needed.	1	2	3	4	5
E2	As a customer, Mobile banking staff understands the level of your specific need.	1	2	3	4	5
E3	Personal attention is given to you as a customer.	1	2	3	4	5
E4	I believe the Mobile banking management has my best interest at heart?	1	2	3	4	5

E5	I believe the workings hours allocated to handle my Mobile banking issues is under convenient operating hours?	1	2	3	4	5
	Customer Satisfaction:	SD	DA	N	A	SA
C1	I am satisfied with M-banking services provided.	1	2	3	4	5
C2	I am satisfied with the M-banking staff response and promptness to my needs.	1	2	3	4	5
C3	I am satisfied with M-banking financial services advice.	1	2	3	4	5
C4	The overall M-banking service quality is excellent	1	2	3	4	5
C5	I am happy with M-banking services.	1	2	3	4	5

Chapter 6 Questionnaire

Variables	Measurement Items	SD	DA	N	A	SA
	System Quality					
SQ1	Mobile banking app loads all the text and graphics in time.	1	2	3	4	5
SQ2	Mobile banking is user friendly.	1	2	3	4	5
SQ3	Mobile banking is easy to navigate.	1	2	3	4	5
SQ4	Mobile banking is visually attractive	1	2	3	4	5
SQ5	I find mobile banking secure enough to conduct and deliver my banking transactions.	1	2	3	4	5
	Information Quality	SD	DA	N	A	SA
IQ1	Mobile banking services delivers accurate information	1	2	3	4	5

	about transactions.					
IQ2	Mobile banking delivers complete information about transactions.	1	2	3	4	5
IQ3	Mobile banking delivers relevant information about transactions.	1	2	3	4	5
IQ4	Mobile banking delivers precise information about transactions and other payments services.	1	2	3	4	5
IQ5	Mobile banking delivers timely information about transaction.	1	2	3	4	5
	Services Quality	SD	DA	N	A	SA
SRQ1	Mobile banking services is delivered 24/7 and consistent.	1	2	3	4	5
SRQ2	Mobile banking services delivers efficient service performance and prompt	1	2	3	4	5

	customer help.					
SRQ3	Mobile banking takes care of its customers and solves their problem	1	2	3	4	5
SRQ4	Mobile banking services delivery meets all my needs.	1	2	3	4	5
SRQ5	Mobile banking services delivery is flexible to use.	1	2	3	4	5
	User Accessibility	SD	DA	N	A	SA
UA1	Mobile banking increases my access to financial services.	1	2	3	4	5
UA2	Mobile banking service innovations (e.g. Whatsapp or USSD code banking) increases my accessibility to financial services.	1	2	3	4	5
UA3	Charges I pay for accessing transactions on mobile banking is affordable.	1	2	3	4	5

UA4	Access to mobile banking services meets my needs.	1	2	3	4	5
UA5	Overall, I have access to mobile banking.	1	2	3	4	5
	Price and Trust	SD	DA	N	A	SA
PT1	Mobile banking services delivered are reasonably priced.	1	2	3	4	5
PT2	Mobile banking services delivers good value for the money I paid.	1	2	3	4	5
PT3	At the current price, Mobile banking services delivers value for good.	1	2	3	4	5
PT4	I have trust and confidence on mobile banking services delivery.	1	2	3	4	5
PT5	Overall, I trust mobile banking service delivery.	1	2	3	4	5
	Customer Satisfaction	SD	DA	N	A	SA

CS1	I strongly recommend mobile banking to others	1	2	3	4	5
CS2	I think that I made the correct decision to use mobile banking	1	2	3	4	5
CS3	I am satisfied with the way that mobile banking has carried out transactions.	1	2	3	4	5
CS4	I am satisfied with accessibility to services I received from mobile banking.	1	2	3	4	5
CS5	Overall, I am satisfied with access to mobile banking.	1	2	3	4	5

Appendix 2

SEM- ANN Source Code

```
import tensorflow as tf
from keras.models import Sequential
from keras.layers import Dense, Activation
import numpy as np
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.model_selection import KFold
import matplotlib.pyplot as plt
import sys
import os
from keras.utils import plot_model
from collections import defaultdict
from sklearn.metrics import mean_squared_error, mean_absolute_error
from math import sqrt
#
from google.colab import files
uploaded = files.upload()
for fn in uploaded.keys():
    print('User uploaded file "{name}" with length {length} bytes'.format(name=fn, length=len(uploaded[fn])))
#
df = pd.read_excel('abdul_data.xls')
train_min, test_min = train_test_split(df, test_size=0.1)
df.columns
#
Index(['SQ1', 'SQ2', 'SQ3', 'SQ4', 'SQ5', 'IQ1', 'IQ2', 'IQ3', 'IQ4', 'IQ5',
       'SRQ1', 'SRQ2', 'SRQ3', 'SRQ4', 'SRQ5', 'UA1', 'UA2', 'UA3', 'UA4',
       'UA5', 'PT1', 'PT2', 'PT3', 'PT4', 'PT5', 'CS1', 'CS2', 'CS3', 'CS4',
       'CS5'],
      dtype='object')
```

```

#
#Model creation
def create_model(input_size,output_size):
    model = Sequential()
    model.add(Dense(12, input_dim=input_size, activation='relu'))
    model.add(Dense(30, activation='relu'))
    model.add(Dense(20, activation='relu'))
    model.add(Dense(20, activation='relu'))
    model.add(Dense(output_size, activation='linear'))
    model.compile(loss='mse', optimizer='adam')
    return model
#history=model.fit(features_train, target_train.values, epochs=5000)
#
def save_model_summary(model,filename):
    # Open the file
    with open(filename,'w') as fh:
        # Pass the file handle in as a lambda function to make it callable
        model.summary(print_fn=lambda x: fh.write(x + '\n'))
def save_model_figure(model,filename):
    plot_model(model, to_file=filename + '.png')
##the is for all input all output. To plot other just change the innmber of input and out
and run it
input_size=20
output_size=10
model=create_model(input_size,output_size)
msd_summary="summary.txt"
msd_plot="model_plot"
save_model_summary(model,msd_summary)
save_model_figure(model,msd_plot)
#
#cross valivadion configuration
n_split=10
n_epochs=30

```

```

#
# we have loss coming out as a value
#all the input all output
features_train=train_min.filter(['SQ1', 'SQ2', 'SQ3', 'SQ4', 'SQ5', 'IQ1', 'IQ2', 'IQ3', 'I
Q4', 'IQ5',
    'SRQ1', 'SRQ2', 'SRQ3', 'SRQ4', 'SRQ5', 'PT1', 'PT2', 'PT3', 'PT4', 'PT5'], axis=1
)
target_train=train_min.filter(['UA1', 'UA2', 'UA3', 'UA4', 'UA5', 'CS1', 'CS2', 'CS3', '
CS4', 'CS5'], axis=1)
features_test=test_min.filter(['SQ1', 'SQ2', 'SQ3', 'SQ4', 'SQ5', 'IQ1', 'IQ2', 'IQ3', 'IQ
4', 'IQ5',
    'SRQ1', 'SRQ2', 'SRQ3', 'SRQ4', 'SRQ5', 'PT1', 'PT2', 'PT3', 'PT4', 'PT5'], axis=1
)
target_test=test_min.filter(['UA1', 'UA2', 'UA3', 'UA4', 'UA5', 'CS1', 'CS2', 'CS3', 'C
S4', 'CS5'], axis=1)
cvscores = []
count=0
for train_index, test_index in KFold(n_split, shuffle=True).split(features_train):
    #print(train_index)
    x_train, x_test=features_train.values[train_index], features_train.values[test_index]
    y_train, y_test=target_train.values[train_index], target_train.values[test_index]
    model=create_model(20,10)
    history=model.fit(x_train, y_train, epochs=n_epochs, verbose=0)
    scores = model.evaluate(x_test, y_test, verbose=0)
    print(" k= "+str(count) + " : " +str(scores))
    count=count+1
    cvscores.append(scores)
print("Average: %.2f(+/- %.2f)" % (np.mean(cvscores), np.std(cvscores)))
#prediction
yhat = model.predict(features_test, verbose=0)
#rmse computed
rmse = mean_squared_error(target_test, yhat)
print("Traing rmse all: %.2f" % (np.mean(cvscores)))

```

```

print("TEST rmse for all : ", rmse)
#
#Selectd: with all selected output
features_train_less=train_min.filter([ 'SQ2', 'SQ3', 'SQ5', 'IQ1', 'IQ2', 'IQ3', 'IQ4',
    'SRQ1', 'SRQ2', 'SRQ3', 'SRQ4', 'SRQ5', 'PT2', 'PT3', 'PT4', 'PT5'], axis=1)
target_train_less=train_min.filter([ 'UA4', 'UA5', 'CS1', 'CS2', 'CS3', 'CS4', 'CS5'], axis=1)
features_test_less=test_min.filter(['SQ2', 'SQ3', 'SQ5', 'IQ1', 'IQ2', 'IQ3', 'IQ4',
    'SRQ1', 'SRQ2', 'SRQ3', 'SRQ4', 'SRQ5', 'PT2', 'PT3', 'PT4', 'PT5'], axis=1)
target_test_less=test_min.filter([ 'UA4', 'UA5', 'CS1', 'CS2', 'CS3', 'CS4', 'CS5'], axis=1)
#cross valivadiion all selected data
cvscores_less = []
count=0
for train_index, test_index in KFold(n_split, shuffle=True).split(features_train_less):
    #print(train_index)
    x_train, x_test=features_train_less.values[train_index], features_train_less.values[test_index]
    y_train, y_test=target_train_less.values[train_index], target_train_less.values[test_index]
    model_less=create_model(16,7)
    history_less=model_less.fit( x_train, y_train, epochs=n_epochs, verbose=0)
    scores_less = model_less.evaluate(x_test, y_test, verbose=0)
    print(" k= "+str(count) + " : " +str(scores_less))
    count=count+1
    cvscores_less.append(scores_less)
print("Average: %.2f(+/- %.2f)" % (np.mean(cvscores_less), np.std(cvscores_less)))
yhat_less = model_less.predict(features_test_less, verbose=0)
#rmse computed
rmse_less = mean_squared_error( target_test_less, yhat_less )
print("Traing rmse all: %.2f" % (np.mean(cvscores_less)))
print("TEST rmse for all : ", rmse_less)

```

```

#
# All the K Folds from 0 to 9 are all the same
#Selectd: with all selected (UA) only
features_train_less_ua=train_min.filter(['SQ2', 'SQ3', 'SQ5', 'IQ1', 'IQ2', 'IQ3', 'IQ4'
,
    'SRQ1', 'SRQ2', 'SRQ3', 'SRQ4', 'SRQ5', 'PT2', 'PT3', 'PT4', 'PT5'], axis=1)
target_train_less_ua=train_min.filter(['UA4', 'UA5'], axis=1)
features_test_less_ua=test_min.filter(['SQ2', 'SQ3', 'SQ5', 'IQ1', 'IQ2', 'IQ3', 'IQ4',
    'SRQ1', 'SRQ2', 'SRQ3', 'SRQ4', 'SRQ5', 'PT2', 'PT3', 'PT4', 'PT5'], axis=1)
target_test_less_ua=test_min.filter(['UA4', 'UA5'], axis=1)
cvscores_less_ua = []
count=0
for train_index, test_index in KFold(n_split, shuffle=True).split(features_train_less_u
a):
    #print(train_index)
    x_train, x_test=features_train_less_ua.values[train_index], features_train_less_u
lues[test_index]
    y_train, y_test=target_train_less_ua.values[train_index], target_train_less_ua.values
[test_index]
    model_less_ua=create_model(16,2)
    history_less_ua=model_less_ua.fit(x_train, y_train, epochs=n_epochs, verbose=0)
    scores_less_ua=model_less_ua.evaluate(x_test, y_test, verbose=0)
    print(" k= "+str(count) + " : " +str(scores_less_ua))
    count=count+1
    cvscores_less_ua.append(scores_less_ua)
print("Average: %.2f(+/-
%.2f)" % (np.mean(cvscores_less_ua), np.std(cvscores_less_ua)))
yhat_less_ua = model_less_ua.predict(features_test_less_ua, verbose=0)
#rmse computed
rmse_less_ua = mean_squared_error(target_test_less_ua, yhat_less_ua)
print("Traing rmse all: %.2f" % (np.mean(cvscores_less_ua)))
print("TEST rmse for all : ", rmse_less_ua)

```

```

#
#Selectcd: with all selected output (CS) only
features_train_less_cs=train_min.filter(['SQ2', 'SQ3', 'SQ5',
                                         'SRQ1', 'SRQ2', 'SRQ3', 'SRQ4', 'SRQ5','PT2', 'PT3', 'PT4',
                                         'PT5'], axis=1)
target_train_less_cs=train_min.filter(['CS1', 'CS2', 'CS3', 'CS4','CS5'], axis=1)
features_test_less_cs=test_min.filter(['SQ2', 'SQ3','SQ5',
                                       'SRQ1', 'SRQ2', 'SRQ3', 'SRQ4', 'SRQ5','PT2', 'PT3', 'PT4', '
                                       PT5'], axis=1)
target_test_less_cs=test_min.filter(['CS1', 'CS2', 'CS3', 'CS4','CS5'], axis=1)
cvscores_less_cs = []
count=0
for train_index,test_index in KFold(n_split,shuffle=True).split(features_train_less):
    #print(train_index)
    x_train,x_test=features_train_less_cs.values[train_index],features_train_less_cs.val
ues[test_index]
    y_train,y_test=target_train_less_cs.values[train_index],target_train_less_cs.values[
test_index]
    model_less_cs=create_model(12,5)
    history_less_cs=model_less_cs.fit( x_train, y_train, epochs=n_epochs,verbose=0)
    scores_less_cs= model_less_cs.evaluate(x_test,y_test, verbose=0)
    print(" k= "+str(count) + " : " +str(scores_less_cs))
    count=count+1
    cvscores_less_cs.append(scores_less_cs)
print("Average: %.2f(+/-
%.2f)" % (np.mean(cvscores_less_cs), np.std(cvscores_less_cs)))
yhat_less_cs = model_less_cs.predict(features_test_less_cs, verbose=0)
#rmse computed
rmse_less_cs = mean_squared_error( target_test_less_cs, yhat_less_cs )
print("Traing rmse all: %.2f" % (np.mean(cvscores_less_cs)))
print("TEST rmse for all : ", rmse_less_cs)
#
plt.xlabel("Number of Epochs")

```

```
plt.ylabel("RMSE")
plt.plot(history.history['loss'], label="full")
plt.plot(history_less.history['loss'],label="less")
plt.legend(loc="upper right")
from google.colab import files
plt.savefig("loss.png")
```

Abstract (Korean)

세계 은행 통계에 따르면 전 세계 20억 명 이상의 사람들이 은행과 금융 서비스를 이용할 수 없다. 2억 명이 넘는 인구를 가지고 있으며 사하라 이남 아프리카에서 가장 높은 인구를 가진 나라 중 하나로 손꼽히는 나이지리아에서는 성인 인구의 60% 이상이 은행을 이용하지 않는다. 반면 모바일 기술의 침투는 자리를 잡아가며 90% 이상의 국내 침투 경험을 쌓게 되었다. 본 연구는 어떻게 모바일 기술의 혁신적인 금융 서비스를 활용하여 나이지리아에 금융을 확장시킬 수 있는지를 탐구한다.

다음의 질문을 답하기 위하여 세 가지 다른 관점으로 연구를 수행하였다.

1. 나이지리아 은행이 보다 체계적인 금융 포용을 달성하는 데 있어서 회사 성과를 향상을 위한 혁신적인 서비스를 채택이 어떻게 체계적으로 더 조직화 될 수 있는지에 대한 방법적 측면

2. 고객에게 제공되는 현재의 디지털 금융 서비스 품질은 새로운 혁신 서비스를 개선하고 적용 시켜서 고객이 만족할 수 있도록 해야함.

3. 서비스 제공 혁신을 통해 은행은 고객의 접근성 및 만족도를 높이기 위해 품질, 가격 및 서비스 신뢰에 대한 고객의 인식을 이해하는 것이 중요함.

이러한 세 가지 연구 프레임의 결과는 서비스 혁신이 나이지리아에 금융 포함을 증가시키기 위한 도구로 채택될 때 IT 거버넌스 메커니즘, 서비스 품질 성능, 가격 가치 및 신뢰가 기업 성과, 고객 만족도, 사용자 접근성의 요인에 영향을 미친다는 것을 보여주었다.

본 논문은 혁신적인 금융 서비스와 결합한 기술의 한 형태로서의 모바일 뱅킹을 어떻게 활용하여 금융 서비스의 접근성을 높이고 제공할 수 있는지에 대한 통찰력을 제공한다. 이 연구의 관리 정책적 의미는 사람들이 금융 서비스에 접근할 수 있는 비율을 증가시키는 데 사용될 수 있고, 이론적 의미는 더 많은 금융 포함을 달성하기 위한 혁신적인 방법을 채택하는 은행의 준비 상태를 평가하는 데 사용될 수 있다.

주요어 : 서비스 혁신, IT 거버넌스, 기업 성과, 서비스 품질, 고객 만족도, 사용자 접근성, 모바일 뱅킹, 구조 방정식 모델링, 인공 신경 네트워크

학 번 : (2017-32868)