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Artificial Intelligence-Based Medical Device Technologies Implementation Strategies in the Nigerian Health Care Industry

Oliver Chikaodinaka Iheme
Walden University

Walden University

College of Management and Technology

This is to certify that the doctoral study by

Oliver C. Iheme

has been found to be complete and satisfactory in all respects,
and that any and all revisions required by
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Review Committee
Dr. Dina Samora, Committee Chairperson, Doctor of Business Administration Faculty

Dr. Deborah Nattress, Committee Member, Doctor of Business Administration Faculty

Dr. Betsy Macht, University Reviewer, Doctor of Business Administration Faculty

Chief Academic Officer and Provost
Sue Subocz, Ph.D.

Walden University
2023

Abstract

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Oliver C. Iheme

MBA, University of Dallas, 2001

MS, the University of Texas at Dallas, 1993

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Doctoral Study Submitted in Partial Fulfillment

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Abstract

Artificial intelligence (AI)-based medical device technologies can aid medical professionals in delivering faster and more accurate treatment, but health care leaders are concerned with eliminating challenges that impede implementation. Grounded in the technology-organization-environment and technology acceptance models, the purpose of this qualitative multi-case study was to explore strategies health care leaders in Nigeria use to obtain, adopt, and implement AI-based medical device technologies. The participants were 11 health care leaders in Nigeria who successfully implemented AI-based medical device technologies in their hospitals. Data were collected using semi-structured interviews and the review of organizational documents. Through thematic analysis, five themes were identified: (a) implementation strategies, (b) barriers to implementation, (c) factors influencing the adoption of the technologies, (d) improvement in the health care system, and (e) infrastructure and equipment. A key recommendation is for healthcare leaders to ensure financing is in place before any meaningful advanced medical device projects could be accomplished. The implications for positive social change include the potential to provide the communities with enhanced care using the monitoring and predictive features of AI-based medical devices and improving patient-centered health quality care.

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Dedication

This dissertation is dedicated to God Almighty who guided me throughout the journey. To my entire family for the continuous prayers and encouragement throughout the doctoral study journey. A special thanks to my children Michael Nnamdi Iheme, Olivia Chidimma Iheme, Jason Chidubem Iheme, and Blessing Amarachi Iheme for the encouragement and support during the difficult nights and days of this program. To my loving wife Loveline Ulumma Iheme, your steady support and words of encouragement helped me resolve most of the challenges of this program. Your continuous prayers made things easy for me. Thanks for being there for me and for the tremendous sacrifices your made throughout this journey. Finally, to my late parents Andrew and Roseline Iheme, thanks for instilling in me the essence of education in achieving one's goals and objectives. May our Lord receive your souls in His Bosom.

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Section 1: Foundation of the Study

The emergence of artificial intelligence (AI) has changed health care and the ways providers deliver care to patients. AI applications in medical devices are now in areas that were predominantly the domain of human experts due to recent development in machine learning, availability of massive datasets, big data analytics, and complex computing infrastructure (Yu et al., 2018). Diagnosis and treatment recommendations, disease prediction and accuracy, patient engagement and adherence, administrative processes, and decision support systems are key areas that health care AI is significantly impacting and augmenting clinicians' decision-making process (Davenport & Kalakota, 2019; Reddy et al., 2019; Ruamviboonsuk et al., 2021). Clinicians encounter challenges to patient care and costs, which causes workforce stress and case overload (Davenport & Kalakota, 2019; Vijai & Wisetsri, 2021; Yu et al., 2018). But the introduction of AI-based medical device technologies in health care systems could transform significant aspects of patient care and reduce the burden of administrative processes that create work-related stress.

With the increasing demand for patient-centered care, the implementation of health care-enabled technology is also a mechanism to achieve patient-centered care objectives. Leaders at the U.S. National Academy of Medicine (NAM), formerly the U.S. National Institute of Medicine, indicated that about 44,000 to 98,000 Americans die annually because of preventable medical errors in the hospital due to a shortage of health care workers and the challenges of interpreting large volumes of high-dimensional data (Kaieski et al., 2020; Wan, 2020). The shortage of health care workers contributes to the

increased workload, stress-related burnout, increased human medical error, and poor health care quality (Coombs et al., 2020; Hazarika, 2020). To reduce the impact of health care workforce shortage and increased workload, health care leaders are searching for technologies that would enable the reduction of clinicians' workload, mitigate medical errors, reduce stress-related burnout, and create new strategic opportunities to improve financial performance and high return on investments. Researchers agreed that the demand for physicians to spend more time with patients to gain better understanding of their needs is adding to their workload and creating more work-related stress (Davenport & Kalakota, 2019; Rong et al., 2020; Yu et al., 2018). Since the main objective of health care providers is to provide more personalized, predictive, preventative, and participatory medicine, AI-based medical device applications could provide the platform to achieve the purpose and allow the physicians to spend meaningful time offering patient-centered care that would enhance patient-physician communications.

Background of the Problem

The health care system in emerging nations has seen a decrease in the number of qualified physicians providing services to their people due to the increased demand for health care workers in developed countries. By 2035, the World Health Organization (WHO) projected that there would be a shortage of nearly 12.9 million health care workers globally (Alami et al., 2020). The emerging nations of Africa bear the burden of more than 25% of global disease but only accounted for less than 3% of the health care workforce globally (Alami et al., 2020). The shortage has resulted in emerging nations not having enough health care workers because of migration to the Western world for a

better lifestyle. Thus, WHO leaders envisioned that AI-based medical device technologies have the potential to reduce global health inequalities.

AI-based medical device technologies are being adopted in developed nations to enhance the delivery of various health care services. The adoption and use in emerging nations could enable the delivery of patient-centered care in those regions (Alami et al., 2020). With the widespread of smartphone connections in African nations (about 700 million in 2020), the introduction of AI-based medical device technologies like remote monitoring, wearables, chatbots, and electronic reservation systems that are supported by these smartphones would enhance the delivery of highly needed patient-centered care in the remotest region of Africa (Alami et al., 2020). AI-based medical device technologies could transform the role of health care providers globally and might even change the patient–provider relationship.

AI-based medical device technologies would improve the performance of healthcare systems while reducing delivery costs in emerging nations. The availability of applications such as telemonitoring presents an approach to physicians in delivering care to patients with high blood pressure and other chronic illnesses in remote areas of the world (Abdullah et al., 2016). These technologies would enable timely delivery of care to patients and potentially help health care professionals predict communicable diseases promptly to ensure intervention before spread. AI-based medical device technologies are advancing health care by improving the organization of treatment strategies, monitoring, and analysis of voluminous patient data (Patil et al., 2021). This background prompted me to explore the successful strategies used by health care leaders to adopt and

implement artificial intelligence within the health care sector and how to replicate those strategies in Nigeria to enhance the delivery of patient-centered care to millions of Nigerians.

Problem and Purpose

The specific business problem is that some health care leaders in Nigeria lack strategies to obtain and implement AI-based medical device technologies. Therefore, the purpose of this qualitative multi-case study was to explore the strategies the health care leaders in Nigeria use to obtain and implement AI-based medical device technologies. The population consisted of 11 executive leaders from five hospitals located in Nigeria who have successfully obtained and implemented AI-based medical device technologies. The implications for positive social change include providing the communities with enhanced care using predictive features of machine learning, improving health quality, and providing the health care leaders with the knowledge and skillset necessary to use AI-based medical device technologies to enhance patient-centered care delivery while creating high-paying jobs for their communities.

Population and Sampling

The population consisted of 11 member leaders (CEOs, chief information technology, physicians, hospital administrators, and managing directors) from five hospitals in Nigeria that have successfully adopted and implemented AI-based medical device technologies. These executives are appropriate because of their vast knowledge and experience within the health care industry. Their educational achievements ensured that they would offer an in-depth discussion on the subject matter. Most of them have

achieved a post-graduate-level degree in different fields and have gained many certifications relating to providing care to patients in hospital settings, and they have successfully adopted and implemented AI-based medical device technologies in their hospitals. To be eligible to participate in this study, the participants must come from hospitals that have successfully implemented AI-based medical device technologies in Nigeria and have some experience in AI-based technologies, adoption, implementation, and use.

A small sample size was used for this qualitative case study. In qualitative research, the sample size tends to be relatively small and case oriented (Trotter, 2012). Sampling involves a small number of participants that allow for a deep and case-oriented analysis, and leads to data saturation, and conveys the trustworthiness of research findings (Boddy, 2016; Malterud & Siersma, 2016; Trotter, 2012). Sample size in qualitative study depends on the study aim, sample specificity, established theory, quality dialogue, and analysis strategy (Varpio et al., 2017). Hence, qualitative research, unlike quantitative research, requires a small sample size to convey the trustworthiness of the findings. In a sampling of a homogenous and diverse population, experts have recommended that a sample size of 10 or more for qualitative research would be adequate based on the phenomenon being studied (Boddy, 2016; Sim et al., 2018). I selected 12 health care leaders from six hospitals in Nigeria who have successfully implemented AI-based medical device technologies in their hospitals, though the final study included 11 participants. I endeavored to select three participants from each hospital, where possible, based on the nature and security issues within the country.

Upon obtaining approval from Walden University IRB, I used purposive and convenience sampling to select the 12 leaders from the health care institutions. The purposive sampling technique refers to a sampling method that allowed a researcher to decide who the participants would be to provide the relevant information relating to the phenomenon being studied (Sharma, 2017). In addition, I also used convenience sampling to identify and invite additional participants that enabled me to ensure data saturation that conveyed the robustness and trustworthiness of the research findings. Convenience sampling allows the researcher to select participants because they are readily and easily available and have the information regarding the phenomenon being studied (Taherdoost, 2016). Convenience sampling helped to overcome many limitations associated with research resulting from access to participants.

Other sample techniques were considered but not used because they would not provide much relevant influence on the study. These options included nominated expert sampling (a classic ethnographic approach that allow researchers to explore cultural and social meaning in various population, communities, and cultural groups and based on consensus experts); geographic sampling that is based on likeminded experts; snowball or referral sampling that allows researchers to ask the targeted participants to nominate other people that may have relevant information relating to the phenomena being studied; and network sampling and targeted sampling techniques (Trotter, 2012). These sampling techniques would not have added any additional values if used for this research. Hence, they were not selected for this research.

Nature of the Study

I used qualitative methodology for this study. The qualitative research method relates to an interpretive philosophy that uses an inductive approach to theory development (Saunders et al., 2016; Stake, 1995), and it is appropriate when the research purpose is to seek a deep understanding of a research subject instead of predicting the outcomes (Tomaszewski et al., 2020). Qualitative research usually involves direct personal experience, with the intent to gaining an in-depth knowledge of the externally observable behavior and internal states of the participants' mindsets (Peterson, 2019). Therefore, qualitative research enables the researchers to understand the uniqueness of the phenomenon under study and allows the researchers to be the primary instrument of data collection and analysis.

The quantitative methodology is not fit for this study. The quantitative method is only appropriate when the research purpose is to examine the relationship between a phenomenon's components and other components or set of variables (Paoletti et al., 2021). This post-positivist philosophy espoused by Yin focuses on adopting objectivity, validity, and generalizability to gain knowledge of the phenomenon being studied (Yin, 2002). Thus, not suitable for the study. The mixed-method approach involves using quantitative and qualitative methods to study the phenomena (Paoletti et al., 2021). Therefore, the mixed method approach is also not suitable for this study because the qualitative method addressed the research question using multiple data sources such as interviews, archived artifacts, and review of company documents rather than predicting the causal relationship between variables.

I used a multi-case study design for this study. Case studies enable the investigation of the extant phenomenon in depth and within a real-life context and address the full complexity of the research question by incorporating multiple sources (Tomaszewski et al., 2020). Other qualitative research designs considered for this research included ethnography, narrative, and phenomenology. Ethnography is mainly used to study the culture or social world, which is not the focus of this study (Saunders et al., 2016). The narrative approach was also not a fit because it centers on a connotation an individual attaches to an experience through storytelling (Tomaszewski et al., 2020). Finally, in phenomenology, the focus is on the essence of a lived experience or phenomenon that can be observed or felt by people (Tomaszewski et al., 2020), which did not fit the study's purpose.

For this study, I used interviews as the primary method of data collection augmented by note taking relating to non-verbal cues and communication of the participants, data from companies' documents, and review of companies' websites information to reach data triangulation. To achieve data saturation multiple sources of data (interviews, company document, note, memos), data triangulation, and member checking should be used (Houghton et al., 2013). Data saturation conveys credibility and trustworthiness of research findings. I used multiple sources of data, triangulation, and member checking to achieve data saturation of my research.

Research Question

The central research question for this study was “What strategies do health care leaders in Nigeria use to obtain, adopt, and implement AI-based medical device technologies?”

Interview Questions

Guided by the interview protocol, the following questions were used to solicit information regarding implementing AI-based medical device technologies strategies from the participants.

1. What AI-based medical device technologies do you currently use at your hospital?
2. How did AI-based medical device technologies enhance the operational efficiency of your hospital?
3. What factors influenced the implementation and adoption of AI-based medical device technologies within the health care industry?
4. What strategies did you employ to adopt and implement innovative medical device technologies such as AI-based medical device technologies within your organization?
5. Which of those strategies do you think best enabled you to adopt and implement AI-based medical device technologies?
6. How did the technology’s purpose and complexity determine the implementation strategy within your hospital?
7. What were the barriers that you encountered and how did you over them?

8. What are the success stories of implementing AI-based medical device technologies in your hospital?
9. What impacts did the physicians' knowledge of the technologies influence your adoption and implementation strategies within your hospital?
10. What other additional information would you like to add that we have not covered relating to the implementation of AI-based medical device technologies?

Conceptual Framework

Many frameworks or models are available to understand implementation strategies of AI-based medical devices in health care systems. However, most of those frameworks are not by themselves encompassing enough to be used as single model to understand health care leaders' perspectives in implementing AI-based medical devices in hospitals. Hence, an integrated framework can bring updated information and other variables to enable in-depth understanding of the phenomenon under study. I used the technology-organization-environment (TOE) model developed by Tornatzky et al. (1990) integrated with the technology acceptance model (TAM) developed by Davis (1989) as the conceptual models for this study. Integrating TOE with TAM enables the researcher to gain in-depth understanding of the individual characteristics of health care leaders that are missing with TOE model.

The TOE model has gained strong accolade among researchers as the best framework to gain understanding of technology implementation strategies. Tornatzky et al. (1990) developed the TOE model to enable researchers to gain an in-depth

understanding of how organizational leaders make the adoption and implementation decisions of new disruptive technologies such as AI and machine learning. TOE is used to investigate an organization's strategies to adopt and implement technological innovations to transform internal and external operations (Clohessy & Acton, 2019; Pateli et al., 2020). The TOE framework consists of three contextual factors—technology, organization, and environment—influencing an organization's implementation strategies of new technologies (Tornatzky et al., 1990). Though the TOE model enables understanding of organizational leader's implementation strategy of AI-based medical device technologies, the model only depicts the organizational level and lacks the individual characteristics perspective of the health care leaders that determine the use of the technologies.

Integrating TOE with the TAM ensured that individual characteristics that determine intention to use of any technology is incorporated. Davis (1989) developed the TAM to enable the understanding of the factors influencing the intention and use of disruptive technologies. The TAM helps explain the adoption of any technology in a more flexible pattern with a robust theoretical and strong standard base and powerful explanatory capability that is easy to understand (Chatterjee et al., 2021; Qin et al., 2020). The TAM consists of two core constructs—perceived usefulness (PU) and perceived ease of use (PEU)—that explain the beliefs and behavioral intention that act as the significant reasons for system use in an organization (Bryan, & Zuva, 2021; Chatterjee et al., 2021). The use of both frameworks explained most of the strategies used by healthcare leaders to adopt and implement AI-based medical device technologies in their hospitals. TAM

enables the researcher to understand individual characteristics that influence the intention and use of advanced medical technologies.

The logical connections between the frameworks presented and the nature of my study included enabling the researcher to explore how healthcare organizational leaders develop technological implementation and adoption strategies of new disruptive technologies, such as AI-based medical device technologies within the hospital setting. The conceptual framework helped to identify, explore, and understand the influence of technological, organizational, and environmental, perceived use, and perceived ease of use constructs on health care leaders' strategies to adopt and implement AI-based medical device technologies in hospital settings. The TOE and TAM conceptual framework provided the guideline to answer the research question of what strategies health care leaders in Nigeria use to adopt and implement AI-based medical device technologies in the hospital settings.

Operational Definitions

Algorithm: Algorithm is a step-by-step, rule based clear-cut instruction, in the form of codes, for the computer to execute certain computing tasks or solve a problem (Hussain, 2021).

Deep learning (DL): DL is a branch of machine learning (ML) that is mainly used for image recognition and analysis (Hussain, 2021).

Digital health: Digital health is defined as the use of wearable devices, mobile health, health information technology, telehealth, telemedicine to improve health care

access, reduce costs and inefficiencies, and increase quality care for patients (Osei & Mashamba-Thompson, 2021).

Low-middle-income countries (LMICs): LMICs means countries defined by the World Bank as having low-income economies, low middle-income economies, or upper middle-income economies (World Bank, 2015)

Mobile health (mHealth): mHealth refers to the use of voice calls, short message service (SMS), wireless transmission of data, and mobile phone applications to support health care provision with the health care system (Osei & Mashamba-Thompson, 2021).

Natural language processing (NLP): NLP is a branch of AI that refers to algorithms that can understand the contents of a document, including textual nuances, such as negation statement (Hamilton et al., 2021).

Assumptions, Limitations, and Delimitations

Assumptions

Assumptions are those things that impact the research findings and are critically important. Assumptions in a study are those things that are out of the researcher's control (Ellis & Levy, 2009; Simon, 2011). To produce scholarly research, the researcher must justify that the assumptions could probably be true. The first assumption of my study was that the participants are a true representation of the population of health care leaders with AI-based medical device technologies experience. The second assumption was that all participants speak English and would understand the interview questions. English is widely used in Nigeria to conduct daily businesses; however, Nigeria has more than 1,500 dialects that could be used to conduct any business. Thus, it was assumed that only

those who speak English participated in this study to avoid misinterpretation of information and due to lack of professional translators. The third assumption was that the health care leaders are responsible for the adoption and implementation decisions of AI in the hospital settings. Finally, an essential assumption in this study was that the participants answered the interview questions honestly instead of answering how the participants believed I wanted the questions answered.

Limitations

Limitations of research study are the weakness that may impact the findings. Limitations of any study refer to the potential weaknesses that are out of the researcher's control (Ellis & Levy, 2009; Theofanidis & Fountouki, 2019). An important limitation of this study was that some hospital administrators might not provide all the necessary documents I needed due to the restrictions imposed by the organizational policies. Another limitation was finding participants who have been successful in using AI-based medical device technologies. However, this limitation was mitigated by selecting hospitals that use modern technologies integrated with AI-based medical device technologies to deliver patient-centered care. In addition, conducting research in another country as this study entailed was a limitation as the culture of Nigerians might make it difficult to use the observation of body language to confirm participants' answers to interview questions.

Delimitations

Delimitations are factors that the researcher can control in a research study. Delimitations are characteristics that limit the scope and set the research study's

boundaries (Theofanidis & Fountouki, 2019). Delimitations are under the researcher's control. Delimitation factors consist of the choice of the study's theoretical background, objectives, research questions, variables of interest, and the sample population (Theofanidis & Fountouki, 2019). The scope of this study is a qualitative multi-case study to explore the AI adoption and implementation strategies used by health care leaders in Nigeria. Only individuals with experience in adopting and implementing AI in five hospitals in Nigeria participated in this study.

Significance of the Study

Contribution to Business Practice

Understanding health care leaders' implementation strategies of AI-based medical devices can lead to adoption of the devices in LMIC hospitals. This study is significant in that AI applications can improve operational efficiency and organizational effectiveness through automation of the workforce, enhancing predictive intelligence of the decision-makers, and creating better competitive advantages (Al Badi et al., 2021). Because it is understood that AI-based medical device technologies have great potential to enhance the existing health care systems in developing countries, this study focused on the benefits and challenges that might contribute to the practitioners' decisions to deploy AI-based medical device technologies in their hospitals. The study's findings could provide the basis for health care leaders to enhance their decision-making process and implement compliance policies to ensure patient compliance with the care plan (Ma et al., 2020). Therefore, the study's findings might further help health care leaders to appreciate the benefits of AI-based medical device technologies such as cost reduction, enhanced

patient care, and the creation of competitive advantages in the global marketplace. The study's findings could also have some practical implications and should be helpful for business leaders, managers, policymakers, practitioners, and organizations in the health care industry in Nigeria. The Nigerian government could also capitalize on the study's findings to adopt AI-based medical device technologies to develop and implement policies to improve the failing health care industry in the country.

Implications for Social Change

The implications for positive social change include providing the communities with enhanced care using the monitoring and predictive features of AI-based medical devices, improving health quality, and providing the health care leaders with the knowledge and skillset necessary to use AI-based medical device technologies to enhance patient-centered care delivery while creating high-paying jobs for the communities. By adopting and implementing AI-based medical device technologies in the hospitals, health care providers could lower the costs of providing patient-centered care and make services available to the remote areas of the communities. The communities would notice an upgrade of their lifestyle, increase in life expectancy rate, and reduction in mortality rate.

A Review of the Professional and Academic Literature

Introduction

AI-based medical device technologies are revolutionizing the way health care leaders are optimizing the hospital operations. The global interest in AI-based medical device technologies has prompted many scholars to study the benefits and applications of such technologies and how they improve organizational efficiency and performance

(Aggarwal et al., 2020; Amann et al., 2020; Esmaeilzadeh, 2020; Guo & Li, 2018; Lee & Yoon, 2021). AI-based medical device technologies are creating opportunities for continuous innovation in different industries, including healthcare, finance, manufacturing, retail, supply chain, logistics, and utilities, and are generating personalized recommendations to customers based on analysis of the enormous dataset (Esmaeilzadeh, 2020). The impact of implementing AI-based medical devices in hospitals includes providing evidenced-based care to patients and optimization of hospital operations.

The emergence of AI-based applications into the health care sector is changing the ways clinicians provide patient-centered care. AI-based medical technologies help in integrating electronic health records (EHRs) with other clinical records, enabling personalized medicine, establishing robotic surgery, improving health care systems management, and have significantly advanced the health care space (Giordano et al., 2021; Guo & Li, 2018; Hazarika, 2020; Reddy et al., 2019; Ruamviboonsuk et al., 2021; Vijai & Wisetsri, 2021; Wan, 2020). The traditional method where clinicians spent time reviewing patient medical records manually took away time that should have been spent with patients (Kumar et al., 2021; Vijai & Wisetsri, 2021). With the introduction of AI-based medical device technologies such as machine learning (ML), deep learning (DL), and reinforcement learning, clinicians get the analyzed patient clinical information readily, enabling them to reach clinical decisions quicker (Vijai & Wisetsri, 2021). For example, AI-based medical device technologies are used in areas including cancer, neurology, medical specialty, and polygenic disorder (Bhagat, 2021). AI-based medical

device technologies have not only enabled significant care quality enhancements, but they are also expected to deliver cost-savings improvements.

The intent of adopting AI-based medical device technologies in health care is to enable health care leaders to achieve robust competitive advantages and generate exceptional operational performance. Many researchers have argued that the benefits of implementing AI-based medical device technologies outweighed the challenges, hence, the rapid evolution in the adoption of the technologies within the health care sector (Aggarwal et al., 2020; Amann et al., 2020; Guo & Li, 2018; Lee & Yoon, 2021). However, the implementation of such technologies in the health care industry is behind other industries such as aviation, telecommunications, and auto because of a lack of sufficient understanding of the dangers that AI-based medical device technologies may pose to patients, health care providers, health organizations, and policymakers (Ruamviboonsuk et al., 2021). AI-based medical device technologies have positively influenced how these non-health care sectors conducted businesses, trading, and management practices and have enabled the creation of a sustainable competitive advantage that advanced exceptional financial performance (Di Vaio et al., 2020). The improvement in these advanced technologies could enhance the widespread implementation of them in health care systems.

The global health care ecosystems are witnessing tremendous paradigm shift in the way health care is delivered due to improvement in AI-based medical devices. The health care industry has witnessed the upsurge in implementing AI-based medical device technologies within the hospital ecosystems because of the changing demography,

administrative requirements, workforce shortages, and increasing morbidity (Aggarwal et al., 2020; He et al., 2019; Reddy et al., 2019). The forgoing has made the case that AI-based medical device technologies would improve health care and enhance patients' wellbeing in terms of data records and early identification of potential diseases. Still, the implementation has not been widespread and raised the issue of why many healthcare providers have not implemented the technology, especially in developing countries. This literature review was conducted to explore and understand the successful strategies used by health care leaders to implement AI-based medical device technologies within the hospital settings and identify issues hindering the implementation by others, especially in LMICs or developing nations.

Search Strategy

In this literature review, I analyzed relevant current professional and academic studies to answer the central research question: What strategies do health care leaders in Eastern Nigeria use to obtain, adopt, and implement AI-based medical device technologies? The review enabled me to accomplish the purpose of my research. The purpose of this qualitative multi case study was to explore the strategies the health care leaders in Nigeria use to obtain, adopt, and implement AI-based medical device technologies in their hospitals. To answer the research question and assemble supporting documents to reach my study's aim, I conducted a literature review of seminal works and peer-reviewed studies on adopting and implementing AI-based medical device technologies in the health care industry. The review focused on the relevant evidence on the strategies, implementation, benefits, and challenges of adopting AI-based medical

device technologies in hospital settings, especially in Nigeria and other LMICs. To be relevant, the literature must have been published within the last 3 to 5 years and be peer reviewed. I retrieved these research documents from databases such as ProQuest, EBSCOhost, Emerald, SAGE Publications, and Science Direct through Walden University library. I also conducted a search using a search engine like Google Scholar. Information was found using keywords like *AI in hospitals, health care AI, Medical AI, digital health, machine learning, deep learning, strategy, technology implementation strategy, technology adoption strategy, AI-based medical device technology adoption barriers, technology-organization-environment model,* and *technology acceptance model*. The literature review contained about 119 sources, with 88% peer-reviewed and government publications or books and 89% within the mandatory 5-year period (Table 1).

Table 1

Literature Review Source Content

	Total	< 5 years	> 5 years	%total < 5 years
Peer-reviewed Journals	107	97	10	82
Non-Peer–Reviewed Journals	1	1	0	1
Dissertations	0	0	0	0
Government Publications	8	6	2	6
Books	3	0	3	0
Total	119	104	15	89

Note. The results of the Journal search for Literature review.

My literature review started with an overview of AI-based medical device technologies in the health care industry. A literature review on the influence and benefits of AI followed, anchoring on quality, diagnosis, predictive ability, and patient outcomes. Next, I reviewed the evidence on AI-based medical device technologies adoption in

LMICs, focusing primarily on strategies, challenges, and barriers. The review uncovered some issues that affected the successful implementation of AI-based medical device technologies, such as data accuracy, privacy, safety, job loss, and accountability. These issues, if not mitigated, would hinder the successful implementation of AI-based medical device technologies in the health care industry. Next was a complete review of the literature on the conceptual frameworks for the research study, the TOE and the TAM. The TOE and TAM reviews consisted of a discussion of different schools of thought or theories and the appropriateness of using both conceptual frameworks as a lens to understand AI-based medical device technologies adoption and implementation strategies in health care. I concluded the review with an assessment and analysis of how LMICs can successfully overcome the adoption barriers and implement AI-based medical device technologies in health care.

AI-Based Medical Device Technologies in Health Care

The health care sector is witnessing the impact of global shift in ways services are delivered to patients. The advancement of disruptive technologies such as AI, big data analytics, blockchain, and the Internet of Things (IoT) in health care is revolutionizing the ways health care providers are managing patients' daily activities in hospital settings (Aggarwal et al., 2020; He et al., 2019; Wiljer et al., 2021). The goals of AI-based medical device technologies are to humanize the field of medicine and making it more inclusive (Macruz, 2021). The evolution could lead to nurturing an open, collaborative, and inclusive environment that would establish a generalizable clinical tool.

The use of AI-based medical devices has the potential to improve operational performance in health care sectors. Digital technologies such as AI-based medical device technologies have enhanced digital knowledge, diagnostic, preventative, treatment, and rehabilitation possibilities and have increasingly changed health care systems and services provisions, especially in areas of structure, culture, professions, treatments, and outcomes (Germamm & Jasper, 2020). Similarly, Antwi et al. (2021) noted that AI-based medical device technology is widely used in medical practice because of its potential to enhance patient care and enable clinicians to diagnose, treat, and predict outcomes, such as medical imaging that can enhance detection. While it is not clear how AI-based medical device technologies would be implemented in the health care systems, there are signs that these devices would improve health care providers' performances in providing effective, efficient, and high-quality care to patients.

The use of AI-based devices is changing the health care landscape and enabling new ways to offer treatment. Researchers have agreed that AI-based medical device technologies have enabled physicians to be proactive in diagnosing and predicting diseases and developing treatment strategies. Despite the benefits of AI-based device technologies, its use in health care is limited compared to other industries (Ruamviboonsuk et al., 2021). Similarly, the current medical system has several shortcomings that impeded an effective use of AI-based medical device technologies, including the uneven distribution of senior clinicians, high rate of misdiagnosis by primary clinicians, the undue length of training period for clinicians, shortage of clinicians in undeveloped areas, and high medical expenses for patients (Yan et al.,

2019). Until these challenges in the health care sector are mitigated, the advancements in AI-based medical device technologies could be limited.

AI

Using AI programs in health care applications enables health care professionals to improve the quality of care. Health care providers attest that using AI could significantly advance health care quality and assist in performing duties requiring high degree of intensive care and reaching faster decisions (Al Badi et al., 2021; Amann et al., 2020; Klumpp et al., 2021; Kumar et al., 2021; Mrazek & O'Neill, 2020; Reddy et al., 2019; Secinaro et al., 2021). There are two main branches of AI-based medical device technologies—virtual and physical—where the virtual branch includes an informatics approach from deep learning to control health management systems, and the physical branch refers to the robots and machine learning algorithms (Patil et al., 2021). These emerging technologies are creating opportunities in the global industrial sectors and revolutionizing the ways health care sector is providing patient care. For instance, AI technology can be used in predictive medicine, determining the probability of disease occurring in the future, taking into consideration relevant risk factors, and its role is to mitigate the impact of the disease on patients by eradicating mortality or reducing morbidity (Houfani et al., 2021). In addition, predictive medicine's goal consists of using the data to predict a patient's risk for an outcome of interest and envisaging treatment options that could be more effective for the patient and intervening before the outcome occurs (Houfani et al., 2021). The integration of AI-based devices with other health care

processes, clinicians would notice improvement in care delivery as the diagnosis and treatment strategies are quickly identified and carried out by physicians.

AI-based device is a group of technology rather than a single system; AI-based technologies could include several specific applications. These applications include ML, DL, deep language processing, natural language processing, voice recognition, and intelligent robots that could enhance physicians' decision-making process in the diagnosis and treatment of diseases, predictive medicine, data mining, pattern recognition, and change both the structure of the market and the nature of services (Bajwa et al., 2021; Chen & Decary, 2020; Hazarika, 2020; He et al., 2019; Kumar et al., 2021; Lee & Yoon, 2021; Mrazek & O'Neill, 2020; Secinaro et al., 2021). Health care leaders are integrating AI-based medical device technologies to augment physicians' decision-making processes.

One of the AI applications that are consistently being integrated with other processes in the hospitals to analyze volume of data is ML. ML comprises supervised learning, which uses data as input and known labeled outcome as output to identify patterns; unsupervised learning that is used to discover the structure of data and make predictions based on the input; and reinforcement learning that allows computer agent to take actions and interact with the environment (Abdulkarim et al., 2022; Bajwa et al., 2021; Carrillo-Larco et al., 2020; Chen & Decary, 2020; Houfani et al., 2021). ML enables algorithms to understand and find the regular pattern behind observed data and create a model based on that data (Yan et al., 2019). ML and DL technologies enhance intelligent image analysis depending on available datasets (Ilhan et al., 2020). Manual

interpretation of medical images is very laborious, requiring considerable specialist expertise, and is subject to inaccuracy. Hence, the use of ML enables health care professionals to offer accurate medicine that predicts treatment strategies that enhance patients' recovery.

Cancer disease is creating global havoc for leaders due to the lack if early detection, and as such has killed millions of people globally. Researchers have noted that early detection of the disease raise hope that more people will be cured of the disease. AI applications for detecting skin cancer, oral cancer, and other disease offer rare hope that more people would be able to have access to screening tools that could change the care for such diseases (Antes et al., 2021). ML has helped physicians to predict and manage cancer and other diseases such as cardiovascular disease, viral disease, and nervous system diseases, thus, enhancing the early diagnosis and prognosis of these illnesses (Houfani et al., 2021). Evidence exists that the introduction of ML in health care sector has improved early detection of cancer and other communicable diseases especially in the sub-Saharan African countries.

Health care leaders deploying DL and natural language processing (NLP) technologies in the hospitals are changing the use of big data. Using big data analytics, physicians are able to extract critical information about the patients from the dataset and electronic medical records (EMRs) to improve diagnoses and treatment recommendations (Bajwa et al., 2021; Chen & Decary, 2020; Goh et al., 2021). DL is a computational method that enable algorithms to automatically program and learn from hug data and is used to train the artificial neural network (Yan et al., 2019). DL has enabled applications

with performance levels accuracy exceeding those of trained physicians in areas such as interpretation of medical images and drug discovery (Barhoom & Abu-Naser, 2022; Hosny & Aerts, 2019). Integrating DL, NLP, and EMR would enhance accuracy of prediction and diagnosis of disease and allow clinicians to provide evidenced-based care to patients.

Radiologist in LMICs and high-income countries (HICs) are using AI-based medical applications to enhance their interpretation of images, thereby reducing the amount of time reading manual reports. AI deep learning algorithms for breast cancer diagnosis would enhance radiologist interpretation of images and ensured time reduction needed by radiologists (Mahajan et al.,2019). By applying text-mining techniques embedded in NLP, clinicians could extract and analyze unstructured text data in EMR and clinical notes to determine the psychosocial factors of patients (Goh et al., 2021). One of the major problems facing clinicians is the time spent in incorporating hand-written clinical notes with EMR. The integration of NLP will eventually mitigate these major issues and enable the clinicians to spend more time to understand the patients' needs and provide lifestyle modification treatment plans.

AI-based voice recognition software is also enabling health care workers to perform their duties more effectively and efficiently. AI voice recognition and assistants are used to perform specific routine and simple tasks in the health care sector, such as reminding patients to take their medication as prescribed by the physicians (Chen & Decary, 2020). AI-assisted surgical robots are being used to analyze data from preoperative medical records to physically guide surgeons' instruments in real-time

during surgical procedures (Bajwa et al., 2021; Chen & Decary, 2020). Thus, AI-based medical devices are enabling the automation of processes that combine complex datasets with different levels of pathways whose results establish guidance for clinical decision-making.

Regardless of the advancement made so far in the use of AI-based medical device technologies to enhance clinical decision-making, its use remains complex and generally unaffordable to patients. For these biomedical technologies to help in diagnosing and treating diseases, they must be robust, low cost, simple in their user interface, be intuitive and portable, and produce only the input and out parameters that are linked to enhancing patient outcomes (Ilhan et al., 2020). Physicians' perceptions of the technology and easy access and understanding of the benefits by patients could improve global adoptions of these advanced technologies.

The rapid advancement in AI-based medical device technologies created numerous challenges and legitimate concerns for health care providers. Achieving true scale in the use of AI-based medical device technologies would involve building trust with health consumers through a collaboration between data providers, health technology companies, regulators, and government agencies. AI-based medical device technologies in health care include risks as security of health care databases and applications, violation of the end user's privacy, the safety of critical AI-based medical device applications, and social risks (Kumar et al., 2021). To improve the adoption rate of AI-based medical device technologies within the hospital setting, health care administrators must establish scientific evidence that used these devices to enhance physician's decision-making

process and improve predictive medicine to manage diseases before manifestation (Giordano et al., 2021). Hospital administrators should therefore ensure that AI-based medical device technologies are developed and applied in such a way that they agreed with the public interest while preserving patient's health data information.

AI-based technologies are enhancing the advancement of smart medical and precision medicine, which would mitigate patient readmissions, wait times, and costs, and improve high-quality medical services. With the right implementation, AI-based medical device technologies could enable clinicians to diagnose disease and enhance treatment processes, reduce the rate of misdiagnosis, improve diagnostic efficiency, recognize medical images, analyze massive datasets quicker than humans, support drug and vaccine research, and improve the accuracy of many complex and difficult operations (Mrazek & O'Neill, 2020; Yan et al., 2019). Businesses are finding the applications for AI across the health ecosystem, from innovation such as drug discovery, imaging, diagnostics, and enhanced genomics to delivery health system efficiencies and enhanced customer relationship management (Guo & Li, 2018; Mrazek & O'Neill, 2020). The AI-based medical device system could enhance patients' health by synthesizing available information, helping patients understand their risks and outcomes, and exploring the available options that will lead to optimal health solutions (Amann et al., 2020; Giordano et al., 2021; Guo & Li, 2018; Mrazek & O'Neill, 2020). These emerging technologies create opportunities to provide evidence-based quality care to patients in the health care industry and bridge the health service gaps in emerging nations (Lee & Yoon, 2021; Mrazek & O'Neill, 2020). Integrating AI with other health care processes leads to

improvement in health care operations and enhances the financial performance of the hospitals.

The growing need for patients' participation in their care and continued demand for better treatment plan have made it imperative to deploy resources that would provide real-time information to clinicians, patients, and caregivers. Such technology-based application would enhance operational effectiveness of health care providers. The AI-based medical device system could enhance patients' health by synthesizing available information, helping patients understand their risks and outcomes, and exploring the available options that will lead to optimal health solutions (Amann et al., 2020; Giordano et al., 2021; Guo & Li, 2018; Mrazek & O'Neill, 2020). These emerging technologies create opportunities to provide evidence-based quality care to patients in the health care industry and bridge the health service gaps in emerging nations (Lee & Yoon, 2021; Mrazek & O'Neill, 2020). Precision medicine which leads to improvement in health care delivery is the outcome of implementing AI-based medical devices in the hospitals.

Risk segmentation and management is an area that has seen improvement with the application of AI in health care systems. Using these technologies enable clinicians to stage patients into risk categories and identify the severity of the ailment of low-risk patients admitted in the hospitals for proper delivery of personalized care tailored to improve lifestyle outside the hospital settings (Giordano et al., 2021; Mrazek & O'Neill, 2020). The use of traditional (non-AI-based) methods to categorize patients based on the severity of ailment could be replaced by continuously monitoring and updating AI-based medical device tools that can identify early imperfections and patterns that predict health

deterioration (Giordano et al., 2021). Incorporating these technologies with other processes could improve the hospital's risk-stratification process and enhance the resources optimization to disease management.

Shortage of Health Care Workers

A plethora of health care problems have created an urgent need to adopt and implement AI-based medical device technologies in hospitals. The increased demand for patient-centered health care delivery and the aging population are causing the shortages of health care workers in hospitals globally (Klumpp et al., 2021; Wan, 2020). Implementation of AI can potentially aid in more efficient use of hospital resources. The demand for medical personnel resulting from an increase in chronic disease due to the aging population and shortage of medical specialists created resource scarcity and medical sustainability challenges. Schwalbe and Wahl (2020) argued that AI-based medical device technologies could be used to handle many of the challenges, such as augmenting clinical decision making towards mitigating the workload of health care workers and identifying diseases earlier than traditional methods. The changes in clinical practice due to technological innovations would help the health care systems withstand the continuous economic and socio-demographic challenges (Klumpp et al., 2021). Integrating AI-based medical device technologies would enable health care providers to withstand the challenges arising from the shortage of health care workers and clinical infrastructure.

The pressure on the clinicians resulting from the shortage of health care workers is making health care providers to devise alternative ways of providing evidenced-based

services outside the hospital settings. Many researchers have argued that the shortage of health care workers has necessitated the rapid use of outside clinics to provide care services typically done in the hospitals that would continue to enable patient-centered care (Aggarwal et al., 2020; Klumpp et al., 2021). Cares delivered in these new environments encompassed advanced technological applications such as wearables, remote monitoring tools, chatbots, and virtual assistants and thus, used to augment patient-centered care delivery outside hospital settings, thereby reducing in-hospital patient visits (Aggarwal et al., 2020; Chen & Decary, 2020; Lee & Yoon, 2021; Ruamviboonsuk et al., 2021). These services are provided using remote monitoring, telehealth visit, and telemedicine which allow for targeting of high-risk populations for more intensive interventions (Aggarwal et al., 2020). These novel modes of delivery patient-centered health care are enabling clinicians to provide services to patients at their homes and monitor treatment compliance.

The demand to detect cancer earlier in the process and the need for quick treatment plan strategies have caused shortage of radiologists and radiographers especially in LMICs. Leng et al. (2020) noted that in LMICs, an increase in cancer incidence is on the rise, which leads to the shortage of radiotherapy availability, causing countries like Nigeria to experience a tremendous shortage of infrastructure. Nkhoma et al. (2021) discovered that about 16 million people (majority of them in LMICs) could die of cancer annually by 2060 due to an increased rate of aging, the high residual burden of infectious agents, human papillomavirus, hepatitis B, and different lifestyle factors. Health care providers in LMICs should have detection and treatment strategies to combat

cancer disease because the lack of such strategy would have global implication in managing clinical resources.

Lack of early detection of the disease has contributed to tremendous patients' death especially in LMICs. Prior research on cancer highlighted that the situation is further worsened by the fact that more than 80% of cancers are metastasized at the time of detection and diagnosis due to late clinical prediction, lack or poor access to preventive care, shortage of health care workers, and treatment facilities (Nkhoma et al., 2021). Similarly, Leng et al. (2020) observed that LMICs bear 80% burden of cancer outbreaks but only get 5% of global resources for cancer treatment, thus creating an imbalance in global resources that has resulted in a severe shortage of quality health care workers within LMICs. The implementation and adoption of AI-based medical device technologies that enabled remote monitoring and effective patient screening would enhance care, reduce unnecessary deaths, and mitigate the shortage of health care workers. However, while the direct use AI-based medical device technologies in LMICs would increase the chances of early cancer detection and treatment, the fact remained that the effective use of AI-based medical device technologies in these LMICs depends on other critical infrastructures such as electricity, trained manpower, internet accessibility, and finances that are in acute shortages in these countries.

Globally, health care system is experiencing the impact of shortages of health care workers which is potentially impacting the quality of patient care. Wan (2020) observed that the clinicians' shortages have created a vacuum in delivering patient-centered care and have led to staff burnout and work-related stress due to unsatisfactory workplaces.

Researchers have found that physicians' burnout results from the physicians' clinical decisions that still depended on the use of the traditional clinical practice guidelines, rather than based on the use of automatic decision support tools that capitalize on the improved availability of medical data, electronic health records (EHRs), clinical and pathological images, and wearables (Klumpp et al., 2021). Hosny and Aerts (2019) observed that burnout due to work-related stress, inefficiencies in clinical workflows, inaccuracies in diagnostic tests, and increases in hospital-acquired infections are significant challenges facing the practice of medicine in both LMICs and HICs. Integrating AI -based medical applications for supporting medical diagnosis and decision-making of physicians would improve the work conditions and reduce the burnout issues in hospital settings. It would also substantially reduce the administrative burden of clinicians that creates the environment for physicians' burnout and allows them time to provide patient-centered health care.

The growing adoption of AI-based medical device technologies creates an opportunity within the health care sector to implement a more robust technology for equitable health care that could ensure cost advantage and enhance industry global competitive advantage. AI-based medical device technology could be employed as a powerful tool and partner to enhance, augment, and expand human capabilities, reduce unnecessary diagnosis and treatments, reduce the cost of treatment, and improve communications between physicians, patients, and family members (Aggarwal et al., 2020; Chen & Decary, 2020; Guo & Li, 2018; Lee & Yoon, 2021; Ruamviboonsuk et al., 2021). AI-based medical applications could make time-consuming repetitive processes

faster, efficient, and allow health care providers to focus on the clinical context of their patients (Hazarika, 2020). To enable and alleviate the resources shortage in the hospitals, health care leaders should endeavor to adopt and implement AI-based medical devices technologies in care, diagnosis, and logistics areas. Therefore, health care leaders should invest in AI-based medical device technologies to create a sustainable competitive advantage that ensure high-level financial performance, operational efficiency, and that takes into consideration improvement in human safety.

The health care sector is experiencing increase in human medical errors among clinicians due to the shortages of health care workers and these are causing tremendous health problems globally. The U.S. National Academy of Medicine (NAM), formerly the U.S. National Institute of Medicine in its report, stated that about 44,000 to 98,000 Americans die annually because of preventable medical errors in hospitals due to a shortage of health care workers and the challenges of interpreting large volumes of high-dimensional data (Hazarika, 2020; IOM, 2001; Kaieski et al., 2020; Wan, 2020). The leaders of the U. S. National Academy of Medicine criticized the health care sectors for lacking the ability to translate knowledge into action and being slow in adopting new technology safely and appropriately (Wan, 2020). Similarly, the shortage of health care workers contributed to the increased workload, stress-related burnout, increased human medical error, lack of continuity of care, and poor quality of health care (Guo & Li, 2018; Hazarika, 2020; Klumpp et al., 2021; Wan, 2020). The demand for medical personnel resulting from an increase in chronic diseases due to the aging population and shortage of medical specialists created resource scarcity and medical sustainability challenges.

Health care leaders are searching for technologies that would enable the reduction of clinicians' workload, mitigate medical errors, reduce stress-related burnout, improve continuity of care, and reduce unnecessary diagnosis and treatment recommendations. Several researchers have argued that the introduction of AI-based medical devices would prevent some of these challenges (Coombs et al., 2020; Guo & Li, 2018; Hazarika, 2020; Wan, 2020). Klumpp et al. (2021) argued that health care leaders should address these challenges fast to enable clinicians to continue to provide enhanced personalized medical diagnosis and treatment. Implementing these advanced medical device technologies could improve clinicians' performance and enable health care workers to spend valuable time with their patients to gain better understandings of their health care needs.

As the complexity of providing care intensified, the need to predict and prevent diseases increased. The implementation of AI-based medical device technologies in a hospital setting creates a challenge to manage and interpret a large volume of data (Kaieski et al., 2020). Aggarwal et al. (2020) observed that AI-based technology is enabling remote monitoring, which enhanced the availability of patient's data and enabled the predictability of preventive diseases. Furthermore, Ahn et al. (2021) noted that AI-based applications enhanced effective resources management in the hospital that improved the quality of medical services through the reduction of labor-intensive burdens on staff, decreasing inpatient waiting time, and securing optimal treatment time. Evidence exists that implementing and adopting AI-based medical device technologies in the hospital settings would assist clinicians with care provisions and improve the quality and volume of care delivery.

One of the challenges faced by health care provided is integrating clinicians' manual clinical notes with electronic health records (EHR) that improve health care treatment decisions. AI-based medical device technologies' natural language processing tools are being deployed to extract critical information about patients from the manual rich, huge data collection, thereby enabling enhanced diagnosis and treatment recommendations (Al Badi et al., 2021; Chen & Decary, 2020; He et al., 2019). Reddy et al. (2019) observed that integrating machine learning algorithms to electronic health records could enable clinicians and health care administrators to retrieve accurate and context-relevant patient information. The integration of manual clinical health care notes with EHR have enabled health care workers make enhanced clinical decisions that have improved evidenced-based medical treatment.

Hospital administrators are facing the challenges of determining daily available beds in the hospitals. In accurate budgeting of available hospital beds causes tremendous wait time and leads to poor financial performance of the hospital operations. Ahn et al. (2021) found that AI-based medical applications could allow clinicians to predict patients' hospitalization periods that could be used to support the decision-making regarding bed management. Currently, most hospitals determine the bed capacity manually by relying on the clinicians' manual check of available beds each day which is time-consuming and exert significant pressure on the hospital systems (Ahnn et al., 2021). With the proper management of resources, the objectives of AI-based medical device technology application in hospitals which are to assess the relationship between prevention and treatment methods, patient outcomes, intelligent interpretation of

voluminous patient data generated in providing care and improve physicians' decision-making process would be achieved.

Prior research substantiated that the implementations of AI-based medical device applications enable clinicians enhance decision making process and allow for quick treatment plans for patients. Several researchers have argued that the implementation of AI-based technology in hospital settings would enhance patient-centered care delivery by augmenting the physician's decision-making process, mitigating human medical errors, improving labor productivity, and liberating human and financial resources (Aggarwal et al., 2020; Secinaro et al., 2021). Reddy et al. (2019) noted that clinical decision support systems enabled clinicians to reduce medical errors and improve health care consistency and efficiency. The integration of AI-based medical device technologies and other similar processes would help clinicians identify gaps in treatment protocols, develop evidenced based treatment plans and reduce potential medical errors that could cause the hospital millions.

AI Benefits

Potential Benefits

The researchers publishing their studies in the literature postulate several benefits from implementing AI-based medical device technologies within the hospital ecosystem. Yan et al. (2019) observed that AI-based medical application is being implemented in the fields of medical diagnosis, treatment, risk prediction, clinical care, and drug discovery within the hospitals. Patil et al. (2021) noted that AI-based medical device technologies helped doctors evaluate health risks, analyze data from the whole population to determine

new evidence, and establish a high-quality health care process to mitigate the risks. In addition, Martinho et al. (2021) confirmed that AI-medical device technologies enabled clinicians to expand their medical knowledge and enhanced cost-effective health care solutions that would identify individuals at high risk for disease, match patient-centered care and out-of-hospital monitoring of therapy responses. AI-based technology could provide a better way to standardize and streamline processes and strategies, predict patient's future hospitalization needs, boost predictive competencies for decision-making, enhance continuity of care, facilitate patient's access to the provider teams, enhance communication, and reduce clinicians' caseload and improve organizational effectiveness (Aggarwal et al., 2020; Al Badi et al., 2021; Patil et al., 2021; Wan, 2020). The widely accepted view is that implementing AI-based medical device technologies in hospitals could provide effective tools in achieving sustainable global health care initiatives and establish an environment to provide low-cost health care to low resources countries.

Improvement in medical operations and enabling physicians to gain better understanding of the patients' medical needs have been thwarted as vital advantages of implementing AI-based medical device technologies in the health care sector. Chen and Decary (2020) noted that AI-based medical applications could be used as powerful tools and partners to improve, extend, and expand human capabilities. Mrazek and O'Neill (2020) further stated that AI could help improve access to health care leading to achieving the World Bank Group's twin objectives of ending extreme poverty and boosting shared prosperity in all countries. Similarly, Antes et al. (2021) and Klumpp et al. (2021) attested that the application of AI-based medical device technologies in

hospitals enabled increased productivity and efficiency of care delivery, allowed the health care system to provide more and better care to more people, helped health care systems manage population health more proactively, allocated resources dynamically, and supported faster delivery of care by accelerating diagnosis time. The use of AI-based medical devices in health care has enabled physicians to have access to patients' information readily and quickly, thereby improving diagnosis and treatment strategies.

Notwithstanding the numerous benefits of implementing AI-based medical device technologies in the hospitals, many patients still prefer treatments from physicians and not from machines especially when finance is involved. Longoni et al. (2020) concurred that many patients prefer human interaction and disagreed with the views of Antes et al. (2021) and other researchers that argued that people preferred to receive care from AI-enabled providers instead of humans when price and performance significantly affected the choice. The argument is centered on the premise that the skyrocketing of health care costs is preventing low-income resources countries from accessing evidence-based patient-centered care. Health care leaders must consider price and performance issues when implementing AI-based medical device technologies to enable patient-centered care delivery in the hospital setting.

Bridging the global health care inequalities gaps has become one of the objectives of health care leaders. Researchers have argued that the increasing demand for patient-centered care and the call to reduce global health care inequalities have led to the implementation of health care-enabled technology such as AI as a mechanism to achieve these objectives (Alami et al., 2020; Bajwa et al., 2021; Wahl et al., 2018). Similarly,

Bajwa et al. (2021) noted that AI and digital health data could mitigate the impact of some of these global health care inequities and workforce shortages. Also, Chen and Decary (2020) observed that ML and other AI-based medical device technologies could enable global health care leaders reduce global health care inequity and improve the chances of achieving sustainable global health initiatives. AI-based medical device technologies are recognized as the technologies that could alleviate and mitigate the impact of global health care inequalities and improve care delivery globally.

AI-based applications are revolutionizing health care sectors in developed countries and leading to improved health care decisions that enabled enhanced patient care. However, deployment of these technologies is behind within LMICs health care sector. Evidence exists in the literature that most of the AI-based health applications are developed and implemented in developed countries without considering the developing nations' context for health care and technology issues in general (Alami et al., 2020; Hadley et al., 2020; Owoyemi et al., 2020; Schwalbe & Wahl, 2020; Wahl et al., 2018). This limits the benefits that LMICs could derive from the implementation of such technologies in their hospitals. Similarly, Hosny and Aerts (2019) argued that most AI-based medical device technologies developments in health care are done in high-income countries; but little is done to understand how AI-based medical device technologies could improve medical practices in low-and-middle-income countries (LMICs). For LMICs to benefits from the new paradigm shift in health care, AI-based applications development should incorporate the sub-Saharan medical needs in training the technologies for care in these countries. LMICs are countries where workforce shortages

and limited resources impact the access to quality care and AI-based medical device technologies could contribute to addressing the inequities at individuals, system, and population levels.

Health care providers in the high-income countries are noticing improvement in health service delivery due to the implementation of AI-based medical applications in the hospitals. Schwalbe and Wahl (2020) revealed that AI-based medical device technologies are changing how health service is delivered in many high-income countries due to the growing availability of large datasets and novel analytical processes that use the datasets in these countries. Similarly, Bajwa et al. (2021) observed that AI-based medical device technologies are currently being used in health care systems in high-income countries to automate time-consuming, high volume repetitive tasks and is shifting to a preventative, personalized, data-driven disease management model that enhances patient outcomes in the most cost-effective method. In addition, Ellahham et al. (2020) found that in high-income countries, AI-based medical device technologies have enabled potential cost and time saving, fast and thorough analysis of huge datasets for the diagnosis and management of diseases, hence, making the providing of health care cost-effective, efficient, and enhancing decision-making process with accuracy. In these high-income countries, AI based medical device technology is used to assist clinicians in performing clinical tasks, enabling quick access to medical information, increasing medical outreach, and reducing errors in the diagnosis and treatment of diseases. AI-based medical devices technologies are therefore enhancing the operational efficiency and increasing the potential better return on investments in these high-income countries.

Notwithstanding that the development of most AI-based applications are done in HICs, the use of AI-based medical device technologies in LMICs is on the rise due to the improvement in data collections and internet penetration in these low-income countries. Researchers argue that the major reasons for the increased implementation of the AI-based medical device technologies in these LMICs are because of the significant need for health care providers to improve the performance of health care services while reducing cost; helping groups suffering from disparaging diseases to access care and follow-up services promptly; compliance with treatment plans in those places where culture or language could create barriers to health care services; helping to predict the spread of disease within remote areas of the communities, and offering significant potential remedies for maternal and child health (Alami et al., 2020; Hadley et al., 2020; Owoyemi et al., 2020; Schwalbe & Wahl, 2020; Wahl et al., 2018). Similarly, due to the large volume of data being generated in the poor-resources setting, development in cloud computing, and a significant investment in digital health information records, poor-resources nations are starting to receive the benefits resulting from the implementation of AI-based health care applications in health care systems (Alami et al., 2020; Wahl et al., 2018). Furthermore, the proliferation of smart mobile phones in LMICs and increased penetrations of access to the internet in remote areas have enabled the integration of smart devices, wearables, chatbots, and telemedicine to provide evidence-based care by clinicians to the remotest part of the world (Alami et al., 2020; Bajwa et al., 2021). The improvement in enablers of AI-based medical device technologies in LMICs would enable the health care leaders optimize the use of these medical devices to essentially

mitigate inefficiency in health care, enhance patient flow and experience, and improve caregiver experience and patient safety through the care pathway.

One advantage of deploying advanced technologies in any industrial sector is to ensure production costs reductions and enhance effective operations in that sector. In health care sector, implementing AI-based medical devices could lead to providing cost-efficient services to patients. The skyrocketing of health care costs has made it impossible for most patients especially in LMICs to access health care at lower costs. The global health care leaders have recognized the importance of AI-based medical device technologies in ensuring access to cost-effective care in developed and developing nations and delivering innovative services across health ecosystems (Alami et al., 2020; Mrazek & O'Neill, 2020). AI-based medical devices are being integrated with big data in developed nations to enhance personalized and responsive preventative ancillary health services that lead consumers toward preventative behaviors (Mrazek & O'Neill, 2020). Similarly, in emerging nations' health care systems, AI-based medical devices technologies could reduce the difficulties in finding appropriate specialists or providers, mitigate the lack of transparency regarding the quality-of-service provision, and improve the underdeveloped medical record systems (Mrazek & O'Neill, 2020). AI-based medical device technology is revolutionizing the health care field, by playing enormous role in integrating electronic health record with other processes, enabling early diagnosis, enabling clinicians access to medical information for treatment protocol development, enabling cost-effective treatment of patients, enabling environment for patient monitoring

and care, allowing for personalized medicine, robotic surgery, and health system management globally.

However, these global health care leaders are also acknowledging that the implementation of AI-based health care technologies in LMICs is plagued with numerous global challenges. Researchers have noted a plethora of challenges that included the training of AI-based applications that demands clean, large, and inclusive high-quality datasets that are not currently available in LMICs; data used to train AI models are entirely collected from high-income countries which makes the models to be skewed toward certain diseases, demographics, and geographies; the lack of expertise or infrastructure needed to create the appropriate governance model to monitor the use of AI-based medical devices, and the problems of AI-based medical diagnostic tools created in the high-income countries that could recommend treatment plans that may not be locally accessible or may be costly to implement that are hindering the implementation of these advanced technologies in LMICs health care systems (Alami et al., 2020; Hadley et al., 2020; Hosny & Aerts, 2019; Owoyemi et al., 2020; Wahl et al., 2018). Similarly, Bajwa et al. (2021) contended that data quality and access, technical infrastructure, organizational capacity, regulation, and ethical and responsible practices are major barriers hindering the adoption of AI-based medical device technologies in health care systems especially in LMICs. To ensure that the AI-based health care applications benefits are achieved in these countries, attention must be paid to how to obtain clean datasets to train the applications, improve the infrastructure, upskilling of expert personnel, and local collaboration.

Notwithstanding the challenges of implementing these AI-based devices, tremendous benefits arise from proper deployment of these advanced technologies in hospitals especially within LMICs. In LMICs, physicians are seeing improved diagnosing of diseases and quicker treatment of patients with difficult cases. AI-based medical device technologies could help clinicians, patients, and family members efficiently process available patient information to generate informed, evidence-based patient-centered care, enhance decision-making, and improve patient-physician communications (Giordano et al., 2021; Mrazek & O'Neill, 2020; Wan, 2020). AI-based medical device applications could substantially reduce the administrative burden of clinicians, make time-consuming, repetitive processes faster and more efficient, and ensure that clinicians have time to make evidence-based decisions about patient health care (Giordano et al., 2021; Guo & Li, 2018; Hazarika, 2020; Mrazek & O'Neill, 2020; Wan, 2020). In LMICs, the adoption of AI-based medical device technologies could significantly promote and affect patient-centered health care delivery by using remote monitoring telehealth visits to target high-risk populations for more intensive interventions.

Researchers have agreed that some of the benefits of implementing these advanced technologies in health care sector especially in LMICs are to enable access to global specialist physicians at cost-effective manner and to provide patient care at lower cost to the remotest parts of the world. Several researchers argue that when AI-based medical device technologies functions are appropriately and effectively utilized in health care, the evidence-based practice could be standardized, leading to improved efficiency in health care services to resolve accessibilities, costs, patient safety, and quality of care

(Giordano et al., 2021; Wan, 2020). Access to cost-effective treatments, especially in low-medium-income countries, plays an essential role in improving people's standard of living. Similarly, AI-based medical device applications could enhance patient-clinician communications, leading to higher patient satisfaction and improved health outcomes. The expected benefits of AI-based medical device technologies within health care systems might include enhanced physician knowledge of the patient status, increased patient adherence to treatment plans, reduced duplication of services and lab orders, enhanced patient safety, and an improved work environment (Wan, 2020). Evidently, hospital standardization in automated care management system designs would enhance the effectiveness in targeting high-risk populations through risk identification processes.

Not only that AI-based medical device technologies enhanced clinicians' decision-making process, risk management, and segmentation, but the implementation would also enable a reduction in hospitalization and readmission rate due to improved patient-provider communications. Implementing health care-enabled technologies such as artificial intelligence (AI)-based medical device applications could result in a notable 38% reduction in hospital utilization rate, 31% reduction in readmission rate, 22% reduction in-home visit rate, 26% reduction in overall cost, 96% increase in adherence to the treatment plan, and about $150 billion in annual savings for health care providers by 2026 (Giordano et al., 2021; Lee & Yoon, 2021; Owoyemi et al., 2020; Wan, 2020). The predictive functions of AI-based medical device technologies have enabled hospitals to take proactive actions for unforeseen events before they occur (Chen & Decary, 2020). Hence, implementing AI-based medical device technologies enabled health care

organizations to create competitive advantages by reducing unbudgeted hospital rooms, thereby reducing costs. Health care leaders must understand the crucial need that implementing health care-enabled technologies will enhance patient-centered care and improve patient satisfaction.

Accuracy in Health care and Predictive Ability

As the accuracy in diagnosis is determined as an area of improvement in the health care industry, the implementation of AI-based medical device technologies would enhance the data collection and analysis processes. The accuracy of the outcome depends on collecting the right kind of clinical and patient-reported data and the integration of analysis processes that would enable predictive medicine or precision medicine (Wan, 2020). Similarly, accurate information collection is imperative to enable clinicians' evidence-based decision process due to health care data's enormous amount and complexity (Hazarika, 2020; He et al., 2019). The above views supported the notion that the accuracy of the prediction depends on the input's accuracy, quality, and integrity of data used to train the medical device applications, hence, the need for health care providers to ensure correct critical data during the decision-making process to avoid defective conclusions that could affect patients' outcomes.

Global health care providers have noticed that accuracy of data collections enhance diagnosis and treatment plans developed by clinicians and enable evidenced-based medical treatment. According to Al Badi et al. (2021), AI-enabled medical device technology such as machine learning (ML) has demonstrated that accurate patient data improved accuracy in diagnosis and decision-making and has resulted in better patient

outcomes than the results senior physicians get using the same data. AI-based medical device technology such as ML has been applied in many datasets on complex tasks that included massive data, generating results comparable to and sometimes superior to human experts in the areas of accuracy and efficiency (Chen & Decary, 2020; Lee & Yoon, 2021). Hence, as the demand for accuracy in diagnosis intensified, the successful application of AI-based medical device technologies would augment physicians' decision-making process in diagnosing these diseases.

To treat the diseases and get enhanced results, physicians should be able to predict the outbreak of the disease early before the onset. Health care providers are deploying technologies that enhance the predictive ability of the health care workforce and enable faster predictions. Secinaro et al. (2021) noted that AI-based medical device technologies are used is in disease prediction and diagnosis treatment, outcome prediction, and prognosis evaluation. AI-based medical device technologies such as machine learning and deep learning could identify meaningful relationships and patterns in raw data, thus enhancing diagnostic, treatment, and prediction of outcomes in several medical conditions (Secinaro et al., 2021). Similarly, Ellahham et al. (2020) noted that accuracy of prediction, the causality of predictive models, human efforts for labeling out-of-sample cases, and reinforcement and learning systems could improve the safety of AI applications in health care systems. Therefore, AI-based medical device technologies' predictive ability allows clinicians to engage in proactive disease management and mitigates the impact of onsets of pandemics.

Gaps in Literature

Most literature review focused on AI-based medical device technologies' ability to enable health care workers provide patient-centered care, improve diagnosis, enhance disease prediction, and enable cost-effective health care systems. There was evidence that AI-based health care device technologies focused on the patient-centered management of the disease; no research study exists on how the technologies would expand from pre-disease to treatment, and post-care to daily life (Lee & Yoon, 2021). Moreover, little study exists regarding the overall amount that a health care organization should pay for AI-based medical device technologies and additional profits generated by health care organizations with AI-based medical device technologies compared to those that do not implement such technologies. It is true that some gap exists in respect to profit maximization of these systems because AI-based medical device technologies could be designed in such a way that even though such design enhanced their effectiveness, it might end up infringing on a patient's rights, and the ensuing legal actions might create disincentives for AI-based medical device technologies use or their innovations in the hospitals.

Similarly, there was a lack of discussions surrounding the legal framework about malpractice lawsuits when a patient is harmed while receiving care using AI-based medical device technologies. According to Aggarwal et al. (2020) and He et al. (2019), researchers are silent in their arguments about malpractice lawsuits resulting from the use of AI-based medical device technologies because of the lack of collaboration between the researchers and legal scholars. To mitigate any more delays in implementing the

systems, legal scholars and scientists need to harmonize efforts to resolve the issues of human and legal rights and reconcile them with the AI-based medical device technologies' development and innovations within the hospital ecosystems.

Also, the impact of the delay by the United States Federal Drug Administration (FDA) and European Union (EU) regulatory agencies to promulgate policies to guide the implementation of AI-based medical device technologies was not discussed thoroughly by the researchers. Aggarwal et al. (2020) argued that the reason for the lack of regulations and policies are lack of understanding of what these devices could achieve and the novelty of the systems. In addition, most of the literature addressed the implementation strategies used in developed countries; little was written about health care leaders' implementation strategies in emerging economies (Aggarwal et al., 2020; Al Badi et al., 2021). Finally, a gap exists in the literature discussing training needs, integration of legacy equipment with disruptive technologies, and the lack of efficient infrastructure in LMICs before AI-based medical device technologies would be widely implemented within the business environment (Di Vaio et al., 2020). Addressing these gaps in future research studies could enhance the understanding of successful implementation strategies for AI-based medical device technologies within health care systems globally.

Medical Errors and Application of Health care AI'

Global health care leaders have acknowledged that reducing medical errors would enhance health care and improve strong confidence in the system by the patients. Human medical errors significantly impact hospital effectiveness and efficiencies and lead to

tremendous costs of obtaining care. Evidence exists that the global health care systems are plagued with human medical errors that cost society billions of dollars annually and disrupt the provision of evidence-based quality patient care. Researchers have discovered that recent advances in AI-based medical systems could enable clinicians to reduce medical errors, enhancing care services quality (Lee & Yoon, 2021). Bhagat (2021) noted that AI-based medical device technology enabled clinicians to organize patient data and treatment techniques and provided physicians with relevant information they needed to make accurate decisions in health care and medications, thereby mitigating medical errors. Hijry and Olawoyin (2021) found that using DL algorithms to predict patients' emergency room (ER) waiting time reduced human error and achieved better accuracy when compared with traditional methods. AI could detect mistakes in any environment and provides actionable strategies that could minimize human errors. Adoption and implementation of AI-based medical device technologies could enable clinicians mitigate the impact of medical error within the health care ecosystems.

Not only mitigating human medical errors and improving confidence in the system; AI-based medical device technologies enable precision medicine that allow the clinicians identify the type of diseases and design evidenced-based treatment plans. Patil et al. (2021) pointed out that AI-based medical device technologies are used to quickly recognize signs and symptoms of disease in medical images using such AI-based devices as computerized tomography (CT) scans, magnetic resonance imaging (MRI), ultrasounds, and x-rays. These devices allowed for rapid diagnostics, reducing patients' wait time for a diagnosis from weeks to few hours, and quickly predicting suitable

treatment plans. Furthermore, Botwe et al. (2021) pointed out that AI could bring advantages in medical imaging practice that would reduce the rate of diagnostic errors, workplace-related stress, and enable clinical decision support to radiologists and radiographers. AI -based health care applications could improve the prediction of disease prognosis and responses to treatments, drug development, remote patient observations, digital patient consultation, and enhanced administrative hospital management that lead to medical errors in the health care ecosystems.

Medical error reduction is one of the most critical uses of AI-based medical device technologies. AI-based medical devices are vital in enabling clinicians to prevent or mitigate human medical errors within the health care systems by enabling them to deliver precise recommendations to patients, which allowed the patients to shift from passive receivers of health services into proactive participants of their own care (Troncoso, 2020). In addition, many experts are of the view that AI-based medical device technologies and ML algorithms could enable doctors to make informed decisions, many times outperforming the physicians on the diagnosis of certain diseases or in the predictive ability of some medical outcomes (Alami et al., 2020; Giordano et al., 2021; Guo & Li, 2018; Hadley et al., 2020; Owoyemi et al., 2020; Paredes, 2021; Troncoso, 2020; Vijai & Wisetsri, 2021; Wahl et al., 2018; Wan, 2020). Esmaeilzadeh (2020) discerned that in cancer screening, AI-based medical applications enabled physicians reduce human detection errors and have been shown to exhibit the same or sometimes better performance than their human counterparts. The use of AI in medical devices and ML could support physicians by enhancing the determination of accurate predictions

regarding the impact of specific treatments on patients and mitigate the impact of medical errors in the hospitals.

The use of these advanced devices has enabled the clinicians to reduce unnecessary referrals to specialists and cut down on number of laboratories needs thereby enhancing patient care. These medical devices have also enabled physicians to avoid long incisions during surgery, hence, mitigating medical errors and loss of blood. AI decision support tools, could enable a reduction in human medical errors by enhancing the identification of difficult-to-diagnose conditions such as rare diseases, enabling better patient/doctor communication, avoiding premature diagnostic closures, and improving referral criteria to reduce unnecessary referrals to specialists (Tremblay, 2020). The integration of ML algorithms and big data analytics could provide meaningful data that could be used to identify gaps in the understanding of diseases and enhance predictions, diagnosis, and treatment decision making processes of clinicians, thereby reducing the human medical errors, and mitigating the burden on the health care systems (Paredes, 2021; Tremblay, 2020). In emerging nations, the use of AI -based medical device technologies and digital health could empower the health care providers to bridge the health services gaps and improve patient-centered care with minimal medical human errors (Mrazek & O'Neill, 2020). Hence, it is crucial that health care leaders integrate AI-based applications with other health care processes to reduce the impact of medical errors in hospitals.

Quality and AI-Based Applications

The increased demand for person-centeredness of health care, variable health outcomes, and changing disease priorities in LMICs have brought the need for high-quality health systems into focus. The quality and quantity of available data would determine AI-based medical device technologies' performances and ability to interpret data from various sources, including the Internet of Things (IoTs) devices, social media, and electronic health records (Sampene et al., 2022). Anom (2020) observed that big data and AI-based medical device technologies enhanced the capabilities of predicting patient deterioration, reducing hospital readmission, clinical decision support, analyzing electronic health records (EHRs), and identifying at-risk patients based on their treatment history and vital clinical data and missing appointment dates. Digital health, AI-based medical device technologies, and big data provided unmatched opportunities to enhance the efficiency and quality of health care delivery globally.

Providing quality health care leads to patients' acceptance of these medical devices in their care. Evidence exists that patients adhere to treatment plans that eminent from AI-based medical devices and have favorable views of the system when they trust the system. Several researchers noted that physicians and patients have a favorable view about the implementation of AI-base medical device technologies and the application of the tools to patient care (Esmaeilzadeh, 2020; Kim et al., 2021; Lai et al., 2020; Roder-DeWan et al., 2020; Roy & Dhote, 2021). DeCamp and Lindvall (2020) further stated that AI-based medical device technologies are received favorably by physicians and patients because of the possibility that the devices would enable patients' greater

engagement and personalized treatment. These technologies facilitated time-savings for doctors, ensured watchful and alert works, provided better monitoring of the population, alleviated some of the deficiencies related to medical errors, and enhanced management of difficulties in the health care systems.

The operations of the health care providers are enhanced, and profits increased when patients have favorable view of the hospitals leading to more patient's referrals. Bhagat (2021) observed that AI-based medical device technologies helped doctors to understand the health endanger of a patient and, with the integration of other processes like electronic medical records, developed the standard of care and recommended lifestyle modification that would enhance the quality of care. Wiljer et al. (2021) and Nkhoma et al. (2021) found that patients and doctors are optimistic about using digital technology such as AI-based medical devices because they enabled patients to access services where distance and shortage of health care workforce are major concerns. With the integration of AI-based medical device technologies with the contact of clinicians, patients could enjoy a high quality of care at a lower cost and have access to specialist physicians globally.

Health care leaders have acknowledged that not only implementing AI-based devices but adopting responsible AI would enhance their operations and encourage widespread adoption of the technologies. According to Kumar et al. (2021), responsible AI-based medical device technologies refer to the integration of ethical and responsible use of AI into the strategic implementation and planning processes in hospitals. Responsible AI-based medical device technology allows clinicians to design ethical,

transparent, and accountable solutions that enable trust and minimized privacy invasion (Kumar et al., 2021). Implementing responsible AI-based medical devices could improve patients' care and enhanced operational performance. Trust among stakeholders and high shared gains from cooperation are factors that could facilitate responsible AI-based medical devices within the health care ecosystems.

Responsible AI consists of accountability, responsibility, and transparency that enable ethical performance of service delivery in health care systems. Kumar et al. (2021) argued that to gain in-depth knowledge of responsible AI-based medical device technologies, hospital administrators must view it from the context of accountability, responsibility, and transparency (ART). Accountability would ensure that the decisions and outcomes are justified, responsibility should promote awareness of commitments to stakeholders, and transparency should enable openness to decision-making processes (Kumar et al., 2021). To implement responsible AI-based medical device technologies, hospital administrators must share data responsibly, adopt ethical principles, generate public trust, foster equitable innovation, and protect the interests of the vulnerable (Kumar et al., 2021). Health care leaders acknowledged that implementing responsible AI- based medical device technology could enable easy access and risk reduction, enabling psychological benefits that promoted patients' happy feelings and comfort, and hence, allowing patients to share health care records readily.

Implementing responsible AI-based medical devices in the hospitals creates sense of security and confidence among the users of the system. Researchers globally agreed that the high-quality health systems powered by AI-based health applications gave people

a sense of security and confidence that their family members could receive adequate care if they become sick (Kim et al., 2021; Roder-DeWan et al., 2020). van Biesen et al. (2021) found that AI-based medical devices and big data could enhance evidence building, knowledge generation from routinely collected data, and shared decision-making, which helped explain evidence to patients and improved the need for core outcome sets. The confidence in the health systems could lead to a more robust patient engagement, better service utilization, a higher adherence to health care recommendations, and enhanced continuity of care, translating to improved quality of care.

As confidence in the health care system is one of the three primary outcomes of a high-quality health system, African countries' governments should make substantial investments to improve the quality of the health care system by improving processes of care, both technical and interpersonal. Accordingly, these tasks demand that the foundation of a health care systems be strengthened and improved in other to provide the needed services (Roder-DeWan et al., 2020). Schwarz et al. (2020) noted that the universal challenges of inequality in health care access, quality of care, patient-centeredness, costs, and persistent unaccepted health inequities contributed to low confidence about the health care system in the LMICs. Building stakeholders' trust and confidence in health care systems is one of the strategic reasons for health care leaders to adopt and implement AI-based medical device technologies within the health care sector.

Patient wait time, data availability, partnership, communication, and medical error reductions have also been noted as areas that the deployment of these advanced medical

devices has improved tremendously in the hospitals. Kim et al. (2021) found that the use of AI-based health care applications improved the wait time and enabled patients to access care promptly. Schwarz et al. (2020) identified enhanced real-time data availability, proactive care partnership between patients and clinicians, real-time communication between patients and physicians, and enhanced quality of care delivery as benefits of AI-based health care applications in global health, while others reported predictive ability, enhancement of patient health based on diagnosis, prognosis, management (Esmaeilzadeh, 2020), improved storage capacities, reduction in medical error rate and patient engagement (Roy & Dhote, 2021) and costs reduction and patient safety (Lai et al., 2020). The use of digital records with mobile applications augmented data availability in real-time, enabling proactive care partnership between patients and clinicians. These medical devices are revolutionizing how health care is offered to patients and how health care system has changed to allow for patient care delivery.

With the introduction of AI-based medical device technologies in the hospitals, the health care leaders have seen improvement in operational effectiveness and efficiencies. The automation of routine tasks has freed the clinicians from such burden and allowed to spend time with patients to understand their medical needs leading to improved health care delivery. Al Badi et al. (2021) noted enhanced efficiency and effectiveness through automating cognitive work, boosting predictive decision-making competencies, and improving services delivery as the benefits of AI-based applications within the health care sector. Similarly, Kumar et al. (2021) found that health care professionals acknowledged that AI-based medical device technologies helped to identify

treatment intensity, classifying patients' risk levels, and enabled electronic health monitoring, resulting in quality patients care. The AI-based medical device technologies and other digital health technologies are central pillars in delivering value-based care across the health care spectrum.

Productivity and Cost Savings

Physicians and other health care workers use AI-based medical tools to effectively reduce the cost of operations in the hospitals. Implementing AI-based applications in the health care sector can significantly enable clinicians and stakeholders to manage the enormous patients' clinical data and transform them into prospective life-saving information base (Bhagat, 2021; Ellahham & Ellahham, 2019). Sallstrom et al. (2019) pointed out that AI-based medical device technologies could enable the World Health Organization's sustainable development goals by increasing access, improving quality, and reducing health care costs globally. Health care cost is skyrocketing, and global health care leaders are deploying these advanced medical devices to reduce the cost of operation due to faster and quicker nature of obtaining operational data from these devices. The implementation of these devices has led to operational efficiencies in many industrial sectors globally.

Predicting diseases and providing real-time access to patient's information have been difficult tasks and that have caused global health care leaders tremendous problems in managing patient's care. Evidence exists that earlier detection of the communicable diseases especially in LMICs and easy access to real-time patient's information would lead to better prognosis and treatment plan. Patil et al. (2021) found that in the future,

AI-based medical device technologies would be used to expand the possibilities to predict and treat more diseases, save health care costs, give doctors the predictive ability with the help of real-time data, and provide a positive impact on doctors and patients in health care. Secinaro et al. (2021) took it further by arguing that AI-based medical device technologies could enhance real-time medical information updates from various sources that allowed clinicians to provide evidence-based health services to patients. AI-based medical device technologies enable efficiency in operation by allowing clinicians to access patient's data through just-in-time techniques, enable nurses to ensure better patient safety while administering medications, and enhance patient engagement in their care through effective communication protocols. Integrating AI-based medical device technologies into the health care space could mitigate the rising medical diagnosis costs and make treatments more affordable.

Another area that implementing AI-based medical device technologies has improved is in patient collaboration and knowledge management. Patient's collaboration leads to adherence to treatment plans, resources optimization, reduction in wait time, costs, and improvement in care delivery. Bhagat (2021) noted that knowledge management is one of the most notable areas of use of AI-based medical device technologies in care. With the integration, organizations gained the essential insight to collaborate with patients in reducing wastage, cutting costs, and streamlining health care workforce timing that can enhance remote patient observance. Similarly, Ellahham and Ellahham (2019) observed that resources optimization, predicting the wait time and appointment delay, and adding automated diagnostic decision support applications could

significantly enable health care providers to reduce the rising health care cost and improve patient satisfaction. Kumar et al. (2021) argued that responsible AI-based medical applications, which made patient interaction more convenient and trustworthy, delivered the financial benefit of the cost reduction resulting from reduced hospitalization, psychological benefits resulting from hassle-free care processes, and created instrumental value of cheerfulness of patients. AI-based medical applications have significant positive influence on costs and time and efficient utilization of resources contributed to optimizing logistic processes and quality of care. Hence, the capabilities of AI-based applications to improve revenue and profitability of the health care sector have opened a tremendous wealth of opportunities across the health care continuum.

AI-Based Technologies in LMICs

The implementation of AI-based medical device technologies is creating a new paradigm shift in the health care sector and holds great promise to enhance health care delivery in developing economies. Sallstrom et al. (2019) argued that geography and economic constraints limited access to physicians in Africa. However, with the integration of AI-based telemedicine technology, the potential to offer patients unfettered access to specialists around the world for better medical treatment is becoming a thing of reality.

In LMICs, the poor infrastructure, shortage of health care workers, and lack of digital knowledge have created poor state of health care sector. Most of the hospitals are lacking devices that would enable adequate health care delivery. Troncoso (2020) noted that primary health care (PHC), defined by regular access to quality care for

comprehensive care, has eluded the people of LMICs; even episodic care is nearly impossible to attain due to poor infrastructure and the critical shortage of clinicians. Evidence therefore exists that the implementation and adoption of AI-based medical device technologies in developing nations or LMICs are falling behind its implementation in developed nations (Alami et al., 2020; Hadley et al., 2020; Owoyemi et al., 2020; Wahl et al., 2018). The lack of modern medical devices and the shortage of health care workers in LMICs have led to poor diagnosis, poor treatment plan, and increased in medical human errors.

Some studies dealing with implementation of new technologies in LMICs revealed that AI-based medical technologies implementations are based on three applications. Hosny and Aerts (2019) observed that AI-based medical device applications in LMICs consists of three applications mainly AI-based medical device technologies powered by low-cost tools running on a smartphone or portable instruments used to address common diseases; AI-based medical device technologies that support clinical decision making enabling non-specialized primary care physicians to perform specialized tasks including reading diagnostic radiology and pathology images; and AI-based medical device technologies that allow public agencies to realize cause-and-effect relationship, allocating resources and mitigating the progression of epidemics. By understanding the types of applications available in LMICs, health care leaders should then invest on the type that could ensure enhanced treatment plans for their stakeholders. AI-based medical device technologies are enabling the identification of health care gaps

in the current health care system, augmenting it, and ensuring equitable coverage for entire populations, leading to an improved lifestyle.

Researchers are of the opinion that due to several AI-based applications available for deployment in LMICs, there would be delays in implementing any of them due to the lack of finances and government support. Several factors influenced the implementation of AI-based medical device technologies in developing countries ranging from the lack of access to affordable smart devices, digital connectivity gap, digital literacy, infrastructure, the gap in the regulatory framework, training, financial support, data capacity, to technical upgrades of legacy systems (Guo & Li., 2018; Mrazek & O'Neill, 2020; Ngwa et al., 2020; Sampene et al., 2022; Schwalbe & Wahl, 2020; Schwarz et al., 2020). Furthermore, AI-based medical device technologies' projects within the health care sector are lagging behind other projects due to substantial financial resources needed to produce effective results, lack of collaboration between government, regulators, medical, consumers, and research professionals, and their inability to develop a consensus regulatory framework to govern the AI-based medical device technologies and agree on the ethical boundaries of their applications (Guo & Li., 2018; Mrazek & O'Neill, 2020). With these access gaps in the emerging countries, applying AI to deliver innovative services across the health ecosystem is of great importance. Health care leaders in LMICs should understand that investing in these technologies would enhance the hospital operations leading to tremendous financial rewards. However, efforts to implement these AI-based medical devices have fallen short in LMICs due to their higher diagnostic costs, shortage in infrastructure, equipment, and high skilled clinicians to

manage the equipment resulting in reduced access to effective health care in these countries.

One other areas of concern that is impacting the implementation of AI-based medical device technologies in LMICs is lack of government digital policy and interoperability between applications. Aerts and Bogdan-Martin (2021) identified that donor dependency, lack of common regulatory standards, lack of interoperability between digital health applications, lack of system and workforce capacity, lack of funding, and lack of alignment between national digital health strategies hindered the adoption of digital health applications in LMICs. The sub-Saharan governments and health care leaders should collaborate to formulate and execute national digital health strategies that establish forward-looking visions that would determine the direction to follow.

The evolution of digital health and integration with AI-based medical device technologies are creating environments to enable incorporating huge data into analysis and treatment plans of patients' care, allowing physicians to understand the life history of patients. Digital health applications encompass the intersection of health, information, and communication technologies, consisting of mobile health, AI-based medical device technologies, big data, telemedicine, health information technologies, electronic health records, and telehealth (Aerts & Bogdan-Martin, 2021; Anom, 2020; Condry & Quan, 2021; Osei & Mashamba-Thompson, 2021; Senbekov et al., 2020). Anom (2020) observed that big data referred to the technique involved in analyzing large datasets to provide helpful knowledge and insights, which enabled the determination of trends and made meaningful predictions by analyzing clinical data that is too complex to be

processed by traditional data processing methods. Digital health and big data analytics are enabling access to patient's information real-time and allowing physicians to make informed medical decisions leading to patient-centered care delivery. Recently, many countries especially in LMICs have been battling with disparity in providing affordable health care to patients. With the implementation of digital health applications, health care leaders are now noticing the closing of some these health care gaps.

With the introduction of digital health in the health care systems especially in LMICs, patients are noticing better doctor-patient relationship and improved communications. Mesko (2020) and Anom (2020) noted that digital health has created an equal term relating doctor-patient relationship and that the ivory tower of medicine has started to break down, making previous inaccessible information and technologies accessible to patients and reshaping health care and enabling patients to enter health care far before any symptoms or diseases are detected. Similarly, Condry and Quan (2021) pointed out that digital health technologies could offer opportunities for health management by establishing the foundations for pharmaceutical trials, medical studies, public health programs, pandemic responses, and the measurement of individual health. The democratization of information, the movement of empowered patients, and the rise of digital health technologies have created a cultural transformation of the basic health care and practice of medicine globally.

In LMICs where access to remote areas create major challenges, digital health has enabled physicians to have access to those patients and allowed them to provide critical care at reduced costs. Moreover, these digital technologies reduce diagnostic time with

significant high level of accuracy and require less infrastructure, equipment, and technicians. Nkhoma et al. (2021) confirmed that digital health care technologies enabled better communications between patients, caregivers, and palliative care services; enhanced patient-physician communications; improved access to care, especially where face-to-face contact is not feasible or costly; and enabled patient, caregiver participation in the decision-making process relating to patient's care. Germann and Jasper (2020) argued that interlinking, connecting, and networking between public health agencies, public health data, and academic researchers' data sources could create a more comprehensive knowledge of health conditions and issues, and enhanced the capability to predict disease, intervene, and provide preventative measures using algorithm-derived probabilities. Bergier et al. (2021) took it further by arguing that digital health technologies enabled health care providers in developing nations the opportunities to improve essential elements of chronic diseases which produce high health care costs, improve access to scarce and remote expertise, improve patient monitoring, enhance participation and therapeutic adherence, lead to better patient outcomes, and enhance participative and patient empowerment. Digital health could transform the health care system from reactive to proactive, predictive, and preventative, promoting healthy populations in LMICs.

Ensuring access to digital communication infrastructure, agreeing on an interoperability framework, establishing, and maintaining a global partnership with the government, and sustaining adequate national funding policy would enhance the technology and lead to global adoption. Aerts and Bogdan-Martin (2021) noted that low-

income nations must have visionary leaders that are committed to digital health, play significant roles, create a national leadership committee that would oversee the governance mechanism between different governmental organizations; and provide funding and collaboration mechanism within the context of sound national information communication technology legislative, policy, and regulatory framework. Germann and Jasper (2020) further argued that the issues such as technical feasibility and massive digital divide in internet connectivity in LMICs, and lack of the necessary systems and human capacities that include digital mindsets that would support the reimaging of health in a digital age must be addressed before widespread adoption of AI-based medical device technologies in the health care sector. For digital health to be a viable alternative to providing patient-centered care, emerging nations must institute regulatory and policy frameworks to enable digital health solutions while protecting patients' privacy. The successful implementation of digital health technologies demands the collaboration between the sub-Saharan leaders, the developers, and the health care leaders to agree on process implementation stages, policies, regulatory framework, and strategies that will ensure the greater benefits of the adoptions to patients.

Global health care leaders agree that substantial challenges impede the implementation of these advanced technologies in the hospitals. Such challenges if not mitigated would continue to affect the widespread adoption of these advanced medical devices in LMICs. In Africa, researchers agreed that the lack of clinical datasets for training AI-based medical models, the lack of diversity in AI-based medical device models, low availability of electronic medical records, low level of digitization across

Africa, constant interruption of electricity, corruption, lack of legal and regulatory framework, cultural differences, bad reputation, and political unrest contributed to the lack of interest in foreign direct investment for implementation of AI-based medical device technology projects in these countries (Germann & Jasper, 2020; Guo & Li., 2018; Mrazek & O'Neill, 2020; Ngwa et al., 2020; Owoyemi et al., 2020; Sampene et al., 2022). Various researchers attested that the health care leaders and hospital administrators in African hospitals have not invested in the new technologies, experiencing insufficient human resources, lacking adequate infrastructures, and entrenched legacy systems (Kim et al., 2021; Mrazek & O'Neill, 2020; Owoyemi et al., 2020; Roder-DeWan et al., 2020). In these hospitals, clinicians are still using the old processes, thereby leading to the poor diagnosis of disease and poor quality of care. The impact of lack of funding for these devices to modernize these hospitals include dilapidated hospital infrastructures, increase in medical tourism, and tremendous clinicians brain drain in those countries. Also, another significant impact of lack of funding of these infrastructures results in poor diagnosis of diseases, poor detections of any pandemic, and less screening due to poor training of clinicians.

Because the diagnosis process for screening and detecting the underlying chronic diseases in LMICs require advanced medical devices, the lack of funding for the infrastructure, equipment, and clinicians has left the hospitals and clinics in a poor state. Evidence exists that health care systems in LMICs, including Nigeria, are poor overall and highly variable across conditions and that the basic foundation of health care systems is weak, lacking adequate infrastructure, consisted of entrenched legacy systems, lacked

modern diagnostic technologies to help physicians diagnose diseases concisely, and workforce shortages are widespread (Kim et al., 2021; Mrazek & O'Neill, 2020; Owoyemi et al., 2020; Roder-DeWan et al., 2020; Schwarz et al., 2020). Turner et al. (2019) stated that with the emergence of new technologies such as AI-based medical device technologies, there is an excellent opportunity to expand capacity and improve the care of critically ill patients in LMICs. Instituting automation of processes such as cataloging charts, filling prescriptions, transcription services, and using medical cases could reduce the burden faced by a medical professional, create positive externalities for patients, and ease the shortage of health care workers, poverty, and epidemiological transition of disease burdens in Africa.

Global health care leaders agree that lack of funding has created significant deficiency in medical diagnostic resources and efforts should be made to develop meaningful strategies to combat the problem. Several researchers agree that hospitals in low-and middle-income countries (LMICs) continued to operate on health systems designed primarily for acute, episodic care, which are poorly equipped to meet the demands of communities, including the growing demand for non-communicable diseases (Mrazek & O'Neill, 2020; Owoyemi et al., 2020; Roder-DeWan et al., 2020; Schwarz et al., 2020). Schwarz et al. (2020) also revealed that while there has been growth in biomedical discovery for preventing, diagnosing, and treating diseases in high-income countries, there has been little innovation in the system of health care delivery in the LMICs to use the new disruptive innovation to improve access to quality of care and more equitable health care outcomes. Similarly, Williams et al. (2021) observed that

health care delivery in LMICs differed from high-income countries due to lack of health care access, economic instability, medical diagnostics and treatment costs, and severe skill and staffing shortages that existed in all aspects of the health care sector. To capitalize on the benefits that the use of AI-based medical device technologies could offer, clinicians in LMICs need modern hospital infrastructure to provide quality care to their patients. Not upgrading these hospitals to state-of art facilities would continue to subject the clinicians to continue to use manual interpretation of medical diagnosis results which takes significant amount of time, resulting in increased waiting time for screening and detecting chronic diseases among patients.

Researchers agree that health care providers are employing these advanced medical technologies in different areas of service delivery. Schwalbe and Wahl (2020) identified the automation of diagnosis for communicable and non-communicable diseases, morbidity and mortality risk assessments, and public health surveillance to predict disease outbreaks as the most used AI-based medical device applications within the LMICs. Akpanudo (2022) noted that the Council for Science and Industrial Research (CSIR) in South Africa employed an expert AI-based medical device applications to identify favorable environmental conditions that could promote cholera outbreaks in Southern Africa. Other researchers observed that in LMICs, AI-based medical device technologies are used to assist young inexperienced physicians and health care workers to perform enhanced diagnoses, analyze medical data, and predict human behavior relating to health care outcomes (Chen et al., 2021; Fletcher et al., 2021; Williams et al., 2021). In LMICs, AI-based medical device technologies are enabling the identification of

environments that prevent communicable disease and providing avenue for better patient diagnosis and treatment strategies.

AI-based medical device technologies are tools that could help to build affordable, accessible, and highly accurate medical diagnostic resources to screen and detect chronic illnesses among patients. Ngwa et al. (2020) pointed out that telemedicine, telehealth, mobile health, and other AI-based medical applications provided potential solutions to most routine treatments in LMICs. Telemedicine allows clinicians to monitor patient's conditions at home through wearable devices and mobile phones that linked patients' medical information to medical teams integrated with electronic medical records (Bergier et al., 2021; Ngwa et al., 2020; Senbekov et al., 2020). Similarly, Bergier et al. (2021) indicated that health care providers in LMICs use chatbots to schedule appointments, locate the nearest health clinics, provide medication information, identify possible health issues, and suggest adequate strategies to solve the health issues. Transitioning from the current system to a more technology-based system would enable access to patients' data and enhanced patient-centered care delivery in LMICs.

The emergence of AI-based medical device technologies in hospital could help reduce the diagnostic processing time and improve the outcome of the health care systems. Notwithstanding the numerous challenges and the shortage of health care workers in the developing nations, introducing AI technologies in health care systems could provide guidance and recommendations to nurses, community health care workers, and experienced paramedical personnel to deal with non-threatening illnesses and reduce the time spent by the specialist treating these minor cases (Akpanudo, 2022; Guo & Li,

2018). In the emerging nations, the widespread use of mobile electronic devices such as mobile phones, laptops, iPads, and wearables which are connected to medical iCloud would allow health care workers to get medical advice based on the patient's health care record and improved the quality of health care provided (Guo & Li, 2018; Ngwa et al., 2020). Osei and Mashamba-Thompson (2021) observed that mobile health technologies would enable high-quality health care services in LMICs ravaged by fragile health systems, high prevalence of tropical diseases, and high rate of infectious diseases, high mortality rate, and inadequate number of trained health care workforce. The proliferation of mobile technologies in LMICs has allowed for powerful cloud computing systems to be possible in remote areas which would lead to the delivering high-quality health care in the remotest areas of Africa.

Using of AI-based devices has also reduced the stress on the existing health care systems and enhanced accuracy in diagnosis and treatment by health care workers in LMICs. Similarly, implementing AI-based medical device powered chatbots that communicate with patients, provide medical advice, conduct training, and reduce triage time would enable specialists to handle complex matters in developing nations (Guo & Li, 2018). However, the lack of human oversight and the potential for machine errors created tremendous barriers to implementing AI-based medical device technologies in Africa's health care systems (Sallstrom et al., 2019). The companies developing AI-based medical device techniques in health care must incorporate the data-regulation norms and the management of sensitive patient data to avoid legal and ethical issues and promote responsible AI-based medical device applications within the hospitals.

In LMICs, AI could significantly boost the attainment of sustainable health care goals and open enormous potential for operational improvement. In a comprehensive assessment of artificial intelligence for health care in Africa, Owoyemi et al. (2020) noted that medical artificial intelligence (MAI) deployed in Kenya enhanced health worker-patient interaction quality leading to a significant number of symptoms evoked. Also, in Gambia, a probabilistic decision-making system assisted rural workers in identifying life-threatening conditions in outpatient clinics. Similarly, in Nigeria, Owoyemi et al. (2020) and Akpanudo (2022) observed that Ubenwa, a startup firm, used signal processing and machine learning-based medical device technologies to enhance the diagnosis of birth asphyxia in low-resources settings and recommended appropriate treatment plan. The applications detected the birth cry of children and then inform physicians of those likely to be experiencing birth asphyxia and recommended the mitigating plans (Akpanudo, 2022; Owoyemi et al., 2020; Sampene et al., 2022). These AI-based medical technologies enabled physicians to obtain critical patients' data that enabled them to develop treatment plans that incorporated patients' medical conditions. The above are few examples of how AI-based devices have contributed to improving health care delivery in LMICs.

The evolution of AI-based medical devices is seen through potential applications that have been deployed across wide range of medical and decision-making continuum. Abdulkarim et al. (2022) found that AI-based medical applications are used in Nigeria to monitor the spread of infectious diseases such as cholera. AI-based medical device technologies have helped clinicians diagnose diabetic retinopathy in Zambia, pulmonary tuberculosis from chest radiographs in Tanzania and Zambia, and detection of fake drugs

in Nigeria (Akpanudo, 2022; Owoyemi et al., 2020; Sampene et al., 2022). In Kenya, Sampene et al. (2022) found that an AI-based medical chatbot system is used to monitor sexual and reproductive health among people. In these countries, AI-based medical device technologies are enabling physicians and regulatory agencies to provide high-quality services to the stakeholders and enable remote monitoring in difficult areas.

The use of AI-based medical device technologies in sub-Saharan African health care sector could be described as deploying intelligent data-driven tools to more effectively utilize available health care resources to streamline health decision-making processes that would enable improved health care service delivery to patients. Ngwa et al. (2020) noted that physicians in African countries used AI-based medical technologies such as telemedicine integrated with wearables and mobile phones because they enabled them to provide enhanced care through access to expert opinions. Furthermore, Turner et al. (2019) pointed out that low-cost wearables could feed data into AI-based medical device systems, which could guide treatment decisions and diagnostics in LMICs. Condry and Quan (2021) found that the emergence of new medical devices created opportunities for early detection and data creation that could enable the analysis of community health situations, including pandemics. The integration of these low-cost wearable devices that offer an affordable approach to physiological monitoring in LMICs could enhance the point-of-care diagnostic, imaging services, and community health services.

With the introduction of new neural network models that translate African languages, many clinicians are now comfortable employing AI-based medical device

applications in their practices. Akpanudo (2022) noted that a new neural network model called AfriBERTa15 could translate medical records from eleven African languages, including Afaan Oromoo, Amharic, Gahuza (a mixed language containing Kinyarwanda and Kirundi), Hausa, Igbo, Nigerian Pidgin, Somali, Swahili, Tigrinya, and Yoruba; languages spoken by more than 400 million people. The partnership of researchers and social enterprises in Africa could develop AI-based medical device applications for optimizing the health care services, planning, and scheduling of community health workers in the communities in most of African languages.

AI in health care systems brings many opportunities that could contribute to the wellbeing of individuals and the advancement of health care delivery globally. In light of the strong demand to implement AI in the health care sector in developing nations, Guo and Li (2018) recommended the following strategies: first, develop the frontline medical AI systems that would be used in the most basic form of providing care to patients; second, establish the regional medical AI support centers that would ensure that the medical personnel is trained, equipment is maintained, repaired, and upgraded to support the frontline medical AI systems, and collect and report clinical information received from primary EHRs, and finally, create a national medical AI development center that would coordinate the development, promotion, and upgrades of medical AI systems nationwide. Owoyemi et al. (2020) took it further by recommending the acceleration of ongoing improvement in Africa's infrastructure, especially electricity and the internet, increasing the number of scientists, and focusing on solutions that could easily be deployed on smartphones. Furthermore, Turner et al. (2019) postulated several strategies

for improving the delivery of critical care in LMICs, such as improving organizational structures, empowerment of nurses, development of training programs, capacity building programs, and locally generated clinical guidelines. Implementing the above strategies in LMICs will not be easy since the health care systems are plagued with several issues such as legacy systems, lack of infrastructure maintenance, lack of support from government agencies and lack of steady electricity supplies.

As AI-based medical device technologies found more uses within the health care systems, many experts are also recommending solutions that would ensure seamless integration with the legacy systems in LMICs. Wolff et al. (2021) recommend that the technological infrastructure be tailored to the application segments, data processing structures that focused on data access and exchange pathway, and privacy-by-design approach leading to a high degree of adaptability and flexibility in regulatory requirements. In addition, Bajwa et al. (2021) observed that in other to take advantage of the strengths of AI-based applications, employing a multistakeholder team during the design and embedding such technologies with the workflows would support the clinical decision-making at the point of care, enabling the unlocking of the power of big data, supporting evidenced-based decision-making, improving patient experience and outcomes, delivering values, and reducing costs, and optimizing health system performance. Therefore, focusing the AI implementation on building intelligence into existing systems and institutions rather than attempting to replace the legacy systems would allow for seamless migration and mitigate the lingering challenges.

Furthermore, as AI-based medical device technologies evolve, many researchers develop more recommendations that would enable widespread adoption of the technologies within health care sector. These recommendations range from enlisting major stakeholders to collaborating with national government to develop strategies and mechanisms to adapt local and national contexts in implementing AI-based devices in health care systems. Mahajan et al. (2019) recommended that creating a multistakeholder marketplace, facilitating the creation of various big datasets, partnerships, and collaboration, spreading awareness of the advantages of AI-based medical device technologies, and promoting startups would improve acceptance of the AI-based medical device technologies in health care sectors of developing nations. Furthermore, Sampene et al. (2022) recommended that Africa must develop technologies that considered Africa's socio-economic and infrastructure realities to create AI-based medical solutions that would meet the continent's most urgent needs such as augmenting clinical decision-making processes, enhancing patients-centered care, improving infrastructures, and mitigating shortage of health care workers. Also, positioning AI-based medical device technologies as strategic assets, ensuring ethical consideration, and enabling joint public-private sector collaborations would ensure a smooth transition and implementation of AI in health care ecosystems, especially in radiology. The leaders of LMICs should promote strategies that would promote seamless transition from legacy systems to technology-based processes to enjoy the benefits resulting from implementation of AI-based medical device applications.

The Technology-Organization-Environmental and the Technology Acceptance Model Frameworks

To integrate the factors to a structured implementation process of AI-based medical device technologies, a range of different frameworks were considered to address the implementation strategies of the technologies within the health care sector. Due to the relatively new nature of AI-based medical device technologies, experts have no consensus opinion about the optimal model that leads to health care leaders' successful implementation of AI-based medical device technologies. The lack of a consensus model has created a massive void among health care leaders regarding the reason(s) to justify implementation. Hence, the literature is still immature relating to specific frameworks that explains implementation strategies of AI-based medical device technologies in health care.

The value of AI in health could not be overstated and as such researchers are reviewing the reasoning behind global implementation in health care systems by health care leaders. Understanding the perspective of health care leaders in adopting and implementing AI-based medical device technologies in the hospital is vital because they play key role in the implementation process. Wan (2020) argued that health care leaders implemented AI-based medical device technologies using the KMAP-O model (knowledge, motivation, attitude, preventive practice, and patient outcomes) to justify the investment. KMAP-O enabled the health care providers to establish preventive practice activities that improve patients' knowledge, motivation, and attitude towards self-care through enhanced educational factors generated by AI-enabled medical device

technologies. Similarly, other experts argued that the technology acceptance model (TAM) developed by Davis in 1989 explained the reasons for implementing health care-enabled technologies. In TAM, Davis postulated that perceived usefulness and perceived ease of use determine the successful implementation of health care-enabled technology like AI-based medical device technologies in a hospital setting. Also, Kaieski et al. (2020) noted that health care leaders justified investment in AI-based medical device technologies using a taxonomy model that comprised the population of interest, patient data, health-related tasks, and health outcomes. When such informational patient data is collected and uploaded to AI-based medical device technology such as machine learning, health care providers could predict the patient's hospitalization rate and improve patient-centered care delivery. In the forgoing, different experts used varied conceptual models to successfully determine why health care leaders decided to adopt and implement advanced medical device technologies in hospital settings.

However, many researchers are still of the opinion that there are more conceptual frameworks that could explain the perspectives of health care leaders in adopting and implementing these advanced technologies. The technology-organization-environmental (TOE) model developed by Tornatzky et al. (1990) is widely used as the lens to gain in-depth knowledge of factors influencing the adoption and implementation strategies of new disruptive technologies used in the health care sector at the organizational level decision making rather than at the individual levels (Damali et al., 2021; Ghaleb et al., 2021; Kinkel et al., 2022; Mohamed & Jokonya, 2021; Pan et al., 2021; Park et al., 2015; Schmitt et al., 2019; Simoes et al., 2020). Pan et al. (2021) observed that integrating the

TOE model with transaction costs theory or other conceptual frameworks enabled researchers to assess the factors influencing organizations' adoption strategies of AI-based medical device technologies in-depth and helped to explain organizations' technology adoption behavior because many other factors influenced the usage of new technologies within an organization. The use of the framework helps to explain the health care leaders' interest and commitment for successful implementation of these new innovative technologies.

The TOE model is used to identify attributes of innovative ideas that influenced organizational leaders' adoption and implementation decision. The TOE framework developed by Tornatzky et al. (1990) consists of three contextual factors: technology, organization, and environment that influenced an organization's adoption of new technologies (Hue, 2019; Kinkel et al., 2022; Mohamed & Jokonya, 2021; Pan et al., 2021; Simoes et al., 2020). The TOE model incorporates organization-specific attributes, technological and environmental factors to describe the factors influencing an organization's leader decisions regarding technological innovation adoption.

The technological factors refer to those factors that are both internal and external to the organization. Several researchers agree that such factors as cost, availability, security, relative advantage, complexity, structure, and resources influence the technology construct of the TOE model (Hue, 2019; Kinkel et al., 2022; Mohamed & Jokonya, 2021; Pan et al., 2021; Simoes et al., 2020). The organizational elements of the TOE include company size, structure, communication process, management, structure, and resources; and while the environment refers to the competitions, government,

regulations, and services providers influencing the adoption of new disruptive technologies (Hue, 2019; Kinkel et al., 2022; Mohamed & Jokonya, 2021; Pan et al., 2021; Simoes et al., 2020). The TOE model is a model that enabled the assessment of factors that influenced the organization's decision to adopt technological innovations (Awa et al., 2017; Mohamed & Jokonya, 2021; Pan et al., 2021; Pateli et al., 2020; Simoes et al., 2020). Researchers use the TOE model as a lens to gain in-depth knowledge about the decision process of organizational leaders in adopting new technology. The model also enables the researchers to understand how health care leaders align the implementation of these innovative technologies with other functional and operational strategies.

To gain insight into organizational leaders' implementation strategies of health care technologies, I evaluated many models in relationship to implementation of disruptive technologies in health. I used the TOE model developed by Tornatzky et al. (1990) integrated with TAM developed by Davis (1989) as the conceptual models to gain in-depth knowledge on how some health care leaders make the implementation decision. I chose the integrated TOE-TAM conceptual frameworks over the traditional celebrated models such as the theory of reasoned action (TRA) developed by (Ajzen & Fishbein, 1980) and the unified theory of acceptance and use of technology (UTAUT) developed by Venkatesh et al. (2003) because these theories assumed that organizational leaders always have perfect information to make the decision which is contrary to the universal norm (Awa et al., 2017; Schmitt et al., 2019). I chose the integrated model of TOE and

TAM because the traditional conceptual frameworks are not suitable for studying technology adoption at an organizational level.

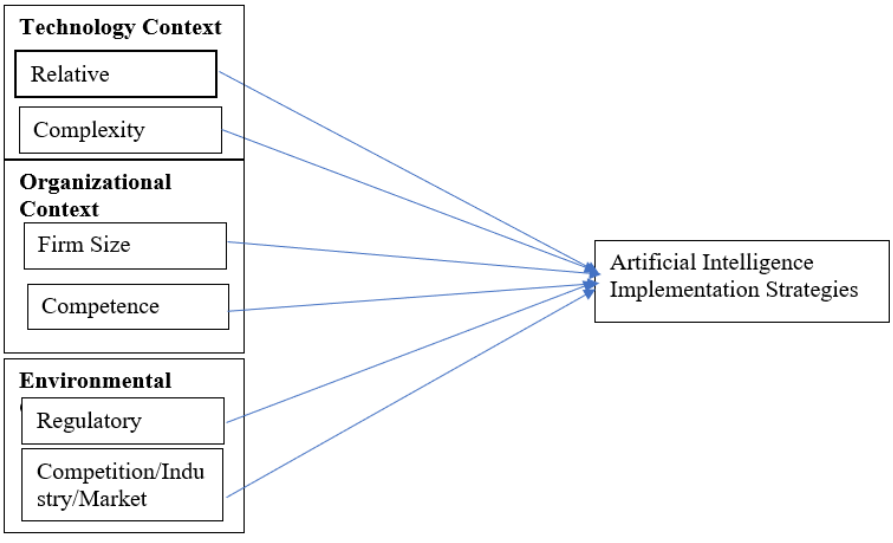
Technology-Organization-Technology Framework

The TOE Model

The TOE model is widely used in information technology to gain in-dept knowledge about adoption and implementation strategies of health care leaders within organizational level rather than individual level. In the TOE framework, Tornatzky et al. (1990) assumed that the implementation decisions of new technology are made based on technology complexity and relative advantage, organization's size and competence, and environmental factors such as competition and regulatory issues affecting the industry (Figure 1) (Awa et al., 2017; Kinkel et al., 2022; Pan et al., 2021; Simoes et al., 2020).

Figure 1

The TOE Conceptual Framework Model



Note. Adopted from "The Adoption of Artificial Intelligence in Employee Recruitment: The Influence of Contextual Factors," by Y. Pan, F. Froese, N. Liu, Y. Hu, & M. Ye, 2021, *International Journal of Human Resource Management*, p. 1-23 https://doi.org/10.1080/09585192.2021.1879206

Relative advantage refers to the number of benefits and innovation, while technological complexity refers to the perceived difficulty of using the new technology (Pan et al., 2021). Similarly, Ghaleb et al. (2021) noted that complexity, compatibility, optimism constructs affected the technology context; top management support, financial support, and training affected the organizational context, while government IT policy, government laws, and legislations influenced the environmental context of TOE framework. Therefore, the managerial decision to adopt new disruptive technologies such as artificial intelligence is influenced by technological, organizational, and environmental factors.

For the technological context, relative advantage includes the benefits that technological innovation brings to create a competitive advantage, while technical complexity determines the technology's difficulty. Technologies' perceived ease of use and perceived useful greatly influenced the adoption of such new technologies (Bryan & Zuva, 2021; Chatterjee et al., 2021; Pan et al., 2021). When the technology is perceived as creating a significant competitive advantage and is not too difficult to use, organizational leaders tend to implement the technology. Similarly, the relative advantage of new technologies like AI-based medical device technologies enabled an organization to gain a competitive advantage, reduce costs, raise top-line profits, generate new

business opportunities, and enhance operational efficiency (Alsheibani et al., 2020; Pateli et al., 2020). Awa et al. (2017) outlined that the perceived ease of use of new technology enabled the organization to reduce the uncertainty and risk inherent in such technology and improved the adoption process. The technology relative advantage relates to the level of expected return on investment an innovation will deliver compared to other business processes; hence, the technological context refers to the opportunities of incorporating an organization's resources into better business process techniques that would enable high-level financial performance and operational efficiency.

The adoption of new advanced technologies shifts the organizational structure, culture, leadership, as well as the employees' roles and skills within the organization. The new organizational capabilities bring novel ideas in the corporate ecosystem and processes. Risk-taking and critical thinking skills influence the degree of AI-implementation in health care sector. From the organizational context, the organizational size, including the structure, staff, financial strengths, management support, culture, and the technical competence of the staff determined the adoption strategies of new technologies (Clohessy & Acton, 2019; Ghaleb et al., 2021; Pan et al., 2021; Schmitt et al., 2019). The organization's size and readiness positively influenced an organization's willingness to implement new technologies because large organizations have the advantage over smaller organizations in that they have more resources and are willing to take additional risks inherent with innovation adoption (Ghaleb et al., 2021). Contrary to the above assertions, Simoes et al. (2020) argued that receptiveness, ability to support new ideas, value-added perception, and early employee involvement rather than firm size

determined the extent of technology adoption within an organization. The influence of organization's size in adoption strategies is still questionable by many researchers, but majority of the experts agreed that organizations' size influenced adoption of new technologies.

AI-based medical device technologies implementation is a complex undertaking that could significantly impact the organization and its operations. Organizational commitment and cultural change form the foundation for successful implementation strategies of AI-based devices. When management creates a supportive climate, communicates, and connects the technology implementation strategies with the organization's shared visions and goals, the staff tend to accept the implementation (Awa et al., 2017; Schmitt et al., 2019). Management commitment to adopting new technologies by providing adequate resources and the capital funds positively influenced adoption strategies of new technologies (Alsheibani et al., 2020). Ghaleb et al. (2021) noted that supports from top management are crucial in adoption decisions because they direct the allocation of resources and integration of organizational services. When technology solves a specific problem for the organization, and the management has excellent knowledge about the impact of the technology relative to other operations, the leadership readily accepts its implementation. Management commitment and firm size enabled the technology adoption strategies within the business sectors. Also, by increasing AI-based medical devices awareness within the organization, the employees could view the technologies as versatile tools that would reduce complex tasks and begin to accept the implementation of the technologies.

Competition forces organizations to innovate and use modern technologies to improve operational effectiveness and enhance competitive advantages. Finally, the environmental context describes the industry's regulations and competition that impact the organization's operation (Pan et al., 2021). Competitive pressure pushes an organization to implement innovative technologies to mitigate the impact of competition (Ghaleb et al., 2021; Hue, 2019; Schmitt et al., 2019; Simoes et al., 2020). If implementing a particular technology enabled an organization to compete globally, adopting such technology is readily accepted. Thus, technological innovation's adoption leads to competitive advantage and enhanced operational efficiency and better financial performance.

Government supports enable each industrial sector to adopt novel technologies to compete globally. Government regulations could either determine the technology implementation strategies or hinder the adoption through an excessive regulatory environment (Alsheibani et al., 2020; Pan et al., 2021). Organizations tend to adopt new technology such as artificial intelligence (AI) when the government provides a needed supportive environment. Similarly, legal frameworks, professional associations, and government policies shape technology adoption strategies (Awa et al., 2017; Schmitt et al., 2019). Hence, for an organization to successfully implement innovative technologies, government support must be guaranteed, and the legal impact must be addressed.

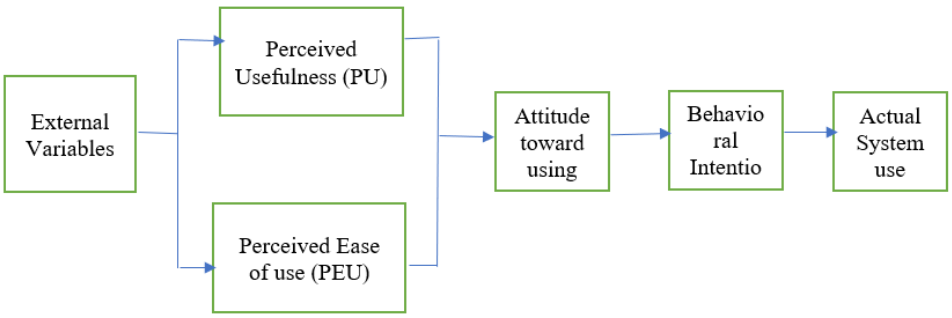
Technology Acceptance Model

The TAM Framework

Davis developed the TAM framework to enable the understanding of the factors influencing the intention and use of disruptive technologies. Na et al. (2022) observed that TAM is based on the theory of reasoned action (TRA) and the theory of planned behavior (TPB). TAM helps to explain the adoption of any technology in a more flexible pattern with a robust theoretical and strong standard base and powerful explanatory capability that is easy to understand (Chatterjee et al., 2021; Qin et al., 2020). TAM consists of two core constructs (perceived ease of use and perceived usefulness) (Figure 2) that explained the beliefs and behavioral intention that act as the significant reasons for system use in an organization (Bryan, & Zuva, 2021; Chatterjee et al., 2021). TAM enables the understanding of why organizational leaders adopts and implement new disruptive technologies from individual perception and the characteristics of the new technologies.

Figure 2

Technology Acceptance Model



Note. Adopted from "Using a TAM-TOE Model to Explore Factors of Building Information Modeling (BIM) Adoption in the Construction Industry," by X. Qin, Y. Shi, K. Lyu, & Y. Mo, 2020, *Journal of Civil Engineering and Management, 26*(3), 259-277 https://doi.org/10.3846/jcem.2020.12176

The use of TAM framework in the information technology ecosystem has enabled better understanding of individual perspective of novel technology implementation. Due to wide use of the framework, researchers have noticed that the framework has undergone several modifications. Qin et al. (2020) observed that TAM had been modified to TAM2 (Venkatesh & Davis, 2000); Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003); and TAM3 (Venkatesh & Bala, 2008) because of the practical and robust use of the model to explain the adoption of new disruptive technology than other models. Chatterjee et al. (2021) noted that TAM consists of two core tenets (perceived usefulness (PU) and perceived ease of use (PEU)) (Fig.2) that explains about 40% of the reasons for using new technology. In the TAM model, Davis (1989) assumed that the users' acceptance or rejection of new technology adoption strategies is based on the users' attitude, which is influenced by perceived usefulness and perceived ease of use (Bryan & Zuva, 2021). Technology uncertainty and complexity determine the user acceptance and therefore influence the perceived usefulness of the advanced devices.

The perceived ease of use (PEU) determines the intent to use and leads to actual use of the technology. The perceived ease of use intends to reduce the uncertainties and risks of adoption of new technologies. Technology systems that are complex strongly

inhibits implementation intentions. The PEU is a major driver of new technology adoption strategies (Reinhardt & Gurtner, 2018). It also determines the quality of services and products. The perceived usefulness (PU) influences the need to use a new technology. PU is the most significant implementation drivers of new technologies (Bryan & Zuva, 2021). In TAM, Davis (1989), assumed that PU impacted the reliability, durability, and appearance of the new technology instead of the performance. TAM is therefore used to explain the adoption strategies for new disruptive technologies from the individual level rather than organizational level.

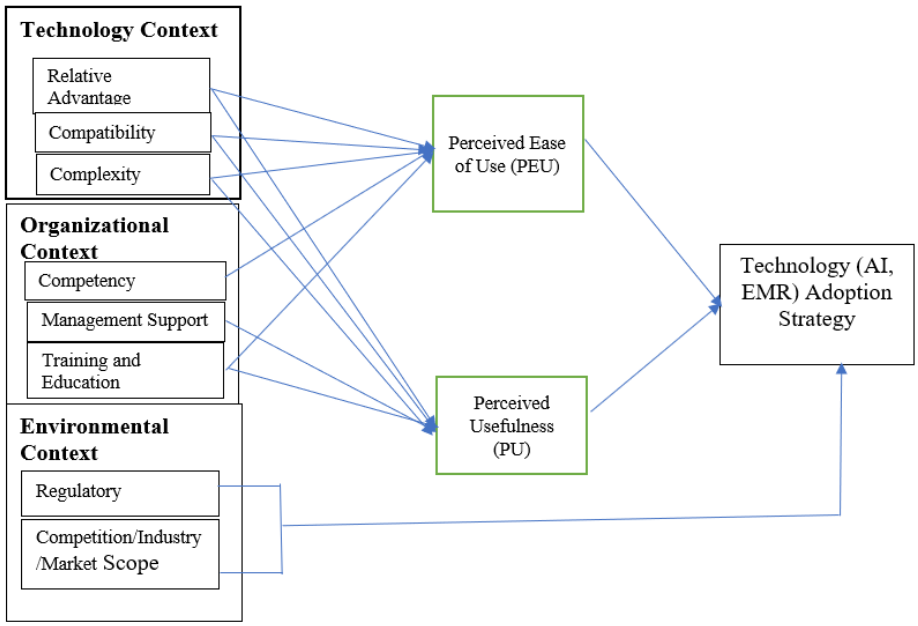
The Integrated TOE-TAM Framework

Key insights from both models would enable the understanding of implementation strategies used by health care leaders to adopt and implement AI-based medical device technologies in the hospitals. Despite the strong acceptance within the technology fields, the original TOE constructs seemed obsolete and generic and lacked the individual context that drives the organization's strategies, motivations, and attitude (Awa et al., 2017; Pan et al., 2021). To mitigate these problems, Awa et al. (2017) recommended that the TOE model be integrated with other theories such as the technology acceptance model (TAM) developed by Davis (1989), or the unified theory of acceptance and use of technology (UTAUT2) developed by Venkatesh et al. in 2007 to add the decision makers' characteristics. Simoes et al. (2020) observed that integrating the TOE model with the diffusion of information theory (DIT) developed by Rogers in 2003 or with the institutional theory (INT) developed by DiMaggio and Powell in 1983 provided some insights that enabled the understandings regarding attributes that influenced adoption

strategies of new technologies. When the TOE model is integrated with another framework such as TAM, individual behavior characteristics are incorporated, enhancing the motivation, and ensuring adoption and implementation of the technology. Researchers have agreed that to understand the implementation of new technologies in health care system, many frameworks could be merged to explain leadership perspectives in developing adoption strategies. Researchers also have agreed that the capabilities of TOE to explain adoption strategies of new technologies would be enriched when integrated with the individual contexts of TAM framework. Several researchers observed that TOE (Tornatzky et al., 1990) and TAM (Davis, 1989) conceptual frameworks are the best lenses to explain AI adoption strategies in organizations (Figure 3) (Abdekhoda et al., 2019; Chatterjee et al., 2021; Na et al., 2022; Qin et al., 2020). By integrating TAM with the TOE framework, both the internal and external influences for the adoption of AI in health care could be understood.

Figure 3

Integrated TOE-TAM



Note. Adapted from "Determinant factors in applying electronic medical records in health care," by M. Abdekhoda, A. Dehnad, & J. Zarei, 2019, *East Mediterranean Health Journal*, *25*(1), 24-33 https://doi.org/10.26719/emhj.18.007

Davis developed the TAM framework to enable the understanding of the factors influencing the intention and use of disruptive technologies. Qin et al. (2020) noted that Tornatzky et al. (1990) proposed the TOE model to explain the influence of technological, organizational, and environmental contexts on the strategies of adopting and implementing new technological innovations within an organization. The TOE framework provides a systematic classification of influencing factors and explains the reasons impacting the technology adoption decision strategies by organizational leaders at the organizational level perspective (Chatterjee et al., 2021; Na et al., 2022; Qin et al.,

2020). These frameworks provide guidance for how health care leaders could facilitate the implementation and realize the potential benefits of AI in health care.

The TAM remains essential in the study of information technology system adoption in an organization. The TAM is considered one of the best models to integrate with TOE to explain AI adoption strategies in organizations because it is an influential model in the field of information systems and has found widespread use in technological adoption strategies (Chatterjee et al., 2021; Na et al., 2022; Qin et al., 2020). TAM helped to explain the adoption of any technology in a more flexible pattern with a robust theoretical and strong standard base and powerful explanatory capability that is easy to understand (Chatterjee et al., 2021; Qin et al., 2020). TAM consists of two core constructs (PU and PEU) that explain the beliefs and behavioral intention that act as the significant reasons for system use in an organization (Bryan, & Zuva, 2021; Chatterjee et al., 2021). By integrating the constructs of TAM with TOE, the framework provides a superior theoretical base in studying the technology adoption, use, and value creation within health care systems.

TAM is a good framework that can predict the user acceptance criteria of new technology in an organization. Qin et al. (2020) observed that TAM had been modified to TAM2 (Venkatesh & Davis, 2000); Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003); and TAM3 (Venkatesh & Bala, 2008) because of the practical and robust use of the model to explain the adoption of new disruptive technology than other models. Similarly, Bryan and Zuva (2021) observed that the TOE model had not been subjected to many variations because it is seen as a

universal theory used to explain new technology adoption strategy from the organizational level, consistent with other adoption model theories, and consistency in technological characteristics of the innovation. The main reason for the modification of the frameworks is that most technology acceptance frameworks are rarely comprehensive and all-encompassing. Conceptual frameworks and theories used to explain implementation strategies within an organization are modified to add new variables that would enable the model to explain the structure and use of such technologies.

Information systems innovation technologies are highly evolving for which there is no single framework that could completely explain the variables influencing the implementation strategies within an organization. TOE and TAM models have been widely employed in understanding data innovation and information technology adoption strategies across various research studies (Bryan & Zuva, 2021; Qin et al., 2020). Chatterjee et al. (2021) revealed that TAM could explain about 40% of the reasons for using new technology. Similarly, the TOE framework explained the adoption decision strategy of new technologies using technological, organizational, and environmental constructs (Abdekhoda et al., 2019; Bryan & Zuva, 2021; Chatterjee et al., 2021; Pan et al., 2021). The use of TOE and TAM frameworks in studying technology adoption strategies enables the researchers to understand the variables underpinning the acceptance of innovative technologies in an organization.

TAM was developed to explain people's behavior intention of adopting new technology. TAM enabled the researchers to understand the impact of behaviors on technology adoption acceptance at different levels, while TOE explained the technical,

organizational, and environmental factors that influenced the technology adoption strategies at the organizational level (Abdekhoda et al., 2019; Chatterjee et al., 2021; Qin et al., 2020). Adoption of disruptive technology such as artificial intelligence demands sound management support from the organizational context and has a significant positive influence on the perceived usefulness (PU) and perceived ease of use (PEU) of such new technology because AI might augment clinicians' decision-making processes in medical procedures (Abdekhoda et al., 2019; Alhashmi et al., 2019). Similarly, organizational competence equally influenced PU and PEU of new technologies because when employees possess the skill sets and training needed to manage the new technologies, acceptance is assured (Abdekhoda et al., 2019; Alhashmi et al., 2019). Furthermore, Abdekhoda et al. (2019) and (Alhashmi et al. (2019) argued that there is a significant positive relationship between the relative advantage of new technologies and PU in the health care sector because the content quality and the ability to enhance the competitive advantage of the organization appealed to the management and improved the notion of the perceived usefulness of the technologies. The technology and organization construct of TOE significantly influenced perceived usefulness and perceived ease of use of technology in the adoption process of new technologies in health care sectors. Chatterjee et al. (2021) also argued that to understand the reasons for AI adoption strategies from the perspective of organizational, environmental, and technological constructs, the integrated TOE framework will play an essential role as it has been employed successfully in various socio-environmental contexts. The integration of TOE and TAM frameworks

provides stronger theoretical information than other traditional frameworks in studying technology implementation strategies.

The integration of TOE and TAM frameworks offers an updated information that enable researchers to focus more on different types of technology adoption strategies at the organizational level. The use of the TOE-TAM frameworks explained most of the strategies used by health care leaders to adopt and implement AI-based medical device technologies in their hospitals. The logical connections between the frameworks presented and the nature of this study included enabling the researcher to explore how health care organizational leaders develop technological implementation and adoption strategies of new disruptive technologies, such as AI-based medical device technologies within the hospital setting. The TOE and TAM conceptual frameworks provided the guideline to answer the central research question of what strategies do health care leaders in Nigeria use to adopt and implement AI-based medical device technologies within the hospital settings.

AI-Based Medical Device Technologies Implementation Barriers

AI-based medical device technologies face plethora of implementation barriers in the health care industry. AI-based medical device technologies are used in various spheres of medicine, such as diagnostics, personalized medicine, and the pharmaceutical industry, and they are revolutionizing the health care sector (Mahajan et al., 2019). Lee and Yoon (2021) noted that many physicians opposed implementing AI-based medical device technologies in their hospitals because of the fear that the technology would make them obsolete in the future. Fears and uncertainty about AI-based medical device

technologies and the lack of understanding of AI and robotics functions are impeding the widespread acceptance of the new technologies within the health care ecosystems (Abdullah & Fakieh, 2020; Sampene et al., 2022). The uncertainty about the impact of the technology is creating major adoption challenges for the AI-based medical device technologies globally.

The societal impact of AI-based medical device technologies is the loss of jobs by several clinicians especially the radiologists. By 2033, about 47% to 50% of jobs, especially in the radiology section, would be eliminated due to the workforce's automation in Europe and the United States (Al Badi et al., 2021; Coombs et al., 2020; Lee & Yoon, 2021; Robinson, 2020). In addition, Robinson (2020) substantiated that by 2037, AI-based medical device technologies would lead to 7 million job losses but could create more than 7.2 million new AI-related jobs. Germann and Jasper (2020) cautioned that more attention must be paid to ensure that digital technologies like AI-based medical device technologies do not underpin or establish new forms of inequalities in which their benefits are realized only in certain regions, countries, or patient groups. Hence, the implementation of AI-based medical device technologies in the health care sector is viewed by many health care workers as a process of eliminating their employment.

There has been considerable argument that implementation of AI in health care systems would lead to job loss and reduce health care workforces. However, He et al. (2019) observed that AI-based medical device technologies in the health care industry would not lead to workforce shortage; instead, they will create new specialty providers and new opportunities to collaborate knowledge between machines and humans. These

specialty providers would be responsible for creating organizations that monitor AI-based medical device technologies, thereby absorbing the retrenched workforce. In a more focused analysis, several researchers argued that AI-based medical device technologies in health care would not replace human intelligence; rather it would enhance and augment the decision-making processes of the clinicians (Bajwa et al., 2021; Chen & Decary, 2020; Di Vaio et al., 2020; Ellahham et al., 2020; He et al., 2019; Jiang et al., 2021; Patil et al., 2021). Jiang et al. (2021) further pointed out that AI would promote the reshaping of the doctor's role and enhance the decision-making process of the clinicians, thus releasing them from routine tasks to spend quality time with the patients. The fear that AI-based devices in health care would lead massive job loss has been refuted by many experts especially in developing countries.

Several researchers have identified other areas that implementing AI-devices in health care could augment clinical practice. Patil et al. (2021) and Robinson (2020) concluded that even though that AI-based medical device technology such as ML algorithm is currently outperforming radiologists at spotting malignant tumors; improving the successful performance of surgical procedures; enhancing treatment plans to improve the organization of treatment strategies; and analyzing data to provide high-quality treatment of diseases, AI-based medical device technologies would not replace clinicians; rather, they would augment the decision-making process. Macruz (2021) pointed out that there is considerable evidence that AI-based medical device technologies' algorithms perform analysis better than human experts in various tasks such as analyzing medical images, symptoms, and biomarkers with diagnosis and

prognosis of the disease but would not replace physicians. Evidence, thus, exist that AI-based medical device technologies would not replace human intelligence and hence, should be embraced by clinicians globally.

The fear that AI in health would lead to workforce reduction is unfounded and to date, no evidence exists that show that AI in health has resulted in tremendous job loss. However, there is tremendous amount of research that have concluded that the implementation of AI in health care systems would enhance organizational operations. Mahajan et al. (2019) argued that AI promoted growth through intelligent automation of the workforce, augmentation of labor and physical capital, and creation of opportunities for new skillsets and business ideas and services. In addition, Macruz (2021) observed that the misconceptions in health care technology regarding AI-based medical device applications arose from a misunderstanding of what AI technology is, the confusion between cultural change and internal process optimization, and the lack of management support to have medical specialists lead the AI-based medical device technologies' development team. Bajwa et al. (2021) then called on health care leaders not to replace the vital tenets of human interaction in medicine when implementing AI-based medical device technologies within the health care sectors instead they should focus on using the technology to improve the efficiency and effectiveness of system interactions. AI brings with it the opportunities such as strengthening national competitiveness, supplementing areas of needs, education and employment that can enhance developing nations' competitive advantage globally.

However, the introduction of AI in health care systems brings with it numerous challenges that must be addressed before a widespread acceptance of the technology. Privacy of patient's data was another area of concern with AI-based medical device technologies in the hospital setting (Al Badi et al., 2021; He et al., 2019; Nkhoma et al., 2021; Radhakrishnan & Chattopadhyay, 2020) because data might need to be shared among many organizations for widespread implementation of AI-based medical device technologies, thereby demanding the need to de-identify them (Mesko, 2020). Houfani et al. (2021) discovered that data quality, security and privacy, data bias, interpretability, injuries, and errors were other significant challenges that must be mitigated before AI-based medical device technologies could find widespread acceptance within the health care systems. Similarly, Ellahham et al. (2020) noted that data privacy and security, anonymity, ethical and medicolegal concerns were major obstacles in the implementation of AI in health care because most AI-based medical device applications demanded a massive volume of data to make informed decisions which subject them to more risks of severe issues of identity theft and data breach. Hence, medical ethics such as individuals' right to privacy might be comprised or threatened by AI-based medical device technologies and big data features due to the collection and storage of various patient data sources.

Transparency and privacy of patients' data continue to be a major impediment in the implementation of AI-based medical device technologies in health care systems because of the black box effects and data sharing with other independent operators. Antes et al. (2021) found that AI-based applications' adoption and implementation have

generated concerns related to loss of privacy, lack of transparency, decreased clinician role in care, increased costs, unfairness in benefits for different groups, and exacerbated inequities (Radhakrishnan & Chattopadhyay, 2020). Anom (2020) argued that patient privacy and security, a fiduciary relationship between physicians and patients, biases, patient consent, unethical manipulation of algorithms, respect for patient's autonomy, beneficence, nonmaleficence, and distributive justice were ethical challenges posed by the adoption of AI-based medical device technologies in hospital settings. Therefore, it is critically important that health care leaders ensured that patients maintain control of their data, that the data must be secured, that all necessary procedures are implemented to avoid the breach of data and inappropriate disclosures, and that bias be mitigated to create enhanced security of data and improve implementation of AI-based medical device technologies in the hospital settings. Strong data protection, key stakeholders, and potential users' involvement, regulation, and ethics-by-design in all AI processes would significantly improve customers' privacy and enabled faster implementation of AI-based systems in hospitals, especially in developing countries.

Another barrier to the implementation of AI-based medical device technologies was the accountability of the system. Aggarwal et al. (2020) argued that since AI-based medical device technology is relatively new, no one is sure who pays for the malpractice case resulting from using the tools. Moreover, Jiang et al. (2021) found that the issue of accepting responsibility when medical errors are made is hindering acceptance in the medical field because there is no global unified law or regulations regarding the application of AI in the medical field. In addition, Habli et al. (2020) found that when

artificial intelligence-based medical device systems are part of the decision-making process, it would be difficult to know how far it should be reasonable to hold human clinicians accountable for patient harm because clinicians do not exercise direct control over such decisions or recommendations and many AI-based medical device systems are inherently non-transparent. Due to the novelty of the technologies, the legal framework that should address the accountability of the system performance is still not in place.

In the health care sector, most country governments have not promulgated regulations to ensure that when patients are harmed by using the technologies, adequate compensation would be guaranteed. He et al. (2019) argued that due to the relatively new nature of the technology, a malpractice suit might include the vendor who provided the software platform, the developer, the source of training data, or the physician. However, researchers believed that since AI-based medical device systems within the health care system are only advisory, the physicians should be held accountable for any decision reached using AI-based applications (Habli et al., 2020; Jiang et al., 2021). Therefore, it is crucial that health care leaders, as well as governmental and regulatory bodies establish governance process to limit the negative implications resulting from adopting AI in health care systems. Hence, until cases are adjudicated to determine where liability could rest, a lack of accountability and transparency could delay the implementation of AI-based medical device technologies.

Furthermore, AI-based medical device technology is a novel technology in global health care, lacking transparency framework that would ensure implementations. Murdoch (2021) observed that current regulations and policies are inadequate to

safeguard patient privacy and called for appropriate safeguards to be put in place to maintain privacy in the context of the public-private partnership. Algorithmic bias, which refers to errors built into AI-based medical device systems based on incomplete or biased datasets that might lead to unfair outcomes, was also identified as a major practical ethical issue (Johnson, 2019; Kerasidou, 2021). Similarly, Quinn et al. (2021) found that the lack of quality assurance, failure to elicit trust, lack of transparency of AI-based medical device technologies such as machine learning (ML), and deep learning (DL) contributed to the black box (an instrument whose inner-workings remains opaque to novice observer), and restricted physician-patient dialogue as the crux of the problems of applying such technologies in the hospital setting. Black boxes made it practically impossible to detect errors in a model's performance, identify and correct model biases, and could lead physicians to assume accurate and reliable input when, they are not (Carman & Rosman, 2021; Quinn et al., 2021). It is therefore recommended that an appropriate oversight must be established to mitigate any potential harm resulting from the implementation of health care AI-based medical device technologies.

The widespread adoption of AI-based medical devices in LMICs continue to face strong challenges due to lack of awareness of opportunities of implementing the technologies in the health care systems. Klumpp et al. (2021) identified the following challenges as hindering the adoption of AI-based medical device applications in the hospital settings: human acceptance and real-time adoption of AI solutions, complexity, the ethical issues relating to personalized datasets, and the stakeholder's commitments to adopt new technology. In a complete analysis of the challenges, several researchers

identified ethical issues, values of trust and empathy, the risk of a new type of paternalism as health care professionals might defer decision-making to AI-based medical device tools, and dehumanization of health care as more tasks are shifted to intelligent machines as influencing the adoption of the technologies within the health care ecosystems (Kerasidou, 2021; Richardson et al., 2021). Mahajan et al. (2019) further argued that ethical frameworks such as patient autonomy, beneficence, nonmaleficence, justice, explicability, transparency, confidentiality, responsibility, and accountability hinder the widespread adoption of AI-based medical device technologies in the health care sector. These ethical issues must be addressed to ensure that trust in the system is established before the widespread acceptance of health care AI-based medical device technologies.

Another challenge that must be mitigated before AI in health is accepted in sub-Saharan Africa is culture. Researchers agree that it is critical to promote and accelerate the development of trustworthy AI in health solutions that are grounded in African cultural heritage. The current focus in AI-based medical device technologies is ensuring 'Good AI,' which is that AI-based medical device technology is developed and implemented ethically and sustainably (Carman & Rosman, 2021). Carman and Rosman (2021) noted that African culture of togetherness would not permit the adoption of individualistic decision-making like the Western culture. Implementing Good AI that followed the four principles (respect for autonomy, beneficence, nonmaleficence, and justice) in Africa must be adjusted to meet the African context that adopts a broader principle of respect for persons which captures the essence of the principles but allows

the integration of cultural nuance of Africa. To develop AI-based medical device technologies for African health care systems, the challenges that resulted from the multicultural context (social, historical, and geographical inequities) must be addressed because different cultural frameworks build attitudes to new technology (Carman & Rosman, 2021). Similarly, Sallstrom et al. (2019) pointed out that for AI-based medical device technologies to function effectively in the African health care ecosystems, native researchers must be part of the development of the new technology with African datasets driving such development. In Africa, the community culture that allows people to engage in joint decision-making or seek guidance from higher authority as part of the decision-making process is the dominant culture rather than the individualistic culture of the West. Hence, applying the principles (respect for autonomy, beneficence, nonmaleficence, and justice) in the African context without adapting them to reflect the fundamental community culture-inspired decision-making processes that Africans engage in and without sensitivity to the local context would be ineffective in achieving the aims.

A lack of knowledge by African health care professionals of how AI-based medical device applications function was a significant impediment to accepting AI-based medical device technologies in Africa. In Nigeria, Robinson (2020) discovered that most of Nigerian doctors knew about AI but did not have in-depth knowledge of the applications. As such, several of them did not understand that AI-based medical device applications are applied in all aspects of medicine and health care, such as radiology, pathology, surgical, imaging, hospital management, drug-dispensing, and nursing care. Lack of formal training, poor knowledge of information technology, no legislation and

control over the software, and poor internet connectivity were major challenges to adopting AI-based medical device technologies in African health care ecosystems (Robinson, 2020). Instituting training programs would enable clinicians to understand the potentials and applications of the technologies to improve health care processes and efficiencies in Africa.

In literature, many challenges have been identified as impeding implementation of AI-based medical device technologies in hospitals. Obstacles such as regulations, integration of electronic health records, standardization, training of professionals, costs, and updates continue to pose a hindrance to the adoption and acceptance of AI-based medical device applications in hospitals (Klumpp et al., 2021). Houfani et al. (2021) found that some technical challenges such as computational and memory expenses, data availability, overfitting, and reproducibility impeded the global deployment of AI-based medical device technologies in health care systems. Furthermore, DeCamp and Lindvall (2020) observed that biases in AI-based medical device technologies algorithms such as missing data, misclassification, observational error, and misapplication posed the most significant concern to health care leaders and are hindering the widespread implementation of the technologies. Data ethics such as informed consent, privacy, ownership, objectivity, transparency, and data protection were causing major challenges in accepting AI-based applications in the medical field (Jiang et al., 2021; Martinho et al., 2021). These challenges demonstrate the lack of readiness by health care leaders to implement AI in health care systems. Therefore, health care leaders, government, and regulatory agencies must collaborate to promote policies that would usher effective

implementation of AI-based devices in health care ecosystems. To ensure that AI-based medical device technologies are accepted within the health care ecosystems, policies and regulations, governance, security, privacy, and ethical issues must be resolved successfully.

Recommendations to Reduce Impact of AI Challenges and Barriers

To mitigate the challenges facing the implementation of AI-based medical device technologies in the medical field, several recommendations have been proposed by global researchers. Jiang et al. (2021) proposed an AI-based ecological network that would enable the identification of the practical problems from the clinical work or public data sample database; clinical application on a small scale before mass deployment, and construction of big data sample database to integrate high-quality datasets and store them securely in data storage software. An ethical adoption of AI-based medical device technologies in medicine that would require ethical experts to participate in the supervision of AI in medicine; the establishment and perfection of the legal system to address the ethical responsibilities of AI-based medical device technologies' developers and practitioners; and improvement in the feasibility of AI-based medical device technologies in the real world (Jiang et al., 2021). Adopting these recommendations would reduce the impact of black box problem of AI-based medical devices and assign responsibilities to different parties when AI-based medical devices cause harm to patients. Accepting the recommendations by health care leaders would also enhance patients' confidence in the system and could lead to strong acceptance of AI-based medical applications in health care delivery.

The adoption of AI-medical device technologies in health care should be careful, slow, and incremental process, involving robust regulation and monitoring of their use and efficacy. Klumpp et al. (2021) recommended that human-computer-interaction (increasing the interaction between human and computer from the pre-design, design, and post-design), medical data space (following international data space guidelines to deliver a secure, controlled data storage and processing), and guidebook and ethics would reduce the influence of challenges that hinder the adoption of AI-based medical device technologies in the hospital settings. Houfani et al. (2021) recommended that physicians use high-quality data generation, quality supervising, and good exploitation of AI methods to mitigate the impact of challenges that hinder the adoption of AI-based medical device technologies. In addition, Anom (2020) suggested creating human oversight to mitigate the risks to patient autonomy and aid the informed consent; encourage AI-based medical device technologies use to the best interest of the patients; and train AI-based medical device technologies using trusted non-homogenous data. The oversight duties of different agencies would create sense of responsibilities of the developers and provide guidance to health care administrators on the implementation and use of the devices.

Black box issues are limiting the implementation of advanced medical devices globally. Quinn et al. (2021) advocated that to solve the black-boxes problems of AI-based medical device technologies, transparent decision-making, good clinical validation, clinical efficacy, and societal efficacy, must be promoted by the developers and users of artificial intelligence in the medical setting. Following the same argument, Hosny and

Aerts (2019) argued that upskilling, education, and computer literacy should be considered essential to enable the application of AI-based medical device technologies and recommended using technologies such as electronic process (eHealth), mobile health (mHealth), and remote telecommunications (Telehealth) to support health care practices in LMICs. Training must be part of the process before acceptance of these devices are affected because training mitigates the anxieties inherent in new technology adoption. By, adopting the above recommendations health care leaders could mitigate the impacts of the challenges that hinder the adoption of AI-based medical device technologies in the health care sector.

Transition

In section 1, I discussed the background of the purpose of this research. I then explained the problem and the purpose of the study before presenting a brief evaluation of the population and sampling techniques for the study. An in-depth description of the nature of the study, a central research question, and interview questions were then presented to enable the reader to understand the logical flow of the research study. A brief discussion on the two conceptual frameworks which acted as the lens to help me understand the phenomenon under study, was presented. Operational definitions and assumptions, limitations, and delimitations were presented. The next topic discussed was an in-depth analysis of the significance of the study with emphasis on contribution to business practice and implications for social change. The next topic was a review of the professional and academic literature. In this review, a comprehensive evaluation of the existing body of knowledge on the influence of artificial intelligence (AI)-based medical

device technologies in health care focusing on implementations strategies, benefits, challenges, barriers, and future health applications were presented. Detailed analysis of the technology, organization, and environment (TOE) and technology acceptance model (TAM) conceptual frameworks used as the lens to gain in-depth knowledge of the phenomenon under investigation and the reasons for not choosing competing frameworks were discussed. The analysis enabled the readers to understand the impacts of AI-based medical device technologies in improving the health care systems in Nigeria. In Section 2, I will address the purpose statement, the role of the researcher, participants, the research method and design, the comprehensive evaluation of the population and sampling, ethical research, data collection instruments, data collection techniques, data organization techniques, data analysis techniques, reliability, and validity and discuss a brief overview of Section 3.

Section 2: The Project

The purpose of this qualitative multi-case study was to explore the strategies the health care leaders in Nigeria use to obtain and implement AI-based medical device technologies. In this section, I discussed the purpose statement, the role of the researcher, the participants, research method and designs, population and sampling, ethical research, data collection instruments, data collection techniques, data organization, data analysis, and the reliability and validity of the study.

Purpose Statement

The specific business problem is that some health care leaders in Nigeria lack strategies to obtain and implement AI-based medical device technologies. Therefore, the purpose of this qualitative multi-case study was to explore the strategies the health care leaders in Nigeria use to obtain and implement AI-based medical device technologies. The population consisted of 11 executive leaders from six hospitals located in Nigeria who have successfully obtained and implemented AI-based medical device technologies. The implications for positive social change include providing the communities with enhanced care using predictive features of machine learning, improving health quality, and providing the health care leaders with the knowledge and skillset necessary to use AI-based medical device technologies to enhance patient-centered care delivery while creating high-paying jobs for their communities.

Role of the Researcher

The role of the researcher is increasingly becoming a focal point in conducting a qualitative research study. In qualitative research, the primary function of a researcher

includes data collection, data organization, and analysis of the results (Simon, 2011). Thus, researchers become the instrument of data collection (Denzin & Lincoln, 2003), which directly impacts data collection and analysis (Geddis-Regan et al., 2021). Data are collected through human instruments instead of through inventories, questionaries, or machines (Simon, 2011). Therefore, the consumers of the research need to know about the human instrument. The qualitative researcher needs to explain important aspects of self, including any biases and assumptions, expectations, and experiences that qualify them to conduct the research (Simon, 2011). The researcher's personal and professional experiences shape how data are collected, generated, and interpreted. The researcher's experience, knowledge of the subject matter, and qualifications could lead to trustworthiness of the research findings.

I used exploratory multi-case study design to explore the health care leaders' strategies in implementing AI-based medical device technologies in their hospitals. Through semi structured face-to-face interviews and review of secondary data from company documents, I collected and analyzed data to support the research findings. As a Nigerian, I am familiar with the system and the challenges that might hinder data procurement. I mitigated the challenges by always building and establishing trust with the participants and through open and honest communications that enabled the participants to make informed decisions regarding their participation.

With my experience in the health care system in the United States and my educational background, I was also able to ask questions that enabled me to obtain the necessary information. I identified the study population, obtained approval from each

participant, and communicated with each participant throughout the study period. I developed and employed an interview protocol that was the same for all participants. An interview protocol allows the researcher to ask the same open-ended questions to each participant (Rubin & Rubin, 2012). Following the interview protocols, the researcher ensures that all questions are completely asked and answered by the participants.

Another role of the researcher includes ethical procedures. A researcher must consider the unique nature of the study and various ethical considerations during the process of the research (Aaltio & Hopfl, 2009). I gathered a signed consent form from each participant that gave approval and willingness to participate before the participant was interviewed. By adhering to the protocols of the *Belmont Report* of 1979 (National Commission for Protection of Human Subjects of Biomedical and Behavioral Research, 1979), I maintained ethical standards throughout the study. Additionally, formal approval from Walden University Institutional Review Board (IRB) with approval number of 06-07-22-0647838 was obtained before any gatekeeper was located in Nigeria.

As it is crucial that the researcher is the instrument of data collection and analysis, it is also important that the researcher's account of the process be explained. Explaining the process adds credibility to the research findings. Reflexivity on the researcher's part is also an essential aspect of the research process and might help clarify decisions made during the study (Aaltio & Hopfl, 2009; Geddis-Regan et al., 2021). Reflexivity is used to ensure that both the researcher's and participants' biases are checked and appropriately addressed to ensure the confirmability and dependability of the study. Research journals and notes enable the researcher to document personal reactions and reflections, insights

into self and past, and how bracketing occurs (Simon, 2011). I used memos and other forms of notetaking to document the process to ensure an accurate depiction of the process and enhance my study's dependability and confirmability. The dependability and confirmability of the doctoral research are tested using audit trail and reflexivity (Houghton et al., 2013). Dependability refers to the process of describing the method used for the research, whereas confirmability refers to the method of explaining the researcher's influence on the results (Johnson et al., 2020). To ensure the credibility of my study, data triangulation, note taking of non-verbal cues, and member checking were used.

Participants

Using purposive and convenience sampling, the population sample of health care leaders was assembled from six hospitals in Nigeria that have successfully adopted and implemented AI-based medical device technologies. Purposive sampling technique refers to a sampling method that allows a researcher to decide who the participants will be to provide the relevant information relating to the phenomenon being studied (Sharma, 2017). Convenience sampling allows the researcher to select participants because they are readily and easily available and have the information regarding the phenomenon being studied (Taherdoost, 2016). Convenience sampling helps to overcome many limitations associated with research resulting from access to participants.

After obtaining approval from Walden University IRB, I used both purposive and convenience sampling to select the 12 leaders from the health care institutions. Sample size in qualitative research revolves around data saturation and is based on the

phenomena under which investigation is taking place (Boddy, 2016; Malterud & Siersma, 2016). In qualitative research, sampling involves a small number of participants, allowing for deep and case-oriented analysis and leading to data saturation (Boddy, 2016; Malterud & Siersma, 2016; Trotter, 2012). Sampling size in qualitative research tend to be small unlike sample size for quantitative research study.

All participating institutions were required to sign a site agreement that allowed me access to their facilities. I gained access to the participants through the recommendations of CEOs and human resources directors of the selected health care institutions. I also searched company websites for qualified participants and obtain the human resources directors' approvals before contacting them. Upon gaining approval from Walden University IRB, an invitation letter (Appendix C) to participate in the study, which details the purpose of the study and explained the voluntary nature of participation, and freedom to withdraw from participation, was emailed or hand-delivered to the selected participants.

To be eligible to participate in this study, the participants came from health care institutions that have successfully implemented AI-based medical device technologies in Nigeria and have some experience in AI-based technologies, adoption, implementation, and use. The participants must have played essential roles in the successful adoption and implementation of AI-based medical device technologies in their hospitals. The selected participants were part of the CEOs, chief information technology, physicians, nurses, hospital administrators, and managing directors.

Establishing trust among participants is crucial during research study because the degree of separation between the researcher and the participants is typified by distrust. Researchers use face-to-face communication to gain knowledge about a phenomenon being studied and collect high-quality information from the participants by gaining their trust and confidence (Elmir et al., 2011; Harvey, 2011). Gaining trust and confidence starts with establishing rapport, having open communication, and establishing respect with the participants since qualitative interviews require assessing the participants' real-life world (Elmir et al., 2011). Developing rapport, open communication, and researcher's ethics enhanced the researcher's access to sensitive live information, mitigated the resistance to answering the interviewer's questions, enhanced participants' confidence, and created a favorable interview environment.

I reevaluated early during the interview the atmosphere of the discussion and adjusted my behavior and voice as needed to elicit information from the participants. Establishing rapport enhanced my credibility and enabled the participants to provide high-quality information during the interview process (Elmir et al., 2011; Harvey, 2011; Saunders et al., 2016). Trust is an important element to achieving credible research finding. My position as a U.S.-based executive of a reputable health care firm enabled me to create a good working relationship with the participants, fostered openness to discuss relevant issues freely, and ensured honest responses from the participants.

Research Method and Design

Research Method

Three research approaches are available for a researcher to use during a research study: quantitative, qualitative, and mixed method. The nature of the research problem guides the research method and design to employ for the study. I used the qualitative research method to explore the strategies used by health care leaders in Nigeria to adopt and implement AI-based medical device technologies within the hospital settings. Qualitative researchers relate to an interpretive philosophy that uses an inductive approach to theory development (Saunders et al., 2016; Stake, 1995), and it is appropriate when the research purpose is to seek a deep understanding of a research subject instead of predicting the outcomes (Merriam, 1998; Tomaszewski et al., 2020). Qualitative researchers are interested in understanding the meaning of the complex interrelationships of social phenomena and how they make sense of their world and experience as it is lived (Merriam, 1998; Stake, 1995). Qualitative research enables the researchers to intensely explore behavior, viewpoints, and life experiences to gain an in-depth understanding of the complexities of the condition through a holistic context of the event in relation to the phenomena which are being studied (Chivanga & Monyai, 2021; Khan, 2014). To completely answer the research question, I needed to gain an in-depth understanding of the phenomenon through semi structured interviews and open-ended questioning; thus, the qualitative research method was appropriate.

Quantitative methodology was not suitable for this study. Quantitative method is only appropriate when the research purpose is to examine the causal relationship between

a phenomenon's components and set of variables (Paoletti et al., 2021). Quantitative research enables the researcher to determine the relationship between two variables. Quantitative researchers focus on testing hypotheses (Chivanga & Monyai, 2021). This post-positivist philosophy espoused by Yin focuses on adopting objectivity, validity, and generalizability to gain knowledge of the phenomenon being studied (Yin, 2002) and assumes that reality is stable and measurable (Chivanga & Monyai, 2021). I did not choose a quantitative method because the study's objective of exploring the AI-based medical device technologies implementation strategies used by health care leaders in Nigeria did not require the examination and analysis of the issues. The mixed-method approach involves using quantitative and qualitative methods to study the phenomena (Paoletti et al., 2021). Therefore, the mixed method was also not suitable for this study.

Research Design

Case study design enables the researcher to gain in-depth knowledge of the studied phenomenon and could facilitate the understanding of the research problem. Qualitative case design enables the researcher to seek a greater understanding of the case and appreciate the uniqueness and complexity of the phenomena within their context (Stake, 1995). Case studies enhance the understanding of the phenomenon that researchers may not be able to get in any other process (Tomaszewski et al., 2020). A case study design is suitable when studying a specific phenomenon that has business application. Case study design enables the investigation of the extant phenomenon in depth and within a real-life context, particularly when boundaries are not readily evident, and addresses the full complexity of the research question by incorporating multiple

sources (Merriam, 1998; Tomaszewski et al., 2020; Yin, 2018). A case study is also suitable when the intent of the study is to use multiple data sources to gain in-depth knowledge of the phenomenon and is designed to bring out the detailed information of the participants using a semi structured interview approach (Baxter & Jack, 2015). Thus, the case study methodology supported the conduct of research to explore new disruptive technologies adoption and implementation strategies used by health care leaders in Nigeria.

Other qualitative research designs considered for this research included ethnography, narrative, and phenomenology, but they would not support the rich and robust explanation and description that is needed for the study. Ethnography is mainly used to study the culture or social world, which is not the focus of this study (Saunders et al., 2016). The narrative approach centers on a connotation an individual attaches to an experience through storytelling, which did not fit this study (Tomaszewski et al., 2020). In phenomenology, the focus is on the essence of a lived experience or phenomenon that can be observed or felt by people (Saunders et al., 2016; Tomaszewski et al., 2020). This type of study does not lead to an understanding of any business problem rather the human experience of a phenomenon. Thus, the use of phenomenology will not lead to a good finding for the study.

To ensure data saturation of my study, I employed interviews, note taking of non-verbal cues, document review, prolonged engagement, data triangulation, and member checking. To achieve data saturation, multiple sources such as interviews, data triangulation, and member checking should be used (Houghton et al., 2013). Data

saturation refer to the point in which no new concepts or themes are observed in the data in subsequent interviews (Boddy, 2016; Trotter, 2012; Varpio et al., 2017). The concept of data saturation ensures that the researcher does not over-collect data and ensures that enough data is available to enable robust analysis of the phenomena being studied (Varpio et al., 2017). Prolonged engagement enables the researcher to spend adequate time in the case-study sites to acquire in-depth knowledge of the phenomenon being studied and reach saturation.

Triangulation is also used to enhance and ensure the accuracy of data collection. Triangulation is a process where multiple sets of data, methods, theories, and perspectives enhance the research study's vigor, breadth, and depth of the findings (Varpio et al., 2017). It also enables a researcher to address a phenomenon from different directions, leading to accurately locating the phenomenon being studied (Rose & Johnson, 2020). Member checking refers to when the researcher presents the summary of data transcripts or data interpretations to participants for validation (Varpio et al., 2017). Member checking ensures that the transcription of interview data reflects the original description of the participant.

Population and Sampling

The population consisted of 11 member leaders (CEOs, chief information technology, physicians, nurses, hospital administrators, and managing directors) from five hospitals in Nigeria that have successfully adopted and implemented AI-based medical device technologies. These executives were appropriate because of their vast knowledge and experience within the health care industry. Their educational

achievements ensured that they offered an in-depth discussion on the subject matter. To be eligible to participate, individuals held a post-graduate-level degree in different fields, had gained certifications relating to providing care to patients in hospital settings, and had successfully adopted and implemented AI-based medical device technologies in their hospitals. All participating institutions signed site agreement that enabled me access to their facilities. I gained access to these participants through the recommendations of the CEOs of the selected health care institutions.

After obtaining approval from Walden University IRB, purposive sampling was used to decide who the participants would be to provide the relevant information relating to the phenomenon being studied. Purposive sampling technique refers to a sampling method that allows a researcher to decide who the participants will be to provide the relevant information relating to the phenomenon being studied (Sharma, 2017). In addition, I also used the convenience sampling technique to identify and invite additional participants that enabled me to ensure data saturation that conveyed the robustness and trustworthiness of the research findings. Convenience sampling allows the researcher to select participants because they are readily and easily available and have the information regarding the phenomenon being studied (Taherdoost, 2016). Convenience sampling helped to overcome many limitations associated with research resulting from access to participants.

Qualitative research sampling enables researcher to select participants that have knowledge of the phenomenon under study. Other sample techniques considered for this research but not used because they would not provide much relevant influence on the

study were nominated expert sampling, (a classic ethnographic approach that allow researchers to explore cultural and social meaning in various population, communities, and cultural groups and based on consensus experts); geographic sampling that is based on likeminded experts; snowball or referral sampling that allows researchers to ask the targeted participants to nominate other people that may have relevant information relating to the phenomena being studied, network sampling, and targeted sampling techniques (Trotter, 2012). Using any of these sampling techniques could not have generated any better participants than purposive sampling method. Some of these sampling techniques depend on the fact that the choice of the participants balances on the choice of the original individuals from the beginning of the process. Hence, the use of such technique might not convey credibility of research findings.

Qualitative research sample size enables the researcher to pursue in-depth descriptive studies of the phenomena. Therefore, the sample size tends to be relatively small and case-oriented (Trotter II, 2012). Sample size in qualitative study depends on the study aim, sample specificity, established theory, quality dialogue, and analysis strategy (Varpio et al., 2017). In a sampling of a homogenous and diverse population, experts have recommended that a sample size of 10 or more for qualitative research will be adequate based on the phenomenon being studied (Boddy, 2016). Qualitative research study does not require a huge sample size to achieve balance and thoroughness during the process. I selected 12 health care individuals from six hospitals in Nigeria that have successfully implemented AI-based medical device technologies in their hospitals, though one participant was unable to participate in the study. In qualitative research,

sampling involves a small number of participants that will allow for a deep and case-oriented analysis, leads to data saturation, and conveys the trustworthiness of research findings (Boddy, 2016; Malterud & Siersma, 2016; Trotter, 2012). Research experts have recommended that data saturation be considered achieved with ten interviews (Sim et al., 2018). I endeavored to select three participants from each hospital, where possible, based on the nature, and security issues within the country.

Data saturation was also assured using interviews, document reviews, prolonged engagement techniques, data triangulation, and member checking. Data saturation refers to the point in which no new concepts or themes are observed in the data in subsequent interviews (Boddy, 2016; Trotter, 2012; Varpio et al., 2017). The concept of data saturation ensures that the researcher does not over-collect data and ensures that enough data is available to enable robust analysis of the phenomena being studied (Varpio et al., 2017). Prolonged engagement and document reviews enable the researcher to spend adequate time in the case-study sites to acquire in-depth knowledge of the phenomenon being studied.

Triangulation is used to enhance and ensure the accuracy of data collection. Triangulation is a process where multiple sets of data, methods, theories, and perspectives enhance the research study's vigor, breadth, and depth of the findings (Varpio et al., 2017). It also enables a researcher to address a phenomenon from different directions, leading to accurately locating the phenomenon being studied (Rose & Johnson, 2020). According to Varpio et al. (2017), member checking refers to when the researcher presents summary of data transcripts or data interpretations to participants for

validation. Member checking ensures that the transcription of interview data reflects the original description of the participant.

To ensure that participants provide accurate information regarding the phenomenon under study, experts have suggested that the researcher establishes a conducive environment that allows for mutual interactions. Rubin and Rubin (2012) recommended that allowing participants to choose the location and time of the interviews enabled them to relax during the interview and offer vital information relating to the phenomena. Researchers use face-to-face communication techniques to gain knowledge about a phenomenon being studied and collect high-quality information from the participants by gaining their trust (Elmir et al., 2011; Harvey, 2011). I conducted face-to-face interviews using interview protocol (Appendix D) with the participants at their stated locations and time to gain an understanding of the interviewees' experience about the phenomenon being studied. Face-to-face interview is the most effective way to collect data because it provides the researchers the opportunities for rich data and it enables the researchers to observe the participants' facial expressions and body language during the interview process that could enhance the conversation (Adhabi & Anozie, 2017; Nelson et al., 2013; Rubin & Rubin, 2012). The best interview process is the one that involves a semi structured in-depth interview with open-ended questions that allows the researchers to elicit appropriate responses from the interviewees (Adhabi & Anozie, 2017). Semi structured interview allows the participant to provide meaningful responses to the interview questions.

For a formal interview to be conducted, the researcher must gain the participants' trust and confidence. Gaining trust and confidence starts with establishing rapport, having open communication, and establishing respect with the participants since qualitative interviews require assessing the participants' real-life world (Elmir et al., 2011). Allowing the participants to choose the location, time, and attire during the interview process creates a conducive atmosphere for the in-depth interview process (Rubin & Rubin, 2012). Developing rapport, open communication, and researcher's ethics enhance the researcher's access to sensitive live information, mitigate the resistance to answering the interviewer's questions, enhance participants' confidence, and create a favorable interview environment (Saunders et al., 2016). Reevaluating early during the interview the atmosphere of the discussion, adjusting behavior, speaking voice, and using open-ended questioning techniques enable the researcher to elicit information from the participants (Harvey, 2011). Successfully engaging participants during interview process to gain in-depth understanding of the phenomenon being studied demands that the researcher establish trust, rapport, and open communications. The process requires skills in communication techniques and interviewing strategies.

Ethical Research

Ethical issues should form an important element of research study involving human components. A good researcher will always strive for the highest ethical standards during the research study by being honest, avoiding deceptions, and accepting responsibility for his work (Yin, 2018). Researchers are obligated to conduct research studies with special care and sensitivity in other to protect participants from harm,

privacy, and confidentiality and obtain their informed consent before allowing them to participate in the study (Kang & Hwang, 2021; Vanclay et al., 2013; Wester, 2011; Yin, 2018). The informed consent form was distributed to each participant to obtain their willingness to participate in the study. According to Vanclay et al. (2013), it is the researcher's responsibility to provide sufficient information to the participants to enable them to gain adequate knowledge of the study and the consequences of their participation in the study. The informed consent form enabled the researcher to explain (a) the purpose of the study, (b) relevant contact information, (c) the voluntary nature of the participation, (d) the right to withdraw from the study at any time, and (e) full disclosure of funding sources or sponsoring institutions (Arifin, 2018; Kang & Hwang, 2021; Vanclay et al., 2013). To participate in the research study, each participant signed and return the informed consent form. I emphasized that participation in the study is voluntary, and any participant can withdraw from the study at any time without explaining. Participation is voluntary, and no participant will receive any financial or other types of compensation throughout the study period.

Researchers have the obligation to protect life, safety, privacy, and confidentiality of the research participants. Ethical researchers should aim at sustaining and adhering to ethical conducts and ensuring that participants' rights are protected, establishing a mutually beneficial relationship that will enhance trust, protecting participants from harm, upholding honesty, and integrity of the project, and ensuring beneficence (Kang & Hwang, 2021; Vanclay et al., 2013; Wester, 2011; Yin, 2018). One requirement at Walden University is that the scholar researcher must complete the Collaborative

Institutional Training Initiative (CITI) program before commencing with the research study. I have completed the CITI program and received the certification needed to engage in research involving human subjects.

After obtaining approval from Walden University institutional review board (IRB), I emailed and/or hand-deliver an invitation letter (Appendix C) to participate in the study, which detailed the purpose of the study, who is doing the research, and an explanation of the voluntary nature of participation and freedom to withdraw from the study at any time to each potential participant. An informed consent form was emailed to the participants who showed interest. Data collection commenced upon receiving the willingness to participate in the study by returning a signed informed consent form following recruitment, data collection, and analysis procedures.

I stored the data and information collected during the research process in an encrypted password-protected external hard drive and locked in a storage facility for the next five years after the study to protect the confidentiality of the participants. Hard copies of written materials of the data were kept in a secured cabinet in a locked room with no access to others for at least five years to ensure adherence to legal and ethical requirements. The data and documents collected during the research will be destroyed after five years. According to Kang and Hwang (2021), upholding the confidentiality and privacy of the participants is an essential aspect of being an ethical researcher and enables the researcher to collect rich and robust data. I ensured that the participants and organizations' privacy and identities remained confidential forever and eliminated

possible identifiers of participants' personal information and organizations' names by assigning codes to them in the analysis.

Data Collection Instruments

Gaining IRB approval allowed me to contact my gatekeepers in Nigeria and scheduled interview time, date, and locations. In a qualitative case study, the interview is one of the essential elements of collecting data and audio recording the conversations provides an accurate recitation of the interview (Alam, 2020; Madill, 2011; Moser & Korstjens, 2018; Noor, 2008; Sutton & Austin, 2015; Yin, 2018). For this study, I used interviews as the primary method of data collection augmented by note taking relating to non-verbal cues and communication of the participants, data from companies' documents, and review of companies' websites information to reach data triangulation. The use of multiple sources of data collection leads to data triangulation which ensures that the flaws of one source may be redressed for by another sources (Alam, 2020; Varpio et al., 2017). Data triangulation is used to enhance and ensure accuracy of data collection which enabled the researchers to use different data collection and analysis techniques to accomplish the research objectives (Rose & Johnson, 2020). Various documents from the companies such as policy and procedures, standard operating procedures (SOPs), memoranda, minutes of strategy meetings, proposals, and technology implementation guidelines were collected and reviewed as part of data collection process. Documents enable researchers to collaborate and augment evidence from other sources and validate information gathered from interviews.

Researchers use notes and memos to collect other non-verbal information during research interview process. In qualitative case study, the use of notes allows the researchers to record and assess the facial impressions, behaviors, and non-verbal cues that might not be adequately obtained through audio-recording of the interviews (Sutton & Austin, 2015). I employed such technique to record information that enabled reflexivity and reflection during the field work. Using note taking during the interview process, I gathered information regarding participants understanding of the phenomenon by interpreting the facial expression, talking style and their attitude. However, before employing the above protocols of data collection, I applied and obtained IRB approval (Approval #: 06-07-22-0647838) from Walden University and permissions from six hospitals' executives from Nigeria that have successfully implemented AI-based medical device technologies in their hospitals. Willing participants signed informed consent forms before I commenced data collection.

Collection Instrument

The role of the researcher is increasingly becoming a focal point in conducting a qualitative research study. In qualitative research, the primary function of a researcher includes data collection, data organization, and analysis of the results (Simon, 2011; Yin, 2018) using case study protocol (Appendix B). Thus, the researchers become the instrument of data collection (Denzin & Lincoln, 2003; Merriam, 1998; Yin, 2018). Geddis-Regan et al. (2021) noted that the researcher is the research instrument in qualitative research that directly impacts data collection and analysis. Qualitative

researchers immerse themselves with the participants to gain in-depth understanding of the phenomenon under investigation during data collection process.

As the primary data collection instrument, I obtained data using semi structured interview that consisted of 10 open-ended questions (Appendix A), which enabled me to solicit strategy information used by the 11 executive leaders from five hospitals that have successfully implemented AI-based medical device technologies in their hospitals in Nigeria following established interview protocols (Appendix D). Originally, I was supposed to collect data from 12 executives but due to circumstances beyond my control, I was only able to collect data from 11 executives from five hospitals. The integration of information from the company documents, and notes relating of non-verbal cues of participants from the interviews enabled the researcher to develop a complete understanding of the phenomenon under investigation (Alam, 2020; Merriam, 1998; Stake, 1995) and contributed to data triangulation that conveyed research validity and reliability (Merriam, 1998; Noor, 2008; Yin, 2018). To enhance the reliability of this study, member checking, which refers to when the researcher presents summary of the interpretation of interview transcripts to participants for validation, was used. In a qualitative research study, the potential for research bias creates a reliability issue. However, the problem can be mitigated by involving the participants to recheck and validate the summary of the interpretation of the interview transcripts.

Member checking is a technique used to convey the credibility of research results. The summary of the interpretation of the interview transcripts was returned to each of the study participants to allow them to confirm the accuracy, by permitting them to comment

on, correct it, and validate it which conveyed the trustworthiness of the research findings (Birt et al., 2016; Stake, 1995). I returned the summary of my interpretation of the interview transcript to each participant for their review, comments, and validation as to the document's accuracy. Participant's collaboration is essential in qualitative research strategies and the correction of researcher's interpretations of the data collected by the participants enable researchers to convey reliability and validity of the research findings (Stake, 1995). The use of member checking enhances rigor in qualitative research study (Lincoln & Guba, 1985). Member checking ensures that the transcription of interview data reflects the original description of the participant.

To ensure data saturation of this study, I used interviews, note taking of non-verbal cues, document review, prolonged engagement, data triangulation, and member checking. Data saturation was reached when no new analytical information arose from subsequent interviews, and the study showed adequate information about the phenomenon under investigation (Alam, 2020; Boddy, 2016; Moser & Korstjens, 2018; Trotter II, 2012; Varpio et al., 2017). Data saturation indicates the gathering of sufficient data for achieving the research objective and is considered an essential aspect of research validity and reliability for qualitative research (Alam, 2020). Policy and procedures, standard operating procedures (SOPs), memoranda, minutes of strategy meetings, and technology implementation guidelines were collected from the companies to support the data collection process.

I employed the use of note taking which allowed me to record and assess the facial impressions, behaviors, and non-verbal cues that might not be adequately obtained

through audio-recording of the interviews. Note taking during the interview process allows the researcher to record the participant's ways of expression, facial and talking styles, attitude, behavior, and activities which might provide more insight for a better understanding of the phenomenon under investigation (Alam, 2020; Merriam, 1998; Sutton & Austin, 2015). The integration of these approaches led to gaining in-depth knowledge about strategies used by the health care leaders in Nigeria to successfully implement AI-based medical device technologies in their hospitals.

Before continuing with data collection process, I obtained Walden University IRB approval, then, I emailed and/or hand-delivered documents (Appendix C) introducing myself to the participants, inviting them to participate, detailed the study's purpose, and included the informed consent form. In the consent form, I stressed that participation in the study is voluntary, and the participants are free to withdraw from the study at any time or have the freedom not to answer any or all the questions posed to them by the me. I requested that those willing to participate in the study sign the informed consent form and return it to a designated email address that I provided to ensure the confidentiality and privacy of the participants. Upon receiving the signed informed consent form from the willing participants, I scheduled interviews based on the date, time, and location of their choice in Nigeria. A semi structured and face-to-face person interview was used as the centerpiece for the data collection process for this study. A semi structured interview enabled the participants to understand the questions more clearly, provides answers and safeguards their independence in their opinion (Alam, 2020). For this study, each interview lasted between 20-60 minutes. The interviews allowed the participants to

describe their experiences implementing AI-based medical device technologies in their hospitals.

Data Collection Technique

After obtaining IRB approval, I scheduled a 20–60-minute interviews with the participants based on the agreed date, time, and location in Nigeria to collect data to answer the research question: What strategies do health care leaders in Nigeria use to obtain, adopt, and implement AI-based medical device technologies? I employed a semi structured interview protocol consisting of 10 open-ended questions to elicit information from the participants about the phenomenon under investigation. A semi structured interview following interview protocol (Appendix D) enables the participants to understand the questions more clearly and safeguards their independence in their opinion (Alam, 2020). Interview protocol enhances the effectiveness of an interview process by guaranteeing that extensive information is obtained about the phenomenon within the stated timeframe (Yeong et al., 2018). I audio recorded each interview to ensure accurate data capture. Audio-recording ensures the ability of the researcher to accurately capture the data (Alam, 2020; Noor, 2008). In addition to audio recording, I took notes of non-verbal expressions and activities that augmented the interview records. Before the recording, I asked and obtained permission from the participants to audio record the conversation. The integration of data collected from companies' documents, and notes enhanced the interview data. The use of multiple sources of data collection in a case study leads to data triangulation which ensures that the flaws of one source may be

redressed by another source (Alam, 2020; Yin, 2018). Therefore, using different sources of data conveys credibility and trustworthiness of research findings.

In this study, I followed an interview protocol designed to solicit information about the phenomenon, and all the questions were asked of all the participants. By focusing on the data collection process, interview protocols allow the researchers to systematize data collection and mitigate the predisposition of premature closure of data collection, anchoring, dominance and recency effects, or confirmatory biases (Gugiu & Rodriguez-Campos, 2007; Snyder, 2012). In a qualitative study, the researchers immerse themselves with the participants to gain an understanding of the phenomenon but also influence the research findings (Rubin & Rubin, 2012). However, ensuring a neutral expression while asking interview questions or taking notes establish the sense of control of the process and help to elicit robust information from the participants. The use of interview protocol allows the researcher to obtain pertinent information about the phenomenon and ensures that the researcher is in control of the process since interview time must be adhered to during the collection of data. Thus, time management is an essential element of the interview process because it helped the researcher mitigate the redundancy of information and improved the efficiency of the process.

After obtaining a Walden University IRB approval, I conducted a pilot study to evaluate and assess the effectiveness of my proposed research study methodology (data collection and analysis). A pilot study allows researchers to discern anticipated problems with methods so that corrections can be made before the commencement of the main study, answer methodological questions, and guide the development of the research plans

(Doody & Doody, 2015; Yin, 2018). I chose three managers working in hospitals to participate in the study. I followed the same interview protocol and asked the same questions to my pilot participants. The pilot study enabled me to assess and validate my data collection and analysis techniques. Upon completing the pilot study, I solicited feedback from each participant about the questions regarding the clarity, understanding, and connection to the research study objectives.

The feedback from the pilot study enabled me to make necessary adjustments to the methods, methodological questions, and research plans. After the adjustments, I proceeded with the data collection. Using primary information on the participants, I contacted them to set up an interview date, time, and location in Nigeria. I had personal meetings with them to ask questions about the research study and myself and to allow me to clarify any ambiguities relating to the study's objectives. During the meeting, I reminded them of their signed informed consent, the voluntary nature of participation, and their right to withdraw from participation at any time without penalty of any kind.

Upon clarifying these issues, data collection commenced. I asked for their permission to audio record the interview process. The use of audio recordings of interview conversations in a qualitative research study provides an accurate recitation of the interview, ensures complete analysis of the participants' responses, and allows the researcher to quote participants' statements verbatim when needed to validate findings (Rubin & Rubin, 2012). Audio recorded interviews are easy to transcribe for member checking.

In a qualitative research study, the potential for research bias creates a reliability issue. However, the problem could be mitigated by involving the participants to recheck and validate the summary of interpretation of the interview transcripts. Member checking is a technique used to convey the credibility of research results. The summary of the of the interview transcripts interpretations were returned to the study participants to allow them to confirm the accuracy, by permitting them to comment on, correct it, and validate it thus, conveying the trustworthiness of the research findings (Birt et al., 2016; Stake, 1995). I returned the summary of the interpretation of the interview transcript to each participant for their review, comments, and validation as to the document's accuracy. Participant's collaboration is essential in qualitative research strategies and the correction of researcher's interpretations of the data collected by the participants enable researchers to convey reliability and validity of the research findings (Stake, 1995). The use of member checking enhances rigor in qualitative research study (Lincoln & Guba, 1985). Member checking ensures that the transcription of interview data reflects the original description of the participant.

Data Organization Technique

Organizing research documents is crucial for the successful completion of research studies. Creating a case study database enables a researcher to retrieve data quickly and assess and evaluate research objectives' relevancy. A case study database allows the researcher to preserve collected data in a retrievable form (Yin, 2018). In this research, I used the NVivo software tool to create my study database stored in a password-protected external hard drive and organized data in folders based on their

connection to the research topic as outlined in the case study protocol (Appendix B). The transcripts from interviews and the audio records were included in the database. The process allowed me to retrieve information faster and quicker, enabling analysis and evaluation of research data. All collected raw data will be securely stored for five years in a password-protected external hard drive in a locked cabinet that only I have access to, and I will destroy them after five years.

Using a case study database ensured that I maintained the confidentiality of the company documents and participants' information since the database will be stored in an external computer hard-disk drive. I was the only person accessing it during the research process. In qualitative research, the concept of confidentiality is justified by the idea of respect for autonomy and means that the participant's information collected during the research will not be disclosed (Morse & Coulehan, 2015; Wiles et al., 2008). Thus, confidentiality means not discussing information provided by any participant with others and presenting findings in such a way that enables anonymity (Wiles et al., 2008). Researchers achieve confidentiality by using pseudonyms or codes, giving participants right over their data, and concealing information that could compromise the participants' identities in the research report (Petrova et al., 2016). To ensure the confidentiality of the research study participants, I used codes to hide participants' identities.

Data Analysis

Data analysis is an important step in research study. Qualitative research study produces massive amount of data that must be summarized, described, and analyzed. The analysis of the research data leads to the study's findings. In a qualitative multi-case

research study, there are two types of analysis: within-case and across-case analysis that are performed to understand the phenomenon (de Casterle et al., 2012; Houghton et al., 2013). The within-case analysis enables the researchers to provide comprehensive information on each case and theme. In contrast, a cross-case analysis is performed to understand the themes across the case, the similarities, and the differences (Houghton et al., 2013). The combination of within-case and across-case analysis techniques leads to meaningful contextual findings and ensures the integrity of each interview (de Casterle et al., 2012). Within- and across-case analysis enable the researcher to identify the key elements of the data and help the researcher to manage the deluge of data.

I used semi structured interviews, review of company documents, and note taking to collect data as I explored the phenomenon under study in my qualitative research study. For this study, I employed an interview protocol (Appendix D) that allowed me to ask open-ended questions to each participant as stated in Appendix A and a review company documents to achieve data triangulation. The use of multiple sources of data collection in a case study leads to data triangulation which conveys confidence in the credibility of the research findings and ensures that a complete picture of the phenomenon is portrayed (Alam, 2020; Houghton et al., 2013; Yin, 2018). Policies, standard operating procedures (SOPs), and technology implementation guidelines were among the documents I collected from the companies and reviewed to support the data collection process. I applied a note taking technique to record the participants' facial impressions, behaviors, and non-verbal cues that might not be adequately obtained through audio-recording of the interviews. Recording these elements of an interview

might yield additional information about the phenomenon (Merriam, 1998; Sutton & Austin, 2015; Yin, 2018). Note takings and memo enable the researchers to document non-verbal information that might not be captured by audio recording during interview process.

Analyzing data is the heart of qualitative research study. Analysis is the most complicated step in research process. In qualitative research, data analysis allows the researcher to search for patterns, identify themes, uncover relationships, develop explanations, make interpretations, and generate findings relating to the phenomenon under study (Leech & Onwuegbuzie, 2007; Yin, 2018). Data analysis of participant interview data and company documents enabled me to understand the strategies the health care leaders in Nigeria use to implement AI-based technologies in their hospitals.

Qualitative data analysis is the process of describing, classifying, and interconnecting the phenomenon with the researcher's perspectives. The purpose of qualitative data analysis is to organize creatively, find patterns, insights, concepts, and determine themes from data that are promising (Houghton et al., 2013; Yin, 2018). The framework for data analysis, as outlined by Yin (2011), includes compiling, disassembling, reassembling, interpreting, and concluding, were used to achieve meaningful themes and patterns that enabled answering the central research question of the study. Compiling involves transcribing the data; disassembling refers to taking the data apart and creating meaningful themes; reassembling enables the research to analyze and restructure data; interpreting allows the researcher to make analytical conclusion of the research while concluding enables the research to answer the research question

through the combinations of previous steps (Castleberry & Nolen, 2018; Yin, 2011). The researcher is the main tool for the analysis and employ analysis protocols to reach the study findings.

To realize this complex goal, I used the NVivo software package. When used by a researcher, the NVivo software allows for quick and easy retrieval of data and provided a comprehensive approach to data management (Cypress, 2019; Dalkin et al., 2021; Houghton et al., 2013; Leech & Onwuegbuzie, 2007). NVivo eliminates the need for manual human coding, allows the researcher to align empirical data with literature, enables the management of data collection and analysis, enables the upload of primary and secondary data, and enhances the ability to extract insights from data by storing it in a more retrievable and searchable format (Cypress, 2019; Dalkin et al., 2021). Therefore, using NVivo conveys the credibility and validity of qualitative research findings and increases transparency by providing an audit trail that can be evaluated and analyzed.

After organizing data in themes using NVivo I began my data analysis. Making analytical conclusions is essential in the research process (Castleberry & Nolen, 2018). Interpreting the data involves creating meanings from the data (Reyes et al., 2021). Yin (2011) posits that interpretation of data should be complete, fair, accurate, and representative of the raw material, add value to existing knowledge and be credible. Interpretation of data involves extracting excerpts that allow the researcher to focus on interpreting the meaning of data and developing thematic patterns across the data (Castleberry & Nolen, 2018). The conclusion is the final stage of data analysis. The conclusion involves gathering research data to develop a meaningful response to the

central research question or purpose of the study (Castleberry & Nolen, 2018). To enable relevance and applicability of my study findings, I used the TOE and TAM conceptual frameworks as the lens to assist in understanding the meaning of study data. The TOE and TAM conceptual frameworks enabled me to compare data collected with existing body of knowledge about the phenomenon under study.

Reliability and Validity

Reliability and validity convey rigor in research findings. The concept of reliability and validity is discussed in relation to quantitative research studies (Yin, 2018). Reliability and validity, known as rigor, are the essential components to assessing a study's quality and trustworthiness of research findings (Merriam, 1998; Roberts et al., 2006; Saunders et al., 2016; Yin, 2018). Reliability refers to the replication and consistency or accuracy of a research instrument (Earle, 2020; Merriam, 1998; Saunders et al., 2016). The goal of reliability is to mitigate research errors and biases in a study (Yin, 2018). On the other hand, validity refers to the scope of which a concept is precisely measured in a study (Heale & Twycross, 2015). Validity also refers to whether the study is assessing its purpose and to which extent it fits the existing knowledge (Earle, 2020). Therefore, validity enables the researchers to assess how well the research instruments measure the phenomena under study.

The researcher must explore ways to enhance reliability and validity during the qualitative case study. In qualitative case studies, trustworthiness which includes both validity and reliability elements, is used to assess the quality of the data collection and conveys rigor so that the findings can be credible, confirmable, transferable, and

dependable (Quintao et al., 2020). Some of the ways to improve reliability and validity formed the basis for discussion in this section. Researchers employ data triangulation, member checking, prolonged engagement, and audit trail to fundamentally demonstrate the reliability and validity of research studies (Quintao et al., 2020; Roberts et al., 2006). Fusch et al. (2018) refer to data triangulation as using multiple data sources (interviews, document review, and memos) to convey the rigor of research findings. Member checking refers to participants' validation of interview transcripts as documenting their intents and information provided during the interview process (Roberts et al., 2006). Reliability could also be enhanced using computerized data analysis software such as NVivo by following the rules incorporated in the software (Roberts et al., 2006). Reliability and validity convey rigor and trustworthiness of research study findings.

For a research study to be viewed as quality research, the research must always lead to a reliable conclusion. Researchers use the concept promoted by Lincoln and Guba (1985) consisting of dependability, credibility, transferability, and confirmability (Morse & Coulehan, 2015, 2015) to assess the rigor of qualitative research. Dependability refers to the process of describing the method used for the research studies (Johnson et al., 2020). Credibility, which refers to the value and believability of the findings, is achieved using prolonged engagement, persistent observation, data triangulation, peer debriefing, and member checking (Houghton et al., 2013). Transferability of the research findings is achieved when the research includes a thick description of the research protocol, research methods, and raw data samples that will enable the reader to arrive at the same interpretations as the researcher (Houghton et al.,

2013). Hence, achieving the transferability of the finding enhances the quality of the doctoral studies. Confirmability refers to the method of explaining the researcher's influence on the results and findings (Johnson et al., 2020). Therefore, credibility, transferability, dependability, and confirmability are essential criteria for quality research.

Reliability

To ensure reliability in qualitative research study, the evaluation of trustworthiness is essential. Reliability refers to the replication and consistency or accuracy of a research instrument (Earle, 2020; Saunders et al., 2016). The goal of reliability is to mitigate research errors and biases in a study (Yin, 2018). Reliability enables the researcher to show that other researchers following the same protocols can replicate the study. Thus, reliability enables a researcher to ensure that the study is devoid of bias from participants and researchers, replicable by other researchers, and data collection techniques and analytic procedures must produce a consistent result (Saunders et al., 2016). Therefore, sustaining trustworthiness of research study depends on the concepts of reliability and validity.

Trustworthiness conveys the integrity of the qualitative research study findings and refers to degree of confidence in data, interpretations, and method used during research to ensure quality research. In qualitative research, the researchers demonstrate the trustworthiness of the research study through dependability (Johnson et al., 2020; Kyngas et al., 2020; Nassaji, 2020). Dependability refers to the process of describing the method used for the research studies and indicates how the study finding should be reported to enable the same interpretations given the same data (Johnson et al., 2020;

Nassaji, 2020). Research study's finding is said to be dependable when it projects consistency across data collection and analysis (Kyngas et al., 2020). The use of audit trail brings to focus the decision-making process used throughout the research study that led to the choice of methodology and findings, case study protocol, case study database, memos, peer examinations, independent coding-recording, and other forms of notetaking to document the process to ensure an accurate depiction enhance the study's dependability (Kyngas et al., 2020; Nassaji, 2020; Quintao et al., 2020; Yin, 2018). Therefore, dependability refers data stability over research study period.

Process log which is the researchers note of all the activities that happen during the research study also enhance dependability of the research study. Researchers ensure the dependability of the research findings when they develop coherent themes across the transcripts (Lemon & Hayes, 2020). For this research, I used a process log, followed the case study protocol (Appendix B), and maintained a case study database created using NVivo software to demonstrate the dependability of my study's findings regarding strategies employed by health care leaders in Nigeria to implement AI-based technologies in the hospitals. The process log contained all the researcher's notes of the activities that occurred during the study and decisions that led to research study designs and methodology (Connelly, 2016). The case study protocol established the rules that guide the fieldwork, while the case study database contained all the material collected that formed the basis for analysis (Quintao et al., 2020). Member checking, which is the process of returning the summary of the transcribed transcript to the participant to

validate as to the originality of the content, was also used to enhance the dependability of this research findings.

Validity

Validity enables the researchers to assess how well the research instruments measure the phenomena under investigation. Validity refers to the scope of which a concept is precisely measured, whether the research is assessing the purpose of the study, and to which extent it fits the existing knowledge (Earle, 2020; Heale & Twycross, 2015). It is a measure of the true nature of the outcome or accurate reflection of reality. To ensure an accurate concept measurement, thick and rich data must be collected to enhance the findings. In quantitative studies, the concept of internal and external validity is used to convey the quality of research findings (Quintao et al., 2020; Yin, 2018). On the other hand, researchers conducting qualitative research rely on the concept of credibility and transferability as a measure of research quality that conveys the trustworthiness of the findings (Kyngas et al., 2020; Nassaji, 2020; Quintao et al., 2020). The validity of research conveys rigor and trustworthiness of the findings.

Ensuring the credibility of research is one crucial aspect of conveying trustworthiness of the research findings. Credibility, which refers to the value and believability of the findings, is concerned with the truthfulness of the research findings and is analogous to internal validity in quantitative research (Connelly, 2016; Houghton et al., 2013; Lemon & Hayes, 2020; Nassaji, 2020). However, Yin (2018) points out that internal validity is typically concerned with an explanatory case study where the researcher examines the causal relationship between two variables and makes inferences

every time the phenomenon cannot be observed. To achieve the credibility of my study, I used the following techniques during the research: member checking, data triangulation, audit trail, and note taking of non-verbal cues. I also ensured that my knowledge of the participants, context, and case study protocol were as accurate and complete as possible and that my interpretation was inclusive to convey the credibility of the research.

The credibility of the research is also enhanced when researchers' and participants' biases are discussed as part of the reflexivity of the research. For a researcher to collect thick and rich data from multiple sources of evidence and interpret the information, the researcher must immerse himself with the participants, thereby creating an avenue for potential biases (Quintao et al., 2020). Participant's biases occur when an action causes the participant to give a false response to interview questions (Saunders et al., 2016). Both types of biases lead to data quality issues. Clarifying the researcher's assumptions, worldview, and orientations at the beginning of the study enhances credibility (Merriam, 1998). Researchers point out that the credibility of research findings could be achieved and enhanced through prolonged engagement, persistent observations, peer-debriefing, member checking, audit trail, data, and methodological triangulation (Connelly, 2016; Lemon & Hayes, 2020; Nassaji, 2020). Fusch et al. (2018) and Quintao et al. (2020) posit that methodological triangulation (within the method and between or across method), which refers to the use of multiple sources of data found within one design or data from a mixed-method approach, enables an in-depth understanding of the phenomenon, thus enhancing the credibility of the

findings. Thus, the use of multiple sources of data or multiple methods to confirm the potential findings enhances credibility (Fusch et al., 2018; Merriam, 1998).

Data triangulation enhances the trustworthiness of research findings. Data triangulation ensures a holistic understanding of the context to develop knowledge about the phenomenon under investigation (Merriam, 1998). Member checking where the researcher takes the summary of interpretation back to the participant to ascertain the accuracy of the transcript was used in this study to ensure credibility of the study (Amin et al., 2020; Fusch et al., 2018; Lincoln & Guba, 1985; Merriam, 1998). The use of the above techniques allows the researchers to promote confidence that they have accurately scrutinized the phenomenon under study and convey trustworthiness of the research findings.

The use of small sample size in qualitative research makes it difficult to generalize the findings to other situations. In quantitative research, the extent to which the findings of one study could be generalized to other situations refers to external validity (Yin, 2018). However, in a qualitative study where the researcher uses a small sample to elicit information to gain in-depth knowledge of the phenomenon, transferability of the findings is more appropriate (Fusch et al., 2018). The issues of generalizability have affected the qualitative research study for years; thus, in this study, the focus was on the concept of transferability to avoid the positivist concept of generalizability. Transferability refers to the researcher's ability to detail accurately the steps undertaken during the research process that will enable the reader to make an informed judgment concerning the transferability of the findings to another specific

context (Houghton et al., 2013). Transferability centers on the extent to which the researcher's interpretation of the data is useful or transferable to other contexts (Connelly, 2016; Kyngas et al., 2020; Lemon & Hayes, 2020; Nassaji, 2020). Transferability of the research findings is achieved when the research includes a thick description of the research protocol, research methods, and raw data samples that will enable the reader to arrive at the same interpretations as the researcher (Houghton et al., 2013). To achieve transferability in this study, I used verbatim transcripts of participant interviews; rich, thick, detailed descriptions in data assumptions and analysis; and transparency about the analysis that conveyed the trustworthiness of the research findings.

The concept of confirmability in qualitative research study demands that the research findings are the result of experiences and information from the participants rather than the preference of the researchers. Confirmability refers to the extent that the study findings are supported by data collected, and it is analogous to objectivity in a quantitative research study (Connelly, 2016; Kyngas et al., 2020; Lemon & Hayes, 2020; Nassaji, 2020). In addressing confirmability, researchers assess whether their findings are influenced solely by data collected from the participants, whether the conclusions considered the researcher's bias, motivations, and other subjective interests (Kyngas et al., 2020). To achieve confirmability, researchers use an audit trail where the researchers record and address all the activities and decisions reached to support the connection between the data and findings (Kyngas et al., 2020; Nassaji, 2020). Reflexivity, which highlights the researchers' perception, and the theoretical or conceptual perspectives'

influence on data collections, ensures that both the researcher's and participant's biases are checked and appropriately addressed also enhances confirmability (Houghton et al., 2013). Peer debriefing sessions which prevent biases from one person's perspective on the research study, also enable researchers to achieve confirmability of the findings (Lemon & Hayes, 2020). In this study, I achieved confirmability of the findings using audit trails, field notes of all decisions and analysis, multiple data sources, and member checking where the participants revalidate the accuracy of transcribed interview data.

Data saturation conveys trustworthiness of research findings. The use of multiple data sources and document review leads to data saturation. Data saturation refers to the point in which no new concepts or themes are observed in the data in subsequent interviews and adding additional participants will not add any value to the analysis (Boddy, 2016; Malterud & Siersma, 2016; Trotter II, 2012; Varpio et al., 2017). The concept of data saturation ensures that the researcher does not over-collect data and ensures that enough data is available to enable a robust analysis of the phenomena under study (Varpio et al., 2017). Researchers use prolonged engagement, persistent observations, data, methodological triangulation, and member checking to achieve data saturation of research study (Houghton et al., 2013; Varpio et al., 2017). Prolonged engagement and persistent observation enable the researcher to spend adequate time in the case-study sites to acquire in-depth knowledge of the phenomenon under study.

Data triangulation enhances the trustworthiness of research findings. Triangulation is used to enhance and ensure the accuracy of data collection. Triangulation is a process where multiple sets of data, methods, theories, and perspectives enhance the

research study's vigor, breadth, and depth of the findings (Varpio et al., 2017). It also enables a researcher to address a phenomenon from different directions, leading to accurately locating the phenomenon under investigation (Rose & Johnson, 2020). Member checking refers to when the researcher presents summary of data transcripts or interpretations to participants for validation (Varpio et al., 2017). Member checking ensures that the transcription of interview data reflects the original description of the participant. To ensure data saturation of my study, I employed a prolonged engagement technique, interviews, data triangulation, and member checking. Interview saturation is a process where all the interview questions are explored in detail and no more new concepts emerges with further questions. I also used the technique of interview saturation which is a point where all questions have been completely explored in detail, and no more new concepts or themes were observed in data in subsequent interviews to improve the data saturation of my study.

Transition and Summary

The purpose of this qualitative multi-case study was to explore the strategies health care leaders in Nigeria use to implement AI-based medical device technologies in hospitals. The population consisted of twelve-member health care leaders from six hospitals located in Nigeria that have successfully implemented AI-based medical device technologies. Purposive and convenience sampling techniques were used to select the health care leaders from six hospitals in Nigeria who have successfully implemented AI-based medical device technologies in their hospitals. To collect the data, I used semi structured interviews that were audio-recorded following interview protocol; reviewed

company documents such as policy, standard operating procedures (SOP), technology strategy guidelines; and took notes of non-verbal cues of the participants facial expressions which enabled me to observe participants' perceptions of the phenomenon under study in their natural settings that might yield information not readily captured by audio recording of the interviews. The audio-recorded interviews were transcribed verbatim and analyzed using NVivo software to search for the meaningful themes that explained the patterns in the study. Member checking, multiple sources of data, and triangulation techniques were used to reach data saturation.

In Section 2, I addressed the purpose statement, the role of the researcher, participants, the research method and design, the comprehensive evaluation of the population and sampling, ethical research, data collection instruments, data collection techniques, data organization techniques, data analysis techniques, reliability, and validity. In Section 3, a brief restatement of the purpose statement and a summary of the findings will be first be discussed. It will be followed by the presentation of the findings, linking findings to conceptual frameworks, applications to professional practice, implications for social change, recommendations for action, recommendation for further study, and reflection. Section 3 will end with a strong conclusion.

Section 3: Application to Professional Practice and Implications for Change

Introduction

The implementation of AI-based medical devices has changed the way health leaders provide services to patients. The high demand for more advanced diagnostic systems for chronic diseases has compelled health care leaders in developing countries to explore the merits of AI-based medical device technologies in their hospitals (Behara et al., 2022). Despite the widespread benefits of AI-based medical device technologies, the adoption rate has remained low in low-middle-income countries (LMIC) or developing countries. Several factors contributed to the low adoption rate of these advanced medical devices in developing countries.

Notwithstanding the low adoption rate in LMCs, these advanced medical devices such as magnetic resonance imaging (MRI), computerized tomography (CT) scan, electroencephalograms (EEG), position emission tomography (PET), chemotherapy machines, radiography machines, mammogram machines, digital x-ray machines, and ultrasound machines are being deployed in the health care sector in Nigeria to improve the health care systems according to the participants. These machines are powered by AI-based software for quicker and faster processing of voluminous data, helping clinicians make a better clinical judgment, providing less invasive possibilities, enabling higher diagnostic accuracy, optimizing treatment activities, and shortening the length of hospitalization for patients (Behara et al., 2022; Boeru, 2022; Kayode et al., 2022). There are still many other ancillary medical devices that are powered by AI-based software. However, this study concentrated on the use of the devices mentioned earlier (MRI, CT

scan, EEG, PET, digital x-ray, and ultrasound machines) in the Nigerian health care sector.

The purpose of this multi-case qualitative study was to explore the strategies health care leaders in Nigeria use to obtain, adopt, and implement AI-based medical device technologies in Nigeria. The participants were health care leaders from five hospitals that have successfully implemented AI-based medical device technologies in Nigeria. The participants provided me with primary data and non-confidential organizational documents such as standard operating procedures, policies, and brochures that enabled me to answer the overarching research question: What strategies do healthcare leaders in Nigeria use to obtain, adopt, and implement AI-based medical device technologies? I achieved data saturation when no meaningful additional information emerged from the process. For this study, I used the latest NVivo software to develop the themes that enabled me to write the findings based on the interpretation of participants' responses to interview questions.

In this section, I will discuss the overview of this study, link the study findings with the conceptual frameworks: TOE and the TAM, the overarching question, and existing body of knowledge on AI-based medical device technologies adoption and implementation. Based on the participants' responses to interview questions, I identified five major themes: (a) implementation strategies, (b) barriers to implementation, (c) factors influencing the adoption of the technologies, (d) improvement in the health care system, and (e) types of equipment utilized in these hospitals. Minor themes identified included clinicians' job loss and employment status, enhancement in competitive

advantage, critical success stories, increase in patient referrals, and reduction in medical tourism. Other topics articulated in this section include the application of the findings to professional practice and implications for social change. I will conclude by discussing recommendations for action and further research study, reflections, and study conclusions. The study findings indicate that health care leaders in Nigeria use different strategies to obtain, adopt, and implement AI-based medical device technologies within their hospitals. They also face tremendous barriers in implementing these advanced medical devices.

Presentation of the Findings

The overarching research question was "What strategies do health care leaders in Nigeria use to obtain, adopt, and implement AI-based medical device technologies?" With the advent of AI-based medical device technologies, the function of health care systems has been altered, and the interactions between clinicians and patients have been strengthened, leading to faster decision making and offering better treatment plans. I undertook this study to gain an in-depth understanding of the strategies health care leaders in Nigeria use to adopt and implement these types of advanced medical devices. Analysis of participants' data would enable me to proffer sustainable recommendations that can enable the successful implementation of AI-based medical device technologies. These technologies help health care leaders gain the benefits of diagnostic accuracy, quicker and reliable decision-making processes, shorter hospitalization stay of patients, and enhanced treatment plans.

Based on 11 semi structured, in-depth interviews and a review of organizational documents, I identified strategies health care leaders in Nigeria used to successfully adopt and implement AI-based medical device technologies within their hospitals. I used purposive and convenience sampling techniques to select the twelve health care leaders from six hospitals in Nigeria that have successfully implemented AI-based medical device technologies. Eleven interviews were completed from five hospitals, and the participants did not have any issues understanding the interview questions, assuring that the questions aligned with the research instrument. I had initially planned to interview twelve health care leaders from six hospitals. However, due to unforeseen circumstances (death in the family) that befell the 12th leader, he could not accommodate my request, hence the reason for interviewing eleven leaders from five hospitals. Moreover, data and interview saturations were achieved after the 9th interview. As such, waiting for the 12th interviewee would not have yielded any additional information.

All the participating health care institutions were selected on the basis that they have successfully implemented AI-based medical device technologies and are all private hospital facilities. These facilities have been in operation for more than 4 years and are well-known within the Nigerian health care sector as leaders in innovative health care technologies. These facilities offer many types of ancillary services ranging from cancer treatment management to integrated in vitro fertilization services (IVF) in Nigeria. The participants claimed that they deployed these types of advanced medical device technologies to be on the same par with internationally acceptable standards and best practices and to reduce the need for Nigerians to travel abroad for medical treatments.

Their achievements are testaments to what the health care sector in Nigeria could reach if the leaders are able to resolve the tremendous barriers that affected the implementation of these advanced medical devices in Nigerian hospitals.

From the current state of the health care sector in Nigeria, some hospitals (predominantly privately owned) have attempted to implement AI-based medical device technologies but have abandoned the projects due to challenges that included funding and equipment challenges. The participants stated that the erratic power supply and equipment cost remained the significant barriers to AI-based medical device technologies implementation in Nigeria. One of the reasons that these challenges continued to impede the implementation of AI-based medical device technologies in the country is the lack of a national infrastructure policy that could ease the burden of acquisitions of these types of advanced equipment in the country according to the participants. Some of the participants (two out of 11) were hopeful that the Nigerian government would soon call for a national infrastructure strategy task force that would comprise of health care leaders, end-users, and government officials to discuss and proffer solutions that would encourage local equipment manufacturers in Nigeria. Referring to the national strategy issue, Participant 3 had this to say:

> I think there has to be a national strategy and this advanced medical device equipment are not cheap; they are expensive, and I do not think it is suitable for the governments to leave hospitals to their own devices. I know, for example, that in India, because the Indians have a very huge market, they have managed to negotiate with some of the equipment manufacturers to create manufacturing

plants in India and for the Indian market. And so, what that does is that there is local content, there is employment locally. It makes it cheaper for them. The only caveat is that they cannot export. But what that has done is that hospitals around it have created a cheaper source that is not affected by the fluctuations and all of that. So that is the national strategy. It may not be 100% local things, plus there are parts that need to be imported and then we can mix them locally so that we do have a Nigerian model of these things, and they will be cheaper. So, if the government has a strategy and can convince a few people and have them come back and invest in the country, the Indians are doing the same now; they were not able to do it 20 years ago. Now they are able to do it, and I can tell you that maybe 50% or 60% of what they use and what they need are not made in India. So, they bought things and brought those things they needed to create locally made goods. We are looking at a 200 million people market, and everybody needs health care. So, a national health strategy for me will be that modern medicine cannot divorce itself from these advanced medical device technologies. And so even if it is going to take 10 years and we are going to begin to see the effects in 10 years, the strategy is necessary now so that we can say that this is our national strategy for how we are going to make sure our hospitals get access to this advanced equipment. Whatever it is, even if it is to discuss with the equipment manufacturers and see how we can do it for the Nigerian market.

After the data collection, I imported the interview records into the latest version of NVivo and transcribed the recorded interviews. I also coded the participants' interviews,

which enabled me to develop the general coding schema (codes). Researchers who use the NVivo software package are able to quickly and easily retrieve data with a comprehensive approach to data management (Cypress, 2019; Dalkin et al., 2021; Houghton et al., 2013; Leech & Onwuegbuzie, 2007). NVivo software also allows researchers to modify or add codes in line with the research objectives as the coding progressed (Zamawe, 2015). Relevant information was coded into different codes that enabled the researcher to extract themes that could help to reach analytical conclusions about the research study findings. The five major themes that I identified in this study were: (a) implementation strategies, (b) barriers to implementation, (c) factors influencing the adoption of the technologies, (d) improvement in the health care system, and (e) types of equipment utilized in these hospitals. In the following sections, I will present the five major themes and subthemes that materialized from the coding analysis of the participants' responses to interview questions and describe the research findings extracted from the themes with direct quotations from the interviews to support the participants' perspectives of the themes.

Theme 1: Implementation Strategies Used

The implementation strategies transcend across organizations, and the participants did not hesitate from discussing different strategies they have used to achieve the goals of obtaining, adopting, and implementing AI-based medical device technologies within their hospitals. The responses to Interview Questions 4 and 5, which directly related to the overarching research questions, contributed to the identification of Theme 1. The hospitals used various strategies in their efforts to obtain, adopt, and implement these AI-

based medical device technologies. The participants mentioned finance, vendor selections, maintenance support and agreement, government support, and staff as necessary strategies for adopting and implementing these advanced medical devices. Seventy percent of the participants (seven out of 10) regarded the financing strategy as the dominant strategy. In comparison, about 50% (five out 10) suggested that vendor strategy is crucial for implementing these advanced medical devices. Other noteworthy strategies included training, power supply, market survey, and need analysis.

Financing Strategy

The financing strategy emerged as the dominant strategy for implementing AI-based medical devices. Experts have argued that AI-based medical device technology projects within the LMICs health care sector are behind other projects due to substantial financial resources needed to produce effective results and a lack of collaboration between government and health care leaders (Guo & Li, 2018; Mrazek & O'Neill, 2020). Most of the participants affirmed that financing must be in place before any meaningful advanced medical device projects could be accomplished. Participant 1 acknowledged the importance of a financing strategy by stating,

> Well, one major strategy is budgeting. So strategic planning, budgeting, and financial projections are integral to determining the finances you need for the projects. However, when the equipment is huge and really expensive, then we had to rely on external funding such as loans and lease agreements to purchase these machines. There are certain special loans that the government backs and gives to organizations to help grow businesses. These kinds of loans are not given to new

> and upcoming businesses; they are given to businesses that are existing to help them expand, so they come at better interest rates than the bank rate, and that helps a lot in purchasing these types of equipment if you are able to get them.

Participant 3 agreed and stated that:

> Because of the advent of covid, the government tried to support medical establishments, hospitals, and pharmaceutical companies with a cheaper loan facility that could be used to purchase equipment. So, what the hospitals are paying back is now less painful. So that is also one of the strategies that are explored to ensure that hospitals have access to low-rate loans to enable the adoption and implementation of these advanced medical device technologies.

Participant 4 concurred:

> This hospital benefited from robust government engagement in the form of facilitating access through the Bank of Industry to loans at reasonable single-digit interest rates. Certainly, well, of course, the single-digit interest rate is the key here in this hospital; the low-interest loan enabled it to come into existence and, with that, be able to get all these types of equipment deployed.

Participant 6 equally agreed:

> The Central Bank of Nigeria has some investment tools that they give to all businesses to take advantage of. We also have the Bank of Industry, which is primarily set up to help organizations expand their businesses. We also have other banks, like Africa Export and Import bank, and then you have also the commercial banks who also are ready to provide loans based on the different

> factors that influence their decisions to either give or not to give. So, you look at the ones that will actually be able to assist you in paying. The commercial banks' interest rate is actually high, very, very high, for that matter. But when you are able to get a loan from the Central Bank of Nigeria, although you have to partner with commercial banks to be able to access the loan, it comes at very, very low-interest rates.

In responding to Interview Question 4, Participant 9 had this to say:

> First, we started small, started with running a general hospital; later, we did some research and found out that cancer is the leading cause of death in Nigeria. So, this discovery prompted us to into what we call the Big Bang approach and the Gradualistic approach of financing the acquisitions. The gradualistic approach is an approach or system strategy that a business uses to grow by relying on the retained earnings built over the years to explore a profitable or expected profitable venture in the area of the business they are into. The big bang has to do with discovering a new place, a new area, new equipment, and potentially effective equipment that will help you deliver effective services. But here, you do not have shareholders' funds enough to go into it. So, what you need to do is to borrow [loans]. So, in order to achieve our goal objectives within a given period of time, what we did was use the Big Bang approach by borrowing from banks, and we were able to raise funds to buy these types of equipment, the majority of them come from the US, and then bring them back to deploy in this area.

Management commitment to using other financing sources rather than depending on internally generated funds and loans was equally necessary for obtaining, adopting, and implementing these types of advanced medical devices. In response to Interview Question 5, Participant 3 stated, “Some of the things that helped reduce the impact of the high-cost barrier are that some of the equipment companies can give flexible payment plans, leases, and things like that.” Participant 7 noted that: “The management agreed to enter into a partnership agreement with the equipment manufacturers in terms of the payment plan arrangement.”

Vendor Selection Strategies

Notwithstanding that only 50% of the participants affirmed the importance of vendor selection as crucial in implementing these types of advanced medical devices, those who did felt that without a proper strategy for selecting the vendors, such a project would eventually be abandoned. Most of them stated that in selecting the right vendor, training, after-sales support, maintenance agreement, and local representation influenced their decisions regarding any vendor. In line with the observations of the participants, Guo and Li (2018) recommended that equipment manufacturers establish regional medical AI support centers that will ensure that the medical personnel are trained, and equipment is maintained, repaired, and upgraded to support the frontline medical AI systems to collect and report clinical information. Peterson et al. (2022) also noted that training is critical in any new technology implementation, arguing that training needed to be done simultaneously with the implementation of the technologies. In response to Interview Question 5, Participant 5 said,

> Obviously, training has to be an important part of the strategy because you must have the wherewithal before you are able to operate this kind of device. Another thing we have noticed is that people must handle this equipment, not just only the medical doctors who are operating, but people who take care of these machines other than the medical doctors in terms of handling because if those people are not trained on how to handle these machines, the likelihood that we get damages is there and they cost a lot of money to repair. So, we emphasized during the selection process to work with vendors who will provide the training for our people on how to operate and handle these machines before committing to purchasing the equipment.

Participant 6 noted,

> As soon as the equipment is installed, the users have to be trained; that is what we call application training. And then the vendor also provides technical support. Technical support when there is downtime in operation, it is expected that the vendor brings in their technical experts to provide support. So, the application training enables the end users to have a wide knowledge of how to manipulate the machines for optimal results. So training is given, and there is what we call training the trainers also. If the vendors cannot be constantly available to give this training, they train someone within the organization who can then train other people but also up-skill their knowledge gap. So, training is a very important aspect in selecting who supplies the equipment to any hospital.

Participant 7 observed that “offering better after-sales support and training helped the vendors to clinch the deal.” While Participant 8 affirmed that after the bids were analyzed, the vendors that gave them better answer to the following questions were the ones that signed supply agreement:

> What is coming in the package? Are there add-ons? Are there things that we were going to have to pay extra? What was the service level agreement like? How often are we going to be doing maintenance? What is the warranty period? Are we going to get training? What about training outside of the training period when we are buying the equipment? Is it going to be free, or is it going to be paid for? So those are all the questions that we asked when we were thinking about buying these advanced medical devices. So based on all the discussions we had with each of the vendors, that informed the decision to go with the current vendor that we have.

Need Analysis

The need to understand what the organization needs to achieve was paramount in performing the need analysis by some of these hospitals. Some of these hospitals understood their needs and where they want to be in the long run through developing their mission and vision statements. Participants voiced the importance of performing the need analysis as a prerequisite for determining what strategies to use in implementing these advanced medical devices. In response to Interview Question 4 and 5, Participant 5 noted:

> If you use the principle of the NEED Analysis process -Keep It Simple (KIS), before you start thinking about the acquisition of these imaging modalities, there must be a need for them. We had to do a study that showed that things are moving from the old use of clocking and medical laboratory to imaging. And also, our study revealed that we equally have the expertise and people who can make use of these types of equipment. And so, when all these are yes, yes, yes, we decided to acquire them.

Participant 7 confirmed and explained:

> Of course, we had to do the need analysis before agreeing to acquire these advanced medical devices. We asked, do we need these types of equipment for our hospital? So, the needs, of course, must be ascertained first. And then you look at also the capacity of the hospital; for instance, if you are in a facility where you cannot use an MRI, for instance, because of its size, but because you need an MRI, an expansion decision will be taken that can accommodate the equipment. So that is a key decision. So that will influence the management to say, ok, since we need this equipment and we do not have the facility to accommodate it, then the facility must be gotten either within or an expansion within the facility to be able to accommodate the equipment. And when we now buy the equipment, what exactly do we want to achieve? That is another key aspect that can influence the decision, and also strategically, you begin to look at the kind of companies that you can approach. The vendors you want to approach. And that can also influence the choice of equipment or models of equipment to be procured. So, these are

> different strategies you can apply in the process of acquiring a particular piece of equipment. And then, of course, if there are financial issues, how do we get the finances to get the equipment? Do we get a loan from a bank? Should we approach an investor who can now come and share in the profit for a period of time? Those are strategic decisions that can help in the acquisition of these types of equipment. These are the questions that must be answered during the process of performing the need analysis, and it helps resolve many issues before procuring any of these types of advanced equipment.

Market Survey

The participants mentioned the importance of doing a market survey to understand whether it was time to spend money upgrading services. The survey results enabled them to decide on the types of equipment to implement that would enable them to provide modern services. In response to Interview Question 4 and 5, Participant 8 stated that:

> Ok, so we did a market survey. We looked at the big hospitals, what our competitors are doing and what services they are offering. And then we also looked at our patient base, you know, the age demographics of patients, what investigations or what clinics are they likely to be attending? So, our patient base is, I would say, between the early 30s and to late 60s. Then, we concluded that a large proportion of patients would actually require specialist care. So, that alone enabled us to plan for upgrading of our hospital to be able to provide high-quality patient care to our clientele. Another reason was the fact that no hospital in the

> area at that time was offering the type of services required by our patients and other patients, which we understood from the market survey. From the market survey, we were able to gather from the HMOs their patients' required services and if we can offer the services resulting from these advanced medical devices to other hospitals that cannot afford to procure them. By understanding the market capacity to absorb the cost of implementing these advanced technologies, we were in a good position to make a purchase or no purchase decisions of these types of advanced medical devices.

Participant 11 affirmed and explained:

> Yeah, our marketing team tried to go and visit other hospitals and find out how they operate in those hospitals, how patients are being cared for, and other things. And then they brought back those new ideas to our hospital, and that allowed us to make the purchasing decisions on procuring these types of advanced medical devices.

Theme 2: Barriers to Implementation

The erratic power supply and equipment costs remained the primary barrier to AI-based medical device implementation in Nigeria according to the participants. Experts argued that in Africa, low availability of electronic medical records, low level of digitization across Africa, constant interruption of electricity, corruption, lack of legal and regulatory framework, cultural differences, high equipment cost, and lack of locally trained engineers hinder the implementation of AI-based medical device technologies in the countries (Germann & Jasper, 2020; Guo & Li., 2018; Mrazek & O'Neill, 2020;

Ngwa et al., 2020; Owoyemi et al., 2020; Sampene et al., 2022). Participants noted that some of the issues raised by these researchers are applicable in Nigeria's health care sector. All participants agreed that understanding and resolving these barriers would enable health care leaders to invest in optimizing their hospital's operations and improve in providing evidence-based treatments to patients. The participants frequently mentioned erratic power supply, equipment costs, maintenance support, manpower, lack of government support, and affordability of the services by patients as significant barriers to implementing these types of advanced medical devices. All participants (100%) stated that erratic power supply and equipment costs posed the highest barriers to implementing these types of equipment in Nigeria.

Equipment Costs

Researchers have argued that one of the major impediments to implementing AI-based medical device technologies in LMICs or developing countries is the cost of purchasing the equipment. According to He et al. (2019), equipment, maintenance costs, and human capital will require tremendous funding to ensure successful implementation and ongoing process improvement of these types of equipment. The participants echoed the same sentiment when most voiced that purchasing these types of equipment was capital intensive. Hence, lack of adequate funding had caused some hospitals in Nigeria to neglect to implement these advanced medical devices. Responding to Interview Question 7, Participant 2 outlined it in this way:

> One major impediment is the costs, you know, the cost of both procuring the machine and making sure it is being properly used. Okay, also, as you know,

> these machines, from time to time, develop some technical faults, and we must wait for the repair service to come out and fix the problem, usually from the manufacturer overseas. That is another cost to the organization. Cost is a major barrier to procuring these advanced medical devices.

Elucidating on the impact of equipment cost in implementing these advanced medical device technologies, Participant 4 attested:

> But really, it is a massive challenge in Nigeria, especially in health care to raise funds to purchase this equipment. So, health care is so underfunded, and so you look at a hospital like ours, and you look at private hospitals in general, you think of them as being more fortunate, and they are. But lack of cash to purchase advanced medical devices for the health care system affects every single hospital in this country, without exception.

Participants 5 and 8 summarized it in this way: “The acquisition of these machines is capital intensive, is quite capital intensive, and quite prohibitive and is a major barrier to the implementation of these types of equipment.” Participant 7 concurred and stated that:

> And so, one of the barriers really is equipment financing because purchasing cost is quite high. In Nigeria, most hospitals do not have much cash to purchase these types of advanced medical devices, and hence they must find an alternative way to raise funds. It is, therefore, clear that financing is one of the barriers to getting equipment like this.

As stated earlier, when I discussed financing strategies above, all participants agreed that they used some aspect of financing strategies to mitigate the impact of the

high cost of purchasing these types of equipment. Most of them borrowed from the Central Bank of Nigeria and the Bank of Industries, which offered them low-interest rates on the cost of capital. The participant agreed that no hospitals approached commercial banks for loans because of their higher interest rates. Another strategy the health care leaders used to mitigate the impact of the high cost of these devices was to approach the manufacturers for payment arrangements or lease options according to the participants. The participants agreed that payment arrangements have helped most hospitals to acquire these devices faster and deployed them quicker than government-backed loans.

Power Supply

The issue of erratic power supply in Nigeria was professed as the highest impediment to the adoption and implementation of these types of AI-based medical devices by the participants. Researchers have argued that the lack of sufficient electricity remained one of the significant barriers to Nigeria's quest to become one of the largest economies in the world by 2030 (Ibrahim & Ayomoh, 2022; Omale, 2022). Nigeria's electricity demand is about 80% lower than the required capacity, and that creates a constant erratic power supply to the people (Ibrahim & Ayomoh, 2022). Responding to Interview Question 7, all the participants demonstrated that the issue of erratic power supply and grid instability were the major barriers affecting the implementation of these types of advanced medical devices in this country. However, the participants explained that even though the erratic power supply was a major barrier, health care leaders have deployed alternative methods such as the use of uninterrupted power supply (UPS),

generators, and solar to limit the impact of unsteady power supply in the country.

Responding to Interview Question 7, Participant 1 elaborated as follows:

> Power supply. The power supply can be erratic. And that means that when you are setting up the equipment, you must plan for how you get uninterrupted power for the equipment. Whether it is by UPS or whatever extra measures, but all that must come into planning. When there is fluctuation in voltage or erratic voltage, the UPS can regularize the voltage. Every medical device is attached to UPS.

Participant 3 conveyed his thought in this way:

> Power fluctuation is part of everyday life in Nigeria because the power is unstable; even when it is available, it still fluctuates and spoils sensitive equipment. So, we have to invest lots of money in UPS (uninterrupted power supplies) equipment just to stabilize the supply and ensure that equipment is not exposed to raw power. Besides, when the power goes off and comes up as it does, sometimes, this advanced equipment must shut down, and we cannot afford that to happen, and as such, we have to have an alternative power supply. So, yes, power has a lot to do, a lot to do with what we are doing. And if we do have stable power from the grid, that would make everybody's life easier. We will not have to spend this money on the alternative power supply because what we are spending on diesel now is almost 50% of our running cost.

Participant 6 concurred and stated that:

> Ok, you see, these types of equipment are high energy consuming equipment, and the issue of power in Nigeria is a strong negative factor for any investor. And so,

> we have these types of equipment that must run 24 hours a day and be powered constantly. Looking at the economy, health care leaders in Nigeria must have external support in terms of acquiring generating plants to support whatever is coming from the national grid. So, it is a significant barrier.

Participant 9 lamented and stated that:

> The most prominent barrier here in the country is electricity. You know, we do not have a constant electricity supply here, and then you are entering into a business where the equipment needs to be under certain levels of temperature on a continuous basis, so it is a very big challenge. Lack of constant electricity is a very big challenge in this country. Our highest level of expenses overhead is on electricity, powering the generators that power the machines. You know, spending so much money, funds on diesel and maintenance. So that is the most important barrier for any person entering these formal medical provisions.

The health care leaders in Nigeria have deployed alternative sources of power to mitigate the impact of the erratic power supply issue according to the participants. The use of these alternative measures ensured that these types of equipment are not damaged because of unstable power and that the operations of the hospitals do not stop. Participant 7 explained it this way: “so what happens is we use other sources of power such as the universal UPS power supply as well as some solar, and as well as generators to try and help with power because these types of advanced equipment all need power for continuous operation.”

Lack of Trained Manpower

The lack of locally trained personnel was uncovered as one of the barriers to the implementation of AI-based medical device technologies in Nigeria. Experts argued that while access to AI skills and training are on the upsurge, African countries still lack a steady supply of locally trained engineers and professionals to manage these types of advanced medical devices (Sampene et al., 2022). These participants emphasized that training was crucial in developing local professionals to ensure nationwide adoption of these AI-based medical devices. In response to Interview Question 7, Participant 6 narrated it this way, "And of course, another barrier will be the skills gap (not having the right people to operate on the machines). But, like I said earlier, training has been able to curtail that barrier." Continuing, Participant 6 added

> But one thing we have not really talked about is the effect of Brain drain on our operations. Brain drain is when doctors leave your shops to apply the skills ordinarily learned here in another country. So, post-COVID-19, a lot of that is taking place; we have lost so many doctors to foreign countries like the UK, America, and other Asian countries, including Saudi Arabia, to mention, but a few have actually taken away a lot of doctors. The effect is huge because, by virtue of the WHO (World Health Organization) standard, we are supposed to have maybe about 40 or 50 patients to a doctor or 100 persons to a doctor, so to speak. But we are seeing a much higher figure for one doctor maybe a thousand persons, to a doctor in Nigeria. That ratio makes it very, very, very dangerous for our country.

> So that is a challenge we are facing, but we are doing our best to cover it so that it will not affect us negatively.

Participant 9 concurred and explained:

> One of the barriers impeding the implementation of these advanced medical devices is personnel. You know the hospital is not all about building. To me, the hospital is 40% equipment, 55% personnel, and 5% building. What I mean by that is that even when you have the equipment, you need trained personnel that are also as intelligent as the machines to handle them and bring out the best in them. You see, in the hospitals, most of the consultants in these specific areas, such as cancer, are from other countries, especially Europe, America, South America, and India or whatnot. So, they are not local personnel, of course, you know, they are being paid in hard currency, and this increases the cost of operations.

Participant 11 stated this way:

> Manpower, I mean, in Nigeria, we do not have many people that are experienced in handling these types of equipment. I am not talking from the medical staff; I am talking from the engineering professionals. So, when we get new equipment, we become anxious, so to speak, because we do not know how long it will take for someone from overseas to come down here, considering the visa issues and everything with Nigeria when the equipment breaks down. So, it is an issue if any of them becomes faulty; how do we handle it because we do not have local engineers readily available that are well-trained in terms of knowledge to handle the machines?

After-Sales Support and Maintenance of the Equipment

Some of the participants mentioned that after-sales support and maintenance had been identified as significant barriers to implementing these advanced medical devices because the technology is imported from foreign countries. However, some of the participants stated that many of the manufacturers are introducing remote support to limit the impact of downtime resulting from equipment malfunction and a lack of local engineers to troubleshoot the problems. Participant 1 explained it this way: “Because these types of equipment are complex, you usually do not want just any engineer to deal with them. So, you have to have an elaborate maintenance agreement which costs quite a lot in this part of the world because we often do not have good local support. Participant 3 summarized it this way:

> Now, not everybody has talked about this, and not everybody has thought about how to maintain this equipment for the customers and their clients. Even the ones that have talked about it might just take one technician, take him to Europe for six weeks, and then he gets trained. And there are many things that he may not know because he does not have the experience and exposure to all parts of the machine. And then sometimes, when he comes, even when he knows what is wrong with the machine, to get the parts will take weeks. So, that is the downtime that is quite discouraging. If it was in Europe and you had equipment that you bought, and it stopped working, and you see that it is going to take a while to fix it, the equipment manufacturer will probably give you replacement equipment so that you can use it and avoid downtime. And so, when you have to import the things

> from Europe, the parts from Europe, you run the risk of depending on them to provide the maintenance support. Maintenance support is a major issue in terms of implementing these technologies.

Participant 11 explained it in this way:

> Sometimes, some of the equipment may develop faults, and the management will need to start making arrangements to get an engineer from overseas to come and service them. So, as you know, we do not have the local engineers that are readily available to work on them if there are any faults here. So sometimes, there may be a slight delay while the management is making frantic efforts to get someone from overseas to come and service these types of equipment.

With the growing trend in the Nigerian health care sector about these AI-based medical device technologies, the equipment manufacturers are establishing local shops to ensure that their engineers are available for quick responses to the needs of their clients. Participated voiced that they have seen tremendous change on turnaround time to resolve equipment faults within their hospitals. Participant 3 explained what the manufacturers are doing in this way:

> But I think these are improving. Some of the big companies have started taking the maintenance side far more seriously. They have better-trained engineers, and they are able to fly in more experienced engineers when they need them. Some of them have decided to store domiciliary parts, some common parts in the country. So that the turnaround time to get the parts is much faster, so that is something that can help.

Affordability of Services

Affordability of services was one of the barriers some participants raised as affecting the implementation of these devices. The participants cited that most Nigerian people cannot afford to pay for services from these AI-based medical device technologies such as CT scan, PET, or MRI, and most of the time opted for low-grade services that non-digital x-rays could provide; hence, such had discouraged leaders from implementing such technology in their hospital. Experts have argued that due to the low numbers of trained health care workers coupled with a lack of evidence-based guidance and the high cost of accessing health care services, health care leaders are discouraged from implementing advanced medical device technologies in their hospitals (Stokes et al., 2022). In answering Interview Question 7, Participant 5 clarified it this way:

> In Africa, most importantly, the sub-Sahara, where Nigeria is, the MRI because when you are looking at patients, you must take cognizance of the economic status of the patient and disposable income. It will be stupid for you to be recommending a treatment plan which the patient cannot buy and at the end of the day, he will abandon it. Like we keep on saying that there are many ways we can deliver the prognosis of a patient even before now, people were being treated for a lot of illnesses that radiology is being used. But the advent of this imaging modality has made it possible and easy to diagnosis. So, the cost implication is equally there. MRI is most expensive than all other imaging modalities that I mentioned this morning.

Participant 11 elucidated in this way:

> One issue is the affordability of the services because in these parts of our country, especially where this hospital is located, we have issues with people being able to pay for the tests. Since it is not a machine that is common, the price is also not cheap and not very easily affordable. Some persons, when you request for CT, they may not do it; they will prefer to go and do a scan, which may not give you an accurate picture of what you are looking for.

Accountability When Decision Errors Occur

One of the barriers identified in the literature was the issue of accountability when errors occurred either due to physicians not following the recommendations that came out from the AI devices or following them and still causing harm to the patients. Researchers believed that since AI-based medical device systems within the health care system was only advisory, physicians should be held accountable for any decision reached using AI-based applications (Habli et al., 2020; Jiang et al., 2021). Some participants agreed and Participant 4 clarified it in this way:

> Well, the final decision rests with the doctor. Yes, the final decision rests with the doctor, so the doctor deploys the AI, so the final responsibility rests with the doctor. So, if there is a mistake by the AI, the doctor is supposed to step in and intervene, and whatever comes out of it, it is the responsibility eventually of the doctor, so the doctor takes responsibility. Eventually, when such do occur, you need to step back and look at the whole situation again and get more and more information to make the decisions at the end.

Participant 8 explained it in another way:

> When errors like that happen, one thing that we do is, that is used as a teaching point. One of the cultures that are here is the no-blame culture. So, the question is not who did it? or why did you do it like that? But the question then should be: is it the failure of the process that these errors occurred? So, it is not an error of an individual; it is an error of the process. And presenting the whole point is, OK, how do we address that process so that the error does not happen again? Yes, and usually, it will be the organization that bears the cost. Medical malpractice, whatever you want to call it now, I think it is changing now, especially because the Medical and Dental Council is also getting involved a lot more.

Medical Legal Issues

One other area identified by the participants was the impact of medical-legal issues that affected implementing these devices. Experts had argued that AI-based medical device technology is a novel technology in global health care, lacking a comprehensive global legal and regulatory framework. Murdoch (2021) observed that current regulations and policies are inadequate to safeguard patient privacy and called for appropriate safeguards to be put in place to maintain privacy in the context of the public-private partnership. In the Nigerian health care sector, some of the recommendations by the experts were being adhered to regarding safeguarding patient privacy information. Participated 3 noted that medical-legal issues affected the implementation of these devices and added:

> Yes, legal issues in an advanced facility like ours, of course, happen. They can be a barrier because if your staff is not trained on medical-legal issues, you will have

> bills to pay when patients are wronged. If the patient leaves the facility with a post-operation infection, of course, he can take a legal issue that can cost the organization very well, and so that is why people are trained to ensure that the instruments are well sterilized, and the nurses are trained to handle operational issues. The patient's medical information (the privacy of patients' information) is a very important aspect of every hospital that wants to keep, you know, legal issues away. Patient information is key; that is why we have electronic medical records in operation here. Only the patient has the right to have his medical report. And so, we identify them by the numbers, identify them by their photographs and identify them by sometimes even the card they use. So, if you do not have all this information, of course, you cannot have access to the information. And suppose the patient wants the information transmitted either through a third party or through another channel, whether to the Embassy or whatever. In that case, it must be communicated in writing and signed by the patient, and then verification will be done directly.

Regarding the issue of safeguarding the patient's information, Participant 8 encapsulated it in the way:

> So, it is always an issue with when you talk about patient confidentiality. So, every organization must have policies in place that guide that, and we have a policy in place regarding the exchange of information. Now, the hospital EMR can only be accessed within the hospital, on the hospital network. Yes. And there also we, the staff are also trained, about patient privacy, about patients' records,

> and patient safety and how to manage those. So, it is something that you have to consciously do when patients come in, and they are being admitted, and they are having an interaction that is always a tool to them, even to the point of investigation results. So, you cannot just come in and say that you want to collect your wife's investigation results; no, it must be a written letter authorizing that. Another step is that that the results of the investigations are only sent out to patients' emails. Yes, so you want the results, you will give an email address, and it will be sent to your email, your own personal email, and not the email of somebody else. Now for the doctors that may need to access the EMR outside the hospital, you cannot do that in a public network; you must do that with the hospital's VPN. These are ways we secure patients' information in this hospital.

Theme 3: Factors Influencing the Adoption of the Technologies

In Nigeria, the health care sector is undergoing a revolution because of the addition of AI-based medical device technologies in the daily operations of hospitals. Many factors accounted for the faster deployment of these devices. Researchers had argued that AI-based medical device technology is widely used in medical practice because of its potential to enhance patient care and enable clinicians to diagnose, treat, predict outcomes, and bridge the health care service gaps in emerging nations (Amann et al., 2020; Antwi et al., 2021; Giordano et al., 2021; Guo & Li, 2018; Mrazek & O'Neill, 2020). These emerging technologies created opportunities to provide evidence-based quality care to patients in the health care industry.

All participants mentioned the importance of these types of advanced technologies and cited that providing quality care, reducing patient loss to other hospitals, becoming a best practice hospital, complexity of treatment, reducing medical tourism, and competitive advantages as factors that influenced the implementation of these advanced technologies in the Nigerian health care sector.

Best Practice

About 50% of the participants stated that providing services at par with developed countries (best practice) was the main factor influencing the adoption and implementation of these advanced medical devices in their hospitals. Participant 3 explained it this way:

> So, we needed to put all the modern technologies that will help our practice provide services equivalent to the ones that are obtained in the US and Europe. As we have seen our practice grow, as we have seen the outcomes improve, we are also encouraged to acquire and implement more advanced medical device technologies.

Participant 4 noted:

> Well, the need to provide health care at an international standard, to be able to render a diagnosis in as definitive a manner as can be, as can be done at any hospital, so we needed the most up-to-date equipment that will enable better care to the patients.

While Participated 7 narrated it in this way:

> The factors that influenced the adoption of these technologies are the need for providing expert services, expert delivery, and expert diagnosis. At this hospital,

> the core value is to ensure that we make the best practice available at par with global best practices. So, because of this, the management has seen it necessary to ensure that the best types of equipment are deployed to meet those core values.

Quality Care

Providing quality care was paramount in implementing these advanced medical devices. All the participants cited that quality care to patients is one of the primary objectives of their hospitals, hence the need for advanced medical devices. Participant 10 stated, “if you want to provide good quality care at the high level available in Nigeria, we are supposed to have some advanced equipment which any other place cannot afford to buy because of financial issues.” Participant 6 summarized it in this way: “Every hospital tries as much as possible to keep its mortality rates low. And so those are key areas of management decisions that influenced the acquisition of these types of equipment, and it is not limited to radiology.”

The complexity of disease and increase in cases

Participants also cited that the complexity of diseases and the increase in the number of cases that they treat necessitated the implementation of advanced medical device technologies in their hospitals. The use of less advanced medical device technologies could lead to clinician’s burnout with the increased in the complexity of diseases in global health care sector, hence the need to implement a more advanced medical devices to enhance treatment and reduce burnouts and stress in the hospitals. Participants stated that these advanced medical devices have helped doctors treat patients

at a faster rate and have improved their morale. Participant 5 explained the factor in this way:

> Well, one of the factors that influenced the adoption, and the implementation is the use in the treatment field from other means of diagnosing illness. If you have a hematoma that is blood in your brain, it is difficult for you to use an x-ray. An x-ray will not actually tell you the nature of the hematoma that you have. An x-ray will only show that there is a particle presence in your brain, either in the occipital lobe or in the frontal lobe or the inside lobe. They cannot do anything in that regard. Employing and adopting an imaging modality, most importantly, MRI, which is used for soft tissue, will give the doctor a good precision and resolution of what is going on and enable the doctor to make an informed judgment regarding the treatment plan. That is why we decided to implement these advanced medical devices.

Participants 7 and 8 affirmed that:

> The increasing complexity of the cases and the patient load led to the demand for these technologies. Initially, before the equipment came, patients were referred outside to other centers that were having such equipment. So that brought in a lot of revenue losses and the like. But with the deployment of such, it does now not only boost the revenue but also placed the hospital on our national scale across the country and even the sub-region when it comes to imaging.

Medical Tourism

The urge to reduce medical tourism among Nigerians made the health care leaders to deploy technologies enabling their facilities to provide evidence-based medical treatments to the populaces. Nigerians spend a tremendous amount of money traveling overseas to receive medical treatment daily. The increased in medical tourism exerts pressure on the Nigerian economy according to the participants. Deploying these advanced medical technologies would ensure that the hospitals provided services that are at par with European nations and the US. The participants stated that reducing medical tourism was an essential factor influencing these devices' implementation. In response to Interview Question 3, Participant 6 proffered the following:

> That is why you find Nigerians going to India, Europe, and the US for health care treatment. And so, what attracts some Nigerians and other African nations to some places are the advanced technologies they have which have helped their doctors to improve their care. So, if we have such equipment back home here, why would the people need to travel? So, money that ordinarily would be used to improve the economy of other countries will now be spent at home here. And it is an advantage to the patients because the costs of hotels, flights, other ancillaries care, and maybe taking a relative for support are now eliminated. He has to spend less money and then gets an equal treatment that he should have gotten abroad here in Nigeria. So, these are factors that have actually played out in why we should have such kinds of equipment.

Participant 7 noted:

> And again, essentially, you are actively trying to decrease foreign medical trips. And that is the idea; there is no need for people to go and spend foreign exchange, travel allowances, and all of that when such things can be found here in the country, thereby making the cost of medical care cheaper. So, the target was to try and reverse or reduce global medical tourism essentially so that one, we can save revenue, and two, medical care can be faster and cheaper for our people and thereby helping the economy.

Competitive Advantage

The participants cited that having these advanced medical devices gave them a competitive advantage over other hospitals. With the capital-intensive nature of these technologies, the few hospitals that deployed them enjoyed more referrals from surrounding hospitals and clinics and employed more qualified consultants. Responding to Interview Question 3, Participant 5 attested:

> And most importantly, it gives us a much more competitive advantage because the patients know that when they come to this hospital, one of the ways of investigating the presence of illness is a good radiology machine compared to other people who only have the medical laboratory without imaging modality laboratory.

Participant 6 summarized it this way:

> Of course, there are hospitals in operation in our neighborhood and around the city of Abuja that still do not have the advanced equipment we have mentioned. And that has given us a tremendous advantage. The level of errors, of course, will

> be higher in such facilities than what is experienced in this hospital. Also, there is something we call Brand Equity. Of course, knowing fully well that this hospital has such kinds of equipment increases its brand visibility among other hospitals and clinics.

Elucidating how these advanced medical devices enabled enhanced competitive advantage, Participant 7 stated that:

> Yes, it has. In town, we get a lot of referrals. We are the go-to center when it comes to MRI imaging in this town. A lot of people want to copy our business model and execute it. These machines are not so common in town. So we are among the few centers, not more than four or five, that have them. But I would, I am bold to say that we are among those that have our own working almost round the clock. We offer services at night and even on weekends.

Participant 9 could not hold his boasting when he stated that:

> Sure, it has. In the whole of South-South, apart from the University of Nigerians, Nsukka, where they have radiotherapy equipment, the whole of south-south comprising of about 12 states, and we are the only one that has these types of equipment. The surrounding hospitals, including the federal medical centers (FMCs), refer patients who need radiation to this hospital. In so doing, it has given us some levels of advantage, has helped us achieve success stories, and exposed us to other medical communities.

Theme 4: Improvement in the Health care Systems

The use of AI-based medical device technologies is improving the health care systems in general and enhancing the patient's well-being in terms of data records and early identification of potential diseases. Prior research substantiated that AI-based medical device technology is widely used in medical practice because of its potential to enhance patient care and enable clinicians to diagnose, treat, and predict outcomes (Antwi et al., 2021). In medical imaging, AI-based medical device technology exhibits impressive accuracy and sensitivity in distinguishing and characterizing abnormalities that enhance service delivery and quality patient care (Antwi et al., 2021). The ushering of these technologies in the health care ecosystems is creating new paradigm shift in the hospitals.

The fourth theme to materialize from the interview questions was the improvement in the health care systems. The participants indicated that the use of AI-based medical device technologies enabled physicians to make quicker decisions regarding treatment plans, accuracy in diagnostic predictions, reduction in patient wait times, increased patient referrals, reduced medical human errors, increased employment, and enabled physicians to offer less invasive surgery. With detailed information regarding patients' medical issues in front of clinicians, the doctors could then make decisions that will enhance patients' well-being and provide evidence-based care.

Quicker Decisions and Accuracy in Diagnosis

Clinicians are using these technologies to augment their decisions regarding diagnosis and treatment strategies. AI-based medical device technologies could help

clinicians, patients, and family members efficiently process available patient information to generate informed, evidence-based, patient-centered care, enhance decision-making, and improve accuracy in diagnostic predictions (Giordano et al., 2021; Mrazek & O'Neill, 2020; Wan, 2020). Participants 1, 5, 6, 10, and 11 acknowledged that these advanced medical device technologies had enabled physicians to make quicker decisions regarding treatment plans. In response to Interview Question 2, Participant 1 clarified as follows:

> Because the digital x-ray works in such a way that when you take an x-ray, you do not have to take a panel from one place to another to go and process. Within a few seconds, the image appears. It enables doctors to attend to patients very fast because they have the required information to diagnose the disease.

Participant 5 contended that:

> Yes, of course, it has helped doctors make quicker decisions. Because when a patient is being taken to health professionals, we have many ways to assess the illness. We can do what we call a clinical examination and state the findings. We can also take samples and send them to a medical laboratory where those samples are run, and the results sent to the doctor. We can also send the patient for imaging radiology investigation. The consulting doctor or the doctor is going to make use of all these three diagnosis ways, your clinical findings, your medical laboratory results, and as well as the radiology investigation to diagnose and treat. So, in answering your question, the answer is yes, it has helped them to identify the cause of illness very quickly. And then enabled them to proffer solutions and

> thereby saving a life and also reducing the period of hospitalization in the hospital.

Participant 6 concurred and added, “the decisions to be made are reached quicker, and they are more accurate. And then, of course, the illnesses are tackled, you know, with efficiency.”

The accuracy in diagnosis was also affirmed as one of the ways that the use of these advanced medical devices had revolutionized the health care systems. AI-based medical device technologies could identify meaningful relationships and patterns in raw data, thus enhancing diagnostic, treatment, and prediction of outcomes in several medical conditions (Secinaro et al., 2021). Participant 4 observed that “with this advanced equipment, one can make accurate diagnoses easily.” Participant 8 added, “these ancillary tools help to make diagnoses, you know, easy, make a diagnosis, a lot more accurate, improve patient care, and improve patient safety.” Participant 9 summarized it in this way “today’s medicine requires a lot of advances in technology to help human decisions. And it is against this background that the use of artificial intelligence-based types of equipment becomes more topical. That’s why most modern hospitals of today have AI-based types of equipment for medical diagnosis, treatment, and management.” In elaborating more, Participant 11 indicated that:

> A patient came in for an ultrasound, the ultrasound just showed that the woman had fibroids, but because of other presenting complaints she had, like bleeding, weight loss, waste pains, and other things, we knew that it was not just fibroids; there may be something more. So, we had to send her for a CT scan. The

> consultant sent her for a CT. So, when the CT results came out, we saw something different. We saw that we were dealing with cancer of the cervix. So, because of the huge mass there, it is now presented in the ultrasound like fibroids. So, we are dealing with a huge cervical cancer that had even metastasized to deliver. So, if not that we have CT scan, I do not think we would have been able to make a better diagnosis that would have led to good treatment for that patient.

Reduction in Patients' Wait Time

Participants commented that their hospitals had noticed a tremendous reduction in patient wait time since adopting and implementing these advanced medical device technologies. Ahn et al. (2021) confirmed that implementing AI-based medical device applications in hospitals enhanced effective resource management by reducing labor-intensive burdens on staff, decreasing inpatient waiting time, and securing optimal treatment time. Participant 1 affirmed that:

> This advanced equipment has shown a marked improvement in patient waiting time, turnaround time, quality improvement, diagnostic capability as a whole, speed of arriving at the diagnosis of disease, speed of managing patients, and significant improvement in the efficiency of the operation.

Participant 5 confirmed and stated, "these technologies enable our hospital to reduce the waiting time or time of hospitalization of our patients." Participant 11 highlighted the importance of these technologies in reducing the patients' waiting time by revealing that:

> In fact, our hospital is one of the best currently in this part of the country; the reason is that in some centers, there is a whole lineup of patients waiting to start

> treatment. Some of them are waiting because the results are unavailable, and some are waiting because they have not had the opportunity, or the equipment is faulty. But since our center has both the equipment and the manpower to do it, once patients come in, within a space of, let us say, 72 hours, all their results are ready, and they can start their treatment immediately. We do not have any lineup of patients waiting to start treatment. Everybody that comes here is sure to start treatment within the next 72 hours.

Increase in Patient Referrals

An increased in-patient referral was outlined as one of the benefits of implementing these advanced medical devices in the hospitals. More than 50% (6 out of 11) of the participants indicated that their hospitals saw a tremendous increase in patient referrals after implementing these devices. Participant 5 attested as follows:

> Apart from using our radiology department to treat illnesses that radiology requires intense diagnosis and as well as treatment, other hospitals too who do not have the wherewithal in this imaging regard also refer their patients requiring diagnostic imaging and treatment to our hospital. And it may interest you to know that we receive referrals from Abuja Teaching Hospital and National Hospital here in Abuja, even as far from Sokoto and other states.

Participant 7 commented that our hospital is the go-to center for MRI services and got a lot of new referrals since implementing these advanced medical devices. Participant 8 elaborated that implementing these advanced medical devices enhanced branding and led to more referrals from surrounding hospitals and clinics. Participant 9 concurred and

stated that “teaching hospitals and federal medical centers (FMCs) refer their patients that need radiation to this hospital because of these types of advanced radiology equipment. In so doing, it has given us some levels of advantage and more referrals from other ancillary hospitals in this area.” Participants 10 and 11 elaborated:

> When we installed a CT scan, for instance, we got more patients for this investigation that we needed to perform. And also, we did not send our patients outside for this type of investigation or lose time. In Nigeria, CT machine is not so readily accessible; just a few centers that have the equipment. So, for any hospital that has it, you not only use it to manage your patients, but some hospitals also send referrals just for the CT scan.

Reduction in Human Medical Errors

The participants also identified a reduction in human medical errors as one of the improvements in implementing these types of advanced medical devices. AI-based medical device technologies are vital in enabling clinicians to prevent or mitigate human medical errors within the health care systems by enabling them to deliver precise recommendations to patients (Troncoso, 2020). Referring to the reduction in human medical errors, Participant 6 attested that:

> You know, in time past, doctors used their intuition based on the complaint given by the patient to be able to address the illness. Now with the advanced technology, the doctor relies basically on what is scanned by machines to get accurate therapy for the illness. So, the level of errors that may come with human intuition is totally eliminated. And that has improved doctors’ efficiency.

Similarly, Participant 7 conveyed that:

> It has improved the doctors' diagnostic processes by assisting them in making the right decision and reducing the unnecessary mistakes that they were making. Oh, it has helped in reducing errors and in the work because these days, errors can lead to a lot of litigation and court cases.

Less Invasive Surgery

Addressing the issue of patients' treatment, most of the participants narrated that the implementation of these types of advanced medical devices has enabled doctors to perform precision surgery that allowed the patients to recover fast. Responding to Interview Question 2, Participant 3 clarified and said, "If I take the imaging test first, for example, it shows me what the bone and the surgery that I am doing. So that I am able to do surgery without making long incisions and reduce blood loss. By far, it improves my accuracy." Participant 6 confirmed and stated:

> The CT scan is high-tech equipment that is able to scan tissues, not hard tissues, and uses magnetic rays to get, you know, the diagnosis. For instance, if you want to do or perform surgery, scans are conducted either by using any of the high-tech equipment, the particular area where the tumor or whatever kind of sicknesses can easily be seen, then the surgeon can remove the tumor with ease.

Similarly, Participant 11 observed:

> I think the CT scan has made a tremendous difference in the hospital. Because this hospital being a cancer center, we rely mostly on what we get from the CT. Sometimes, some basic ones, like X-rays and ultrasound, may not give us or be

> very specific when it comes to details of these cells, the tissues, or the organs in the body. But when you use the CT scan machine, we are able to get more detailed information about the location of a particular tumor, for example, the size and all the surrounding tissues, and that will be able to help the doctor to make a better prescription for the patient. So, the CT helps us to get the actual measurements of the size of the tumor cell or whatever parts of the body we want to focus on. So that when we are given radiotherapy, we are more exact in terms of location and size to avoid damaging other cells.

Other Critical Success of AI in Health Care Systems

The participants lauded that the adoption and implementation of AI-based medical device technologies have increased the visibility of their hospitals. They narrated instances that showed how successfully using these medical devices has helped patients regain their health. Participant 2 confirmed the importance of these devices by stating:

> We have had a patient that was having an active bleed, and she came in here from a neighboring hospital with two bags of blood connected. The patient was actually losing like two liters of blood every six hours. And within one hour and thirty minutes, we were able to stop the bleeding. That is because Cath lab machine. Also, we have had patients that were having an active myocardial infarction (MI), you know, and we were able to open them up, open up the blood vessels. We have also had a patient who was having an aneurysm of the brain that was facing an aneurysm for that matter, so, you know, we had to bring him in and worked on

> him and in his brain, we were able to put a flow diverter and stop the blockage of the aneurysm, and the patient walked out of the hospital on his two legs.

Responding to Interview Question 8, Participant 3 also revealed:

> This morning I was shown a video of a patient who came in about three months ago, had an accident, spinal cord injury, and was paralyzed all the way up and down. He was monitored from an emergency room, and MRI and CT scans were done to see what was happening to his neck; we planned for his surgery, and a spine surgeon was around. We used the image intensifier just to make sure that all our processes and everything were just right to reduce the pressure on his spinal cord. We said, look, there is no guarantee because of the length of time and the amount of damage to the spinal cord, there is no guarantee of where they would go. But at least we have reduced the pressure on the spinal cord. Hopefully, we will see how the recovery goes. As I am talking to you now, this man is walking. He is actually one of the better-than-expected outcomes, but he is walking now. He came back yesterday, three months down the line, and he is walking.

Participant 6 remarked: “One of the key successes we achieved is that our results are more reliable and that the treatments are very successful, and that is very important.” Participants acknowledged that their patients had seen a remarkable improvement in their health with the use of these types of advanced medical devices.

Increase in Employment

One significant barrier uncovered in the literature review was the uncertainty about job security. Several researchers argued that implementing these AI-based medical

device technologies would lead to job loss among clinicians. According to Lee and Yoon (2021), many physicians oppose implementing AI-based medical device technologies in their hospitals because they feared that the technology would make them obsolete. Fears and uncertainty about AI-based medical device technologies and a lack of understanding of AI and robotics functions are impeding the widespread acceptance of innovative technologies within the health care ecosystems (Abdullah & Fakieh, 2020; Sampene et al., 2022). However, the participants conveyed that the deployment of these technologies has led to hiring more people in their facilities impeaching the well-understood knowledge. Responding to Interview Question 7, Participant 1 stated, “digital machines lead to an increase in patients, and the hospitals keep growing, leading to an increase in employment.” Participant 3 concurred and stated as follows:

> We have not seen that. Maybe that phase will come when you go to robotic surgery, and the robot can do the job that a human being can do. We have not gotten there. In fact, in some situations, the equipment is making us employ more people. Like the neuro monitor that we just bought, I have to hire a new physiologist to operate it. It is not like you cannot do the work without a neuro monitor, you can, but if we decide that we would have to have this, then we have to have the people who are trained to operate the equipment. So, as you can see, it has not made us reduce staff.

Participants 4, 5, and 6 affirmed that the acquisition of these types of equipment has made their hospitals increase employment among medical clinicians.

Some of the participants elaborated that these types of advanced equipment would not replace clinicians rather AI-based medical devices will augment their decisions-making process. Researchers had argued that AI-based medical device technologies in health care would not replace human intelligence; rather it would enhance and augment the decision-making processes of the clinicians (Bajwa et al., 2021; Chen & Decary, 2020; Di Vaio et al., 2020; Ellahham et al., 2020; He et al., 2019; Jiang et al., 2021; Patil et al., 2021). Participant 8 concurred and stated, "AI is an addition; it is a tool and will not replace anybody. It will therefore make clinicians' work more efficient, and it is supposed to augment our work." Similarly, Participant 9 attested that "it will not lead to job loss; rather, it will increase the job hunt for the clinicians because of the training they will get operating the equipment."

Theme 5: Infrastructure and Equipment

With the advent of artificial intelligence (AI)-based technologies in the health care sector, health care systems have been revolutionized to provide services that were not possible twenty years ago. Recently, the medical community introduced a new term called "medical technology", which refers to a variety of tools that enable the clinicians to improve the quality of services offered at their hospitals that enhanced patient-centered care, accuracy in diagnosis, reduction in treatment complications, optimizing treatment plans, less invasive surgery, and less hospitalization stay (Boeru, 2022). Health care leaders are adopting and implementing these technologies because of the potential benefits they bring.

However, experts argued that the improvements were only applicable in high-income countries and still lacking in low-medium-income countries (LMIC) or developing nations. Researchers argued that evidence exists that health care systems in LMICs, including Nigeria, are poor overall and highly variable across conditions and that the basic foundation of health care systems is weak, lacking adequate infrastructure, consists of entrenched legacy systems, lacks modern diagnostic technologies to help physicians diagnose diseases concisely, and workforce shortages are widespread (Kim et al., 2021; Mrazek & O'Neill, 2020; Owoyemi et al., 2020; Roder-DeWan et al., 2020; Schwarz et al., 2020). However, due to the prohibitive cost of purchasing these types of equipment, most of them are financed with loans from banks. According to Sampene et al. (2022), health care leaders in Africa financed about 42% of their infrastructure needs, and the cost was not cheap. The research uncovered the expensiveness of implementing these advanced medical technologies in sub-Saharan African countries.

Contrary to the experts' opinions, hospitals in Nigeria have deployed these types of advanced AI-based medical device technologies to enable clinicians to optimize treatment plans, obtain an accurate diagnosis, and reduce the hospitalization stay of patients. Participants boasted that they had deployed these types of advanced medical devices to be on the same par with the high-income countries in providing evidence-based patient-centered care to Nigerians, reducing medical tourism.

The fifth theme to materialize from the interview questions was the type of AI-based medical device technologies used in their hospitals. The theme of infrastructure and equipment materialized from the participant's responses to the overarching Interview

Question 1. All participants (100%) noted that they had deployed various advanced medical devices such as MRIs, CT scans, Cath Lab., digital x-rays, patient monitors, ultrasounds, and PET in their hospitals. Responding to Interview Question 1, Participant 1 and Participant 2 have this to say:

> In this hospital, we have a lot of equipment, starting with the catheterization laboratory (Cath Lab), which is a GE machine, is a multipurpose, dynamic fluoroscopy machine that can perform virtually all the systems, other body organs, and system checks as far as interventional cardiology, radiology and urology are involved. Other parts of the hospital have CT machines, ventilators, X-rays, MRIs, and patient monitors.

Participant 9 responded as follows:

> We have the equipment; we have the MRI. We have the CT scans, all modern equipment, and radiotherapy equipment, and as you can see, we are also installing cyclotron equipment, mammograms, 3D X-rays, and all whatnot. These are all artificial intelligence-based types of equipment. So that is the core of our operation in this hospital.

Participant 3 concurred and boasted as follows:

> We have a 1.5 Tesla MRI scanner and a 64-slice CT scanner. We also do have a bone density tonometry machine, which is also highly sophisticated. Our mammogram machine is a three-dimensional (3D) mammogram, which also comes with the latest software. Now, of course, we have a sophisticated Cath

> laboratory (catheterization lab), which boasts a lot of software-powered equipment.

These participants argued that these types of advanced equipment have helped clinicians optimize treatment plans and developed accurate diagnoses that ensured patients received evidence-based treatments. Evidence exists that these types of equipment have enabled physicians to reach faster and quicker decision-making processes regarding patients' treatment plans. According to Turner et al. (2019), with the emergence of these new technologies, such as AI-based medical device technologies, there is an excellent opportunity to expand capacity and improve the care of critically ill patients in LMICs. Boeru (2022) took it further and pointed out that the implementation of these types of AI-powered medical device technologies could enable physicians to make better clinical judgments regarding treatment plans and diagnoses. The participants also noted that one of the benefits of deploying these types of advanced medical devices is the reduction in the hospital stay of patients, which translated to low health care costs for them. Participant 4 agreed with the experts and stated that:

> In this hospital, we have a lot of imaging modalities. One of the imaging modalities is MRI (magnetic resonance imaging device), and as well as CT scan. In addendum to this two advanced radiology equipment, we also have digital X-rays as well as ultrasound. These devices are used for accurate diagnostic of medical illness and, at the same time, what we call interventional radiology, which means that they can be used as therapeutic measures. We all know that some pathologies are hidden. And for you to elucidate these pathologies, there

> must be a way of using rays to expose them. So, the CT scan, digital X-ray, and MRI use the mechanism to expose these pathologies. These types of imaging modalities have helped our physicians make decisions on diagnosis and treatment plans quicker and faster. We have also noticed in this hospital that the use of these imaging modalities has improved hospital operations, reduced clinical complaints, reduced human medical errors, and reduced the number of days patients stay in our hospital, resulting in lower health care costs to patients.

Doctors' Perception of AI-Based Medical Device Technologies

The participants also cited that these types of equipment are deployed at the request of the physicians that use them to augment their decision process regarding treatment plans. Nigerian doctors viewed these devices as tools that make them perform at the same level as the doctors in Europe and the USA and enabled them to make fewer medical errors. Responding to Interview Question 1, Participant 1 stated, "It enables the doctors to attend to patients very fast because they have the required information to diagnose the disease. Patient's waiting time is reduced significantly." Participant 3 confirmed and attested that:

> The adoption of every technology within the facility advances the skills of the doctor, and so they are happy. In most cases, it is the users that demand for such equipment. And so, if they do not want such technology, it would not be deployed. The owners just do not dump that equipment; they actually liaison with the end user, who ordinarily will want an advancement. For instance, if we were using an analog x-ray machine before now, the processes are longer, that also

> affects the waiting time of a patient and then that affects the overall satisfaction. So that can be a concern for the doctors because they will have to put more time into whatever they are doing rather than the automation that the new technology will bring. And so, they will be the ones to advance the acquisition of advanced technology to ease their work and even make their work much more professional.

All the participants stated that adopting these advanced medical devices has made the work of physicians much more effective, and accuracy has been improved. Doctors spend more time interacting with their patients than when their hospitals were using analog machines. Participant 9 summarized it in this way:

> Sure, it makes their work easier. It makes diagnoses easier and more accurate and provides efficient and effective medical administration. And above all, it gives you, you know, gives you the satisfaction that you have created good value that people are satisfied using, coming here for treatment because they will get positive and assuring results.

Participant 11 concurred and concluded that:

> They are very good. They help us to make better diagnoses. We are anxious when there is any breakdown with the machines. But generally, I think the use of the machines is very wonderful. It helps in hospitals, and it is something that should be commended. If all hospitals could have the CT scan, I think it would make the treatment of patients better; we would have better prognoses when it comes to treating patients than we already have.

The participants' responses to this interview question demonstrated the importance of implementing these advanced medical technologies in their hospitals. The review of the company documents corroborated the assertions by the participants. The ensuing is an excerpt from the company document furnished:

> Our team of highly trained radiographers and radiologists is committed to offering quality medical care by focusing on combining the latest innovative technologies with specialized expertise to diagnose and treat patients. The Imaging and Radiology unit of this hospital offers an extensive range of services using state-of-the-art equipment to deliver medical screening effectively and in good time.

The participants validated that transitioning from the current system to a more technology-based system enabled access to patients' data and enhanced patient-centered care delivery. In line with this study, the participants' responses substantiated Abdulkarim et al.'s (2022), Akpanudo's (2022), Ngwa et al.'s (2020), Owoyemi et al.'s (2020), and Sampene et al.'s (2022) assertions that the use of these advanced medical devices enabled the physicians to make quicker and faster decisions regarding patients' diagnosis and treatment plans.

Linking Findings to Conceptual Frameworks

In conducting a qualitative research study, researchers could use any combination of conceptual framework as a lens to gain better understanding of the phenomenon under investigation. I used the technology, organization, environment (TOE) model developed by Tornatzky et al. (1990) integrated with the technology acceptance model (TAM) developed by Davis (1989) as the conceptual frameworks for this study. The TOE model

was used to identify attributes of innovative ideas that influence organizational leaders' adoption and implementation decisions of innovative technologies (Schmitt et al., 2019). Tornatzky et al. (1990) postulated that three tenets: technology (complexity and relative advantage), organization (size and competence), and environment (competition and regulatory issues) influenced an organization's adoption and implementation of innovative technologies (Hue, 2019; Kinkel et al., 2022; Mohamed & Jokonya, 2021; Pan et al., 2021; Simoes et al., 2020). TOE framework enables researchers to understand the implementation strategies of health care leaders.

Technology acceptance model has been used globally to understand the intention and use of technologies by organizational leaders. Davis (1989) developed the TAM framework to enable the understanding of the factors influencing the intention and use of disruptive technologies. TAM helped explain the adoption of any technology in a more flexible pattern with a robust theoretical and strong psychometric base and powerful explanatory capability that is easy to understand (Chatterjee et al., 2021; Qin et al., 2020). Davis (1989) posited that TAM consisted of two core constructs: perceived usefulness (PU) and perceived ease of use (PEU) that explained the beliefs and behavioral intention that function as the significant reasons for system use in an organization (Bryan, & Zuva, 2021; Chatterjee et al., 2021). The perceived ease of use and perceived usefulness constructs of TAM strongly influence adoption strategies of AI-based medical device technologies in health care systems.

TOE framework has gained strong accolade among researchers who are trying to gain in-depth understanding of the phenomenon under study. Several researchers

observed that TOE (Tornatzky et al., 1990) and TAM (Davis, 1989) conceptual frameworks are the best lenses to explain AI adoption strategies in organizations (Abdekhoda et al., 2019; Chatterjee et al., 2021; Na et al., 2022; Qin et al., 2020). The study findings validated that the use of both TOE and TAM clearly explained the influence of these conceptual frameworks' constructs on health care leaders' adoption and implementation decisions of these AI-based medical device technologies. The participants confirmed that the complexity of the technology, the size and financial strength of the organization, the competition, the perceived usefulness, and the perceived ease of use guided their decisions in implementing AI-based medical device technologies in their hospitals.

Researchers have agreed that the capabilities of TOE to explain adoption strategies of new technologies would be enriched when integrated with the individual contexts of TAM framework. The integrated TOE and TAM models have been widely employed in understanding data innovation and information technology adoption strategies across various research studies (Bryan & Zuva, 2021; Qin et al., 2020). TAM enabled the researchers to understand the impact of behaviors on technology adoption acceptance at various levels, while TOE explained the technical, organizational, and environmental factors that influenced the technology adoption strategies at the organizational level (Abdekhoda et al., 2019; Chatterjee et al., 2021; Qin et al., 2020). Adoption of disruptive technology such as AI-based medical device technologies demanded sound management support from the organizational context and had a significant favorable influence on the perceived usefulness and perceived ease of use of

such modern technologies because AI augments clinicians' decision-making processes in medical procedures (Abdekhoda et al., 2019; Alhashmi et al., 2019). As applied to this study, the participants validated that before these advanced medical technologies were implemented in their hospitals, all these constructs played significant role in their decision-making process.

Applications to Professional Practice

Evidence from this study revealed that many health care leaders in Nigeria have some strategies that enabled them to implement AI-based medical device technologies in their hospitals. The purpose of this qualitative multi-case study was to explore the strategies that the health care leaders in Nigeria used to obtain, adopt, and implement AI-based medical device technologies. This study is significant in that artificial intelligence (AI) applications are considered factors that improved operational efficiency and organizational effectiveness through workforce automation, enhancing decision-makers' predictive intelligence and creating better competitive advantages (Al Badi et al., 2021). The responses from the participants, review of organizational documents, and literature review helped me to gain an in-depth understanding of the strategies and challenges with AI-based medical device technologies implementation in LMICs and developing countries.

Several researchers have argued that AI-based medical devices improve health care leaders' hospital operations. The health care leaders' attitude towards AI-based medical device technologies implementation strategies, implementation barriers, factors influencing the adoption of the technologies, and improvement in health care systems

strengthened the researchers' argument that AI-based medical device technologies implementation improved physicians' decision-making process and enabled accuracy in diagnosis and treatment plans (DeCamp & Lindvall, 2020; Wiljer et al., 2021). The findings from this study could contribute to the existing body of knowledge on AI-based medical device technologies. The study findings might have some practical implications and could be helpful for business leaders, managers, policymakers, practitioners, and health care organizations in Nigeria to gain valuable insights into implementation strategies and benefits of AI-based medical device technologies. The Nigerian government could capitalize on the study's findings to adopt AI-based medical device technologies to develop and implement policies to improve the failing health care industry in the country.

The study findings also revealed the urgent need for health care leaders and the Nigerian government to seek a sustainable solution to enable local manufacturers of advanced medical technologies in the country and recommend national technology strategies for easy implementation. Researchers have attested that AI-based medical device technologies' projects in the developing countries' health care sector are behind other projects due to substantial financial resources needed to produce effective results, lack of collaboration between government, regulators, medical, consumers, and research professionals, and their inability to develop a consensus regulatory framework to govern the AI-based medical device technologies and agree on the ethical boundaries of their applications (Guo & Li., 2018; Mrazek & O'Neill, 2020). With the collaboration of the Nigerian government and health care leaders, sustainable national strategies should be

developed to enable local content manufacturers, thereby reducing the cost of importing the technologies.

From the findings of this study, erratic power supply and finances were the major obstacles to adopting and implementing AI-based medical devices in Nigeria. Based on this study's findings, health care leaders should seek a sustainable solution to mitigate the impact of these barriers. Also, health care leaders should collaborate with policymakers to develop national strategies to reduce the overall impact of these barriers. From this study, the most significant contribution to professional practice could be unveiling the potential implementation strategies of AI-based medical device technologies in hospitals in developing countries. Health care leaders in developing countries could use the findings to implement AI-based medical device technologies in their hospitals.

Implications for Social Change

By adopting and implementing AI-based medical device technologies in hospitals, health care providers could ultimately lower the costs of providing patient-centered care and make services available to remote areas of the communities. The implications for positive social change included providing the communities with enhanced care using the monitoring and predictive features of AI-based medical devices, improving health quality, and providing the health care leaders with the knowledge and skillset necessary to use AI-based medical device technologies to enhance patient-centered care delivery while creating high-paying jobs for the communities. The implementation of AI-based medical device technologies enabled improvement in the physicians' decision-making

processes, reduction in medical errors, diagnosis accuracy, increased productivity, patient referrals, and health care outcomes.

Diagnosis accuracy and improved decision-making positively impacted society and hence conveyed confidence in health care systems and act as a process for social change. Implementing AI-based medical device technologies improved health care systems and positively influenced patient confidence and experience. Implementing AI-based medical device technologies could improve patients' waiting times and increased their access to specialists outside of their geographical areas, hence, enhancing positive social change. Other hospitals could learn from the study's findings the best practice and implementation strategies of AI-based medical devices, thus, enhancing their operations and providing evidence-based care to their patients.

Recommendations for Action

The analysis of participants' responses to the interview questions and the review of organization documents and notes contributed to the realization of multiple themes regarding the strategies that health care leaders in Nigeria use to obtain, adopt, and implement AI-based medical device technologies in their hospitals. Some researchers have argued that digital health technologies might create an equal term regarding the doctor-patient relationship and that the ivory tower of medicine has started to break down, making previously inaccessible information and technologies accessible to patients and reshaping health care and enabling patients to enter health care far before any symptoms or diseases are detected (Anom, 2020; Mesko, 2020). Implementing AI-based medical devices might revolutionize the health care sector and enabled evidence-based

patient care. This study's findings might influence other health care leaders to appreciate the benefits of AI-based medical device technologies and implement sustainable AI-based medical device strategies for their organizations.

Equipment cost was identified as a major barrier in implementing AI-based medical device technologies in Nigeria. However, participants narrated several strategies that were used to mitigate the impact of the cost. I therefore recommend that health care leaders have essential plans for implementing AI-based medical device projects based on their financial capacity, informed decisions, and potential business outcomes. It is essential that these leaders understand the financial implications involved in implementing any kind of AI-based medical device technology project and the benefits accruing to the organizations. Several hospitals in Nigeria had started these projects but could not finish them because of a lack of funding.

Secondly, the erratic power supply was another major obstacle to adopting and implementing AI-based medical device technologies in Nigeria. Investment in alternative power supplies such as solar, UPS, and generators would help mitigate this challenge's impact in implementing AI-based medical devices. Participants revealed that erratic power supply not only affected the implementation of such technologies but also damaged the equipment and data loss. Hence the need for a robust power supply and backup systems that would withstand the challenges in the Nigerian health care sector. The current health care system demanded that automated backup systems be installed because of the volume of patient data generated using AI-based medical device

technologies. I recommend that efforts should be made by health care leaders to invest in automated backup systems that would ensure less data loss.

The TOE conceptual framework showed that technology complexity influenced the adoption of these advanced technologies. Leaders must ensure that adequate training, maintenance agreements, and after-sales support were addressed before any system could be selected during the vendor selection process. Training was a valuable tool that improved the functioning of the technologies and mitigated the anxieties resulting from the implementation of these modern technologies. Training enabled the users to gain in-depth knowledge about the operations of the machines and the benefits of proper usage. I recommend that leaders should have plans to provide adequate training to the end-users. Maintenance agreements and after-sales supports were critical to reducing downtime since most of this equipment was purchased from foreign countries. Leaders should ensure that their vendors provided remote maintenance protocols to enable faster turnaround of faulty equipment. I recommend that health care leaders must ensure that vendors provided faster and quicker access to maintenance and after-sales support to ensure less downtime of the machines.

The lack of local content manufacturers in Nigeria made the equipment acquisition costs very prohibitive. Nigeria did not have a national strategy that addressed the implementation strategies of these modern technologies, thereby creating a huge vacuum for the local economy. I recommend that health care leaders collaborate with the Nigerian government to design a national strategy to ensure that local manufacturers are established in the country. The strategy would be achieved by ensuring that the issues of

erratic power supply, road infrastructures, and less prohibitive policies are addressed immediately.

My research findings and recommendations proffered are crucial because health care systems in developing countries are being revolutionized to meet the global standard of quality care outcomes. Implementing some of these recommendations by health care leaders might influence the adoption and implementation of AI-based medical device technologies in developing countries. I will disseminate the results of this study to interested stakeholders after publication via ProQuest, Walden Scholar works, literature, presentation in seminars, conferences, publications in business and academic journals, and social media. To show appreciation, I will also provide each participant with a summary of the study findings and recommendations.

Recommendations for Further Study

For this study, I used a purposive and convenience sample techniques to select the participants from hospitals in Nigeria. Semi structured interviews and review of company documents formed the basis for understanding AI-based medical device implementation strategies used by health care leaders in the country. The study findings exposed vital information that future researchers might explore regarding implementation strategies of AI-based medical device technologies. Researchers have argued that in qualitative research, sampling involves a small number of participants, allowing for deep and case-oriented analysis and leading to data saturation (Boddy, 2016; Malterud & Siersma, 2016; Trotter II, 2012). A crucial limitation of this study was the small sample size of eleven health care leaders from Nigerian hospitals who have successfully implemented AI-based

medical device technologies in their hospitals. I recommend that future researchers expand the sample size and use quantitative research methodology to examine the country's AI-based medical device technologies implementation strategies.

The societal impact of implementing AI-based medical device technologies is the loss of jobs by many people. By 2033, about 47% to 50% of jobs, especially in the radiology section, would be eliminated due to the workforce's automation in Europe and the United States (Al Badi et al., 2021; Coombs et al., 2020; Lee & Yoon, 2021; Robinson, 2020). This issue of job loss was refuted by the participants and evidence exists that the implementation of these types of medical devices has led to increased employment in the country. I recommend that further study be carried out to investigate why the Nigerian health care sector is not experiencing the same impact on employment as the rest of the world.

The success factors were significant in making the adoption decision of these AI-based medical device technologies in Nigeria. Future studies should concentrate on crucial success factors such as accuracy in diagnosis, improvement in the decision-making process, and overcoming barriers to implementation. Future studies should also focus on how implementing AI-based medical device technologies enhanced the organization's competitive advantages and improved productivity and health care outcomes. Finally, further study is needed to understand the perceptions of patients and caregivers on the importance of AI-based medical device technologies' inclusion in their care processes and their expectations.

Reflections

In conducting this multi-case study, I explored the strategies health care leaders in Nigeria used to adopt and implement AI-based medical device technologies in their hospitals. I used a purposive and convenience sampling techniques to select eleven health care leaders who have successfully implemented AI-based medical device technologies in their hospitals. The purposive sampling enabled me to select leaders with relevant knowledge, experience, skills, and competencies to respond to the research questions. I used email to contact the participants, who allowed me to interact with them frequently.

Using qualitative research methodology allowed me to conduct semi structured interviews with participants, which improved my understanding of the strategies used by these leaders to implement these AI-based medical device technologies in their hospitals. By agreeing to interview participants at their preferred time and place, they were able to express themselves freely, which enabled me to gain better insights into the research problem. Through data collection, organizing, and analyzing the data, I gained in-depth knowledge of the research problem, which allowed me to identify the themes used to reach the study findings.

Throughout the interview process, I acknowledged the possibility of personal bias, so I worked hard to ensure that it did not interfere with the study findings. I used bracketing during the interviews to minimize personal biases and to ensure that I remained focused on the study protocols. Bracketing is a method researchers use to mitigate potential bias or preconceptions relating to the research study, thereby conveying

enhanced rigor of the research findings (Tufford & Newman, 2012). The use of bracketing in qualitative research enhances the rigor of the findings.

My goal in conducting this research study was to improve my research skills and knowledge as I explore not only a burning health care topic of global interest but also a topic that is close to my heart. Reflecting on my experience within the doctoral study process, I acquired a better understanding of the doctoral study process, hence, enhancing my academic research abilities. The findings from this study have enriched my understanding and appreciation of academic research studies. The study findings also enabled me to gain in-depth knowledge of the challenges health care leaders in Nigeria faced in deploying advanced medical devices in their hospitals.

Conclusion

Health care leaders in developing countries face tremendous obstacles in implementing effective AI-based medical device technologies in their hospitals. Researchers have argued that the implementation and adoption of AI-based medical device technologies in developing nations or LMICs is behind their implementation in developed nations (Alami et al., 2020; Hadley et al., 2020; Owoyemi et al., 2020; Wahl et al., 2018). Several factors influenced the implementation of AI-based medical device technologies ranging from substantial financial resources needed to produce effective results, lack of collaboration between government, regulators, medical, consumers, and research professionals, and their inability to develop a consensus regulatory framework to govern the AI-based medical device technologies and agree on the ethical boundaries of their applications (Guo & Li., 2018; Mrazek & O'Neill, 2020). Most AI-based medical

device implementation projects were abandoned by hospital administrators due to the lack of strategies to successfully implement effective AI-based medical device technologies.

In this multi-case qualitative study, I used integrated TOE-TAM conceptual frameworks to explore the strategies the health care leaders in Nigeria used to obtain, adopt, and implement AI-based medical device technologies in their hospitals. I administered ten open-ended questions using a semi-structured interview technique to eleven health care leaders from five hospitals in Nigeria. Company documents were reviewed to corroborate the interview findings. Five themes that were identified from the analysis of the interview transcripts were (a) implementation strategies, (b) barriers to implementations, (c) factors influencing the adoption of the technologies, (d) improvement in health care systems, and (e) types of equipment utilized in these hospitals. The findings revealed that health care leaders in Nigeria used a mix of implementation strategies to implement AI-based medical device technologies in the country.

The participants substantiated that implementing AI-based medical device technologies improved accuracy in diagnosing, enhanced decision-making processes, improved quality of health care outcomes, and improved clinicians' job satisfaction. Due to the tremendous benefits that result from implementing AI-based medical device technologies, management is encouraged to invest more funding in these technologies. All the participants acknowledged that the significant barriers to implementing AI-based medical device technologies in Nigeria were the erratic power supply and the prohibitive

cost of acquiring the machines. Therefore, health care leaders in Nigeria must design a sustainable strategy to mitigate the impact of these significant barriers to implementation.

Finally, the study findings broach that the health care sector in Nigeria has knowledgeable leaders who understand the importance of implementing AI-based medical device technologies in their hospitals and are ready to embrace the technology for better productivity. It is therefore reassuring to know that health care leaders in Nigeria have better knowledge of the benefits of advanced medical devices. Hence, prompting more hospitals to invest in implementing AI-based medical devices technologies and enabling collaboration between health care leaders and policymakers to design sustainable national health care infrastructure policy that will enable nationwide adoption of these advanced medical technologies. The findings support the existing body of knowledge regarding the need to implement effective AI-based medical device technologies in developing countries.

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Appendix A: Interview Questions

1. What AI-based medical device technologies do you currently use at your hospital?
2. How did AI-based medical device technologies enhance the operational efficiency of your hospital?
3. What factors influenced the implementation and adoption of AI-based medical device technologies within the health care industry?
4. What strategies did you employ to adopt and implement innovative medical device technologies such as AI-based medical device technologies within your organization?
5. Which of those strategies do you think best enabled you to adopt and implement AI-based medical device technologies?
6. How did the technology's purpose and complexity determine the implementation strategy within your hospital?
7. What were the barriers that you encountered and how did you over them?
8. What are the success stories of implementing AI-based medical device technologies in your hospital?
9. What impacts did the physicians' knowledge of the technologies influence your adoption and implementation strategies within your hospital?
10. What other additional information would you like to add that we have not covered relating to the implementation of AI-based medical device technologies?

Appendix B: Case Study Protocol

A. Case Study Overview

1. Research Purpose
    a. The purpose of this qualitative multiple case study is to explore the strategies health care leaders in Nigeria use to obtain and implement AI-based medical device technologies in their hospitals.
2. Research Question
    a. What strategies do health care leaders in Nigeria use to obtain and implement AI-based medical device technologies?
3. Conceptual Framework
    a. Technology-Organization-Environment (TOE) framework (Tornatzky et al., 1990)
4. Role of Protocol
    a. Protocol serves as the guide for the researcher's line of inquiry and supports the research activities relating to data collection, analysis, findings, and recommendations.
    b. Researcher will use the protocol to ensure trustworthiness of case study methods, design, and research findings.

B. Data Collection Procedures

1. Data will be collected from the review of company documents, field notes, observations, and including the conduct of semi-structured interviews of twelve

executive leaders of three hospitals in Nigeria who have successfully implemented AI-based medical device technologies in their hospitals.

2. Specific interview sites and contact details at each site will be identified when IRB approval is obtained, emails responses as to interest received, and date, time, and locations finalized with the participants.
3. Expected preparation before fieldwork to conduct interviews:
    a. Informed consent forms mailed, and signed consents received from the participants.
    b. Date, time, and locations for the interview sites agreed upon by all parties.
    c. Interview questions reviewed and finalized based on feedback from pilot study.
    d. Ensuring that data collections tools are functioning properly.
        i. Digital audio tape
        ii. Tablets for recording field observations
        iii. Creation of case study database

C. Protocol Questions: Case Study Interview Questions

1. What AI-based medical device technologies do you currently use at your hospital?
2. How did AI-based medical device technologies enhance the operational efficiency of your hospital?
3. What factors influenced the implementation and adoption of AI-based medical device technologies within the health care industry?

4. What strategies did you employ to adopt and implement innovative medical device technologies such as AI-based medical device technologies within your organization?
5. Which of those strategies do you think best enabled you to adopt and implement AI-based medical device technologies?
6. How did the technology's purpose and complexity determine the implementation strategy within your hospital?
7. What were the barriers that you encountered and how did you over them?
8. What are the success stories of implementing AI-based medical device technologies in your hospital?
9. What impacts did the physicians' knowledge of the technologies influence your adoption and implementation strategies within your hospital?
10. What other additional information would you like to add that we have not covered relating to the implementation of AI-based medical device technologies?

D. Outline for the Case Study Report

1. Case study overview
2. Research findings
3. Application to professional practice
4. Implications for social change
5. Limitations and Research gaps
6. Reflections and Study Conclusions

Appendix C: Invitation Letter

Chief Executive Officer/Chief Information Communication Technology Officer

Hospital Address

Date: XX/XX/2022

Dear Sir/Ms.,

My name is Oliver Iheme, and I am a doctoral candidate in the College of Management and Human Potential at Walden University. I am interested in conducting a qualitative study to gain in-depth knowledge about how health care leaders obtain, adopt, and implement disruptive technologies such as artificial intelligence (AI)-based technologies within the hospital systems. As you have been a key person in developing health care strategies relating to adopting and implementing disruptive technologies such as AI-based applications over the last few years, I would like to invite you to participate in a face-to-face, 20-60-minute interview to answer 10 open-ended questions.

The purpose of this qualitative multiple case study is to explore the strategies health care leaders in Nigeria use to obtain, adopt, and implement AI-based medical device technologies in the hospitals. The results of this study could promote positive social change by providing the communities with enhanced care through the use of predictive features of AI-based applications, improving health quality, and providing the health care leaders with the knowledge and skillset necessary to use AI-based medical device technologies to enhance patient-centered care delivery while creating high-paying jobs for the communities. The outcomes of in-depth interviews and analysis may enable

health care providers to ultimately lower the costs of providing patient-centered care and make services available to the remote areas of the communities.

I am requesting to schedule a time in which I will answer any questions you may have and conduct a face-to-face interview with you. My interviews are semi-structured, consisting of 10 open-ended questions approved by Walden University Committee members, formal, and designed to solicit information regarding health care leaders' strategies to obtain, adopt, and implement AI-based applications in their hospitals. Your answers will be audio-recorded and transcribed. At the end of the interview, I will transcribe your responses and provide you with an opportunity to verify the content for accuracy.

I would like to contact your secretary to schedule the day and time to conduct a face-to-face interview with you lasting no more than 60 minutes. If you have any questions about the study or me, kindly call me at +1(214)738-2884.

Sincerely

Oliver Iheme

Appendix D: Interview Protocol

1. Introduction of self to participant.
2. Review of consent form, answer any questions and concerns of participant.
3. Present a copy of the consent form to participant.
4. Chat with participant about family and friends to set the interview mood.
5. Explain the coded identification procedure and process to the participant, record the date and time.
6. Start interview with question #1, use follow up questions to solicit for more information and continue to the final question.
7. Finalize interview sequence; discuss member-check with participant and set day and time for member checking.
8. Answer any questions from the participant and thank the participant for their participation in the study. Remind participant on how to contact the researcher for any follow-up questions and/or concerns.
9. End of the session.