EasyChair Preprint

№ 12857

Smart Health Care Delivery System: the Nigerian Secondary Health Care Perspective

Lubem Gafa, Akwuma Nathaniel Eru and
Temitope Olufunmi Atoyebi

April 4, 2024

Smart HealthCare Delivery System (A Nigeria Secondary HealthCare Perspective)

***GAFA Lubem[1], ERU, Akwuma Nathaniel[2], ATOYEBI, Temitope Olufunmi[3]**

**Department of Computer Science, College of Environmental Science and Technology Makurdi, Benue State.*

[2]Department of Department of Information Technology & Information System, Faculty of Computing, Nile University of Nigeria, Abuja–Nigeria.

[3]Department of Department of Information Technology & Information System, Faculty of Computing, Nile University of Nigeria, Abuja–Nigeria.

**sethgafa@gmail.com*

[2]nathaniel.eru@nileuniversity.edu.ng

[3]temitope.atoyebi@nileuniversity.edu.ng

Corresponding Email: *sethgafa@gmail.com*

ABSTRACT

The health sector in Nigeria, particularly the Secondary hospitals, is collapsing due to a number of factors, including inadequate referral systems, poor decision-making, excessive bureaucracy, subpar medical personnel, corruption, improper patient attention, improper documentation of patient records for continuity despite the population growth. The aforementioned issues with secondary hospital management have been demonstrated to arise from the health sector's underutilized and inaccessibility of smart technologies. The term "smart health delivery system" explains how smart technology ideas and methods are incorporated into the healthcare sector. *Additionally, it utilizes the information and communication technologies (ICT) to guarantee that health care delivery keeps up with technological advancements. By using a patient-concentric approach, the tech-driven consolidated platform can automate the entire clinic process and update patient record management. As such, a smart healthcare delivery system was proposed using the spiral model, consisting of medical personnel module, administrative personnel module as well as patients' management module. Three experiments demonstrated the system's ease of administration as regards to the management of the secondary hospitals, proper patient documentation, the system also enables patient manage their appointments. It was concluded that the proposed system effectively addressed medical personnel recklessness, proper patient medical record management, and elimination of excessive bureaucracy. Thus, it is advised that the suggested system be put into place in Nigeria Secondary Hospital in order to enhance healthcare services delivery and to ensure long-term viability of the secondary medical field.*

Keywords *Secondary health care, Smart healthcare, Service delivery, Spiral Model, Module.*

1.0 Introduction

The Nigerian health system (federal and state) is required to provide accurate health-related services so as to meet the needs of her citizen. One of the most fundamental human needs is healthcare, indicating that it is an important component of human life.

Also, in Nigeria the secondary healthcare hospitals are the second tier of health service delivery. They are primarily responsible for accommodating and managing urgent issues like fire, trauma centers, children's hospitals, rehabilitation, and geriatric care for hospitals with specific medical conditions like psychiatric care, childbirth delivery, and several diseases, in addition to medical emergencies. It generates income as well.

As such, the provision of healthcare services by the secondary hospitals has been severely hampered by poor administration, red tape, poor medical personnel, and incomplete patient record documentation. This has caused a lot of menace in the health sector and the society at large due to underutilization of smart technologies principles.

The smart technologies also refer as Information and communication technology (ICT) is essential to the provision of digitalized services delivery. Furthermore, smart healthcare is an emerging technological concept that integrates a new generation of information technology. It is not just a technical advancement for the delivery of health services; rather, it is a multi-level transformation that involves changes to medical management and treatment concepts, informatization construction, and other aspects of healthcare delivery. (WHO et al, 2024)

In this context, Smart healthcare service delivery is a concept that uses wearable technology, the internet of things, and mobile internet to connect healthcare resources and institutions, dynamically accessing information and intelligently controlling medical ecosystem needs, safeguarding patients receive necessary services and simplifying resource allocation and also ensuring a more advanced form of medical information construction and administration.

Therefore, a secondary health care delivery system is proposed that uses a software development spiral model, a risk management tool that blends waterfall-style and iterative development process. That will assist the secondary hospital in Nigeria in managing day-to-day operations efficiently, improving administrative roles by getting rid of unnecessary bureaucracy, keeping an eye on cash receipts, maintaining medical staff vigilance to improve the quality, effectiveness, and outcome of health services, maintaining and sustaining proper patient documentation for continuity, and increasing patient referrals for the secondary hospitals.

2.0 literature Review

Healthcare is a broad field, which is one of the main reasons why the competition among experts in the digital health sector might go on forever. However, according to (Nwankwo,2017) Healthcare refers to the maintenance or improvement of health through the prevention, diagnosis, treatment, and management of illness, injury, and other physical or mental impairments in individuals or populations. It encompasses a wide range of services, including medical, dental, nursing, pharmaceutical, and allied health professions.

It is significant that the environment surrounding health is evolving quickly. By combining cutting-edge technologies with top-notch network services, people can enhance healthcare delivery and increase its

accessibility for an increasing number of people. (Haleem et al, 2021). Schwab's (2013) emphasis that Healthcare systems are often viewed as financially unstable in developed economies, yet they are still advancing in emerging economies. These systemic adjustments are the outcome of government pressure to keep health care costs under control. (Anyika, 2014). Thus, these can be addressed with the implementation of the smart healthcare system. There are many benefits to this technology for both patients and healthcare professionals. Even with its current set of challenges and detractors, Smart Health care system can support and improve the patient experience and the management of the secondary hospitals in general.

2.1 Healthcare and Smart Health

Healthcare is paramount to the growth and sustainability of any nation. In Nigeria, the healthcare sector faces numerous challenges including inadequate infrastructure, shortage of skilled professionals, and disparities in access between urban and rural areas. Corruption and underutilization of the smart technology tools. Despite Nigeria high-population, the sector is underdeveloped and fails to delivered it purpose and also yield a positive income. The health care industry is a vast one that encompasses the public as well as private and public entities (Jerry & Sunday, 2016). In actuality, service delivery should be led by the general public health sector.

2.2 Levels of Healthcare in Nigeria

There are three distinct service delivery tiers or levels in the Nigerian health sector: primary, secondary, and tertiary. Operating at the Secondary Health Care (SHC) is the second level, or middle tier. Secondary health care (SHC) includes Government General Hospitals, Central Hospitals, and private hospitals providing specialized medical care. SHC centers offer advanced care, employ more people with higher degree, and have modern facilities. Diseases that cannot be adequately managed in SHC, are been refers to Tertiary Health Care (Hassan.2022).

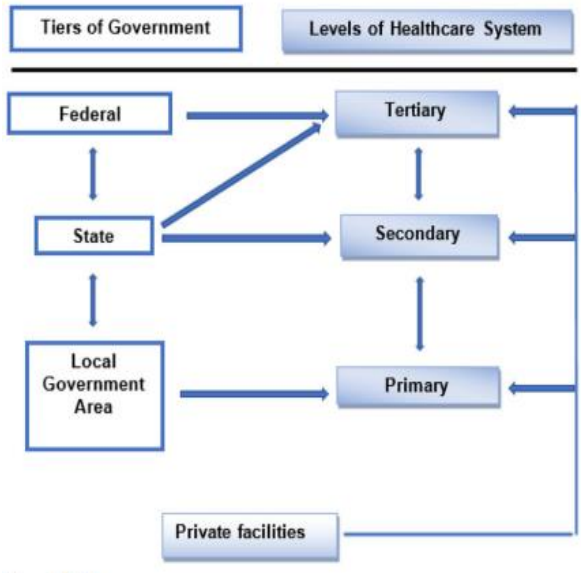

Fig.1: Levels of HealthCare Delivery Levels Nigeria (TWG-NSHDPF, 2009)

The core objectives of secondary healthcare are to provide specialized medical care, support continuity of care, respond to emergencies, promote health education, and contribute to medical research and training to improve health outcomes and quality of life for patients. Upon all, to provide health services that the primary health tier cannot over.

2.3 Smart healthcare

The term "smart healthcare" describes the process of incorporating innovation, data, and technology into healthcare systems and procedures in order to increase effectiveness, accessibility, and care quality. The following are important facets of smart healthcare: (Martin et al., 2010).

Digital Health Records: Transitioning from paper-based to electronic health records (EHRs) allows for secure storage, retrieval, and sharing of patient information among healthcare providers. EHRs streamline administrative tasks, reduce errors, and improve coordination of care.

Telemedicine and Remote Monitoring: Telemedicine enables remote consultations between patients and healthcare providers through video conferencing, phone calls, or secure messaging platforms. Remote monitoring technologies allow for continuous monitoring of patients' health status, facilitating early intervention and personalized care.

Wearable Devices and Sensors: Wearable devices, such as fitness trackers and smartwatches, equipped with sensors can monitor vital signs, physical activity, and other health parameters. These devices provide valuable data for managing chronic conditions, tracking progress, and promoting healthy behaviors.

Health Apps and Digital Tools: Mobile health (mHealth) apps offer a wide range of functionalities, including medication reminders, symptom tracking, virtual coaching, and health education. These apps empower individuals to take control of their health and engage in self-management practices.

Artificial Intelligence (AI) and Data Analytics: AI algorithms analyze large volumes of healthcare data to identify patterns, predict outcomes, and optimize clinical decision-making. AI-powered tools can assist healthcare providers in diagnosis, treatment planning, and personalized medicine.

IoT and Smart Devices: The Internet of Things (IoT) enables connectivity between medical devices, equipment, and systems, allowing for real-time monitoring, predictive maintenance, and automation of healthcare processes. Smart devices in hospitals and homes improve operational efficiency and patient safety.

Blockchain Technology: Blockchain technology provides secure and transparent storage of healthcare data, ensuring privacy, integrity, and interoperability of health information. Blockchain-based solutions enable seamless sharing of medical records, supply chain management, and identity verification.

Genomics and Precision Medicine: Advances in genomics and molecular diagnostics enable personalized medicine approaches tailored to individuals' genetic makeup, lifestyle, and environmental factors. Precision medicine holds promise for more targeted therapies, improved treatment outcomes, and preventive interventions.

Healthcare Robotics: Robotics and automation technologies assist healthcare professionals in tasks such as surgery, rehabilitation, and patient care. Robots enhance precision, efficiency, and safety in healthcare delivery, particularly in complex procedures and repetitive tasks.

Cybersecurity and Data Privacy: As healthcare becomes increasingly digitized, ensuring cybersecurity and protecting patient data are paramount. Robust security measures and data privacy regulations safeguard against data breaches, unauthorized access, and cyber threats.

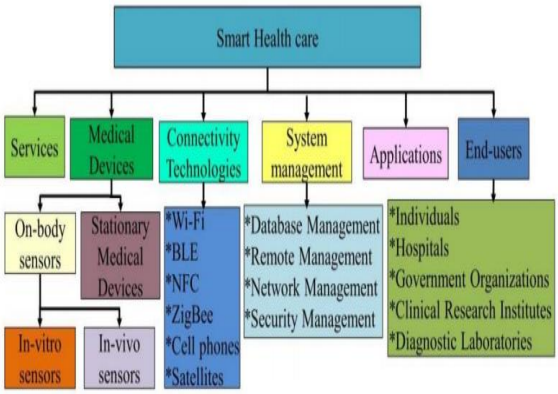

Fig.2: Classification of smart healthcare (Sundaravadivel, 2018)

Overall, smart healthcare leverages technology and innovation to transform healthcare delivery, enhance patient experiences, and drive better health outcomes. Embracing smart healthcare solutions can lead to more efficient, accessible, and patient-centered healthcare systems.

2.4 Models of HealthCare System

Smart healthcare systems utilize technology, data, and innovation to improve healthcare delivery through various models and approaches.

Itanyi et al. (2023) utilized the integrated healthcare services across care levels, promoting collaboration among providers, multidisciplinary teams, and community organizations to improve care coordination, reduce fragmentation, and enhance patient outcomes. He combines regression analysis and decision tree for medical data collection. Though, the government policies were a major setback for the model. Furthermore; Haleem et al. (2021), in their paper. Uses mobile Telemedicine concept to utilizes technology to offer remote healthcare services, such as consultations, diagnosis, monitoring and fellow up overcoming, geographical barriers, improving access, reducing costs, and increasing efficiency, particularly in underserved areas. One of the major bottlenecks was that not all patients have android form to utilized the platform. In another research, Ogaji et al. (2020) uses logistic regression to optimized Remote Monitoring devices which uses wearable devices and sensors to monitor patients' health remotely, enabling early detection of health issues, promoting self-management, and reducing hospital admissions. Though, the model fails due to the fact linear regression couldn't handle high-influx of data. The findings of Koce et al. (2019) in a study on "referral system" , they ascertain that receiving referrals from primary care physicians, secondary healthcare facilities serve as referral hubs for patients in need of specialized care beyond primary care, arranging for additional assessment, treatment, and management though it was poor implemented and could not yield the desired result.. Also, Nwankwo (2017) worked on "health monitoring devices", his finding stipulate that health monitoring devices basically are Wearable sensors being used to monitor vital signs and manage chronic conditions remotely, enabling continuous health monitoring and early detection of issues. Though, one of the major challenges of those monitoring devices are inadequate source of electricity to sustain the model, extremely expensive and high manpower skills is required.

Thus, each of these models represents a different approach to implementing smart healthcare solutions, with the common goal of leveraging technology and innovation to improve healthcare delivery, enhance patient outcomes, and optimize population health. Though, all the models fail to address the issues of corruption, real time monitoring of health personnel activities, to serve as reminder system for the medical personnel and the patients and the elimination of administrative excessive bureaucracy. Therefore, a secondary health care delivery system that's uses a spiral model of software development with an enhanced databased will be used to counter the research gap of the related literature review.

2.5 Why Smart Health Delivery System

Utilizing technology and innovation in healthcare delivery, smart health system aims to improve patient outcomes, increase efficiency, and address a range of issues. (Dzenowagis, 2018)

Smart health delivery solutions, such as telemedicine and mobile health apps, will enable remote consultations and healthcare services, overcoming geographical barriers and increasing access to care, especially in underserved or remote areas. (Eysenbach, 2001); It will also enhance healthcare efficiency, prevent unnecessary hospital admissions, decision making, sharp practices, optimize resource utilization, and reduce travel and time for patients and providers. Arin & Hongoro, 2013).

3.0 Methodology

The spiral software model was utilized for this research paper. This is a result of its adaptability to various software development models, risk management, iterative software development process, and robustness. Use case diagram and flow charts are used for the flow of the system interaction.

3.1 Use case diagram

Figure 1 shows a graphic representation of how three users—patients, doctors, and the administrative section—interact with the system. Both the doctor and the patients' appointments are scheduled and canceled by the administrative staff.

Fig 3. Showing the use case diagram for the health care delivery system.

The administrative staff manages schedules, assigns doctors, and allows patients and doctors to schedule appointments, log in and out, view doctors, and communicate electronically.

3.2. Flowchart Diagram

Figure 4 illustrates a healthcare delivery system workflow, allowing doctors, administrative staff, and patients to sign in and out using unique credentials. This system ensures smooth operations in secondary hospitals, allowing doctors to manage patients, work within schedules, and patients to view schedules.

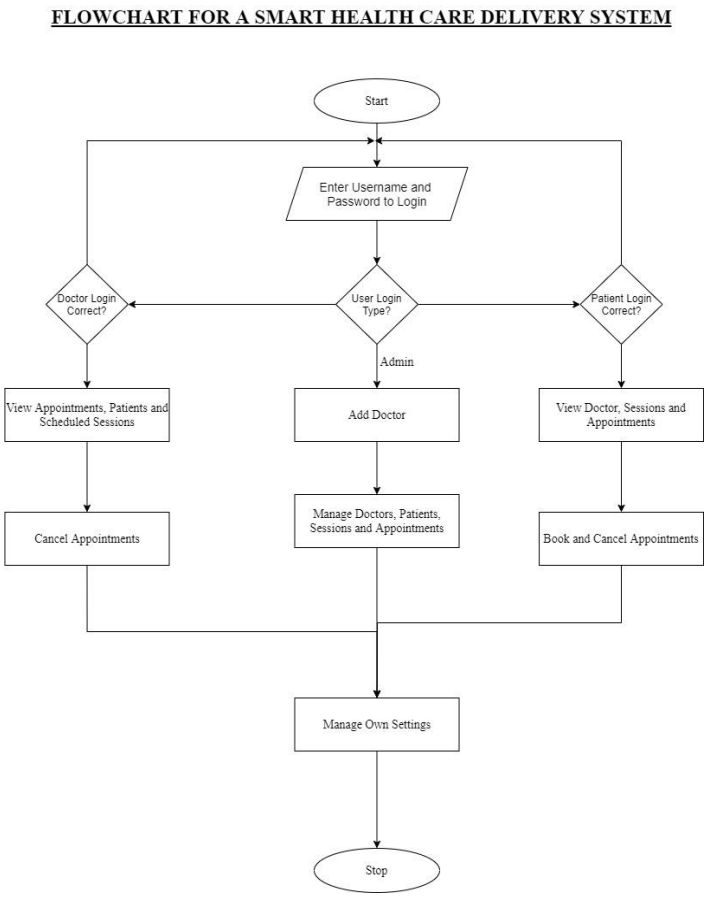

Fig 4 . Showing the Flowchart diagram for the health care delivery system

4.0 Result

The system was developed and experimented. Three modules representing (The Administrative "Figure 5", Doctors "figure 6" and patients "Figure 7") was successful carried as prove of concept showing the roles of each module.

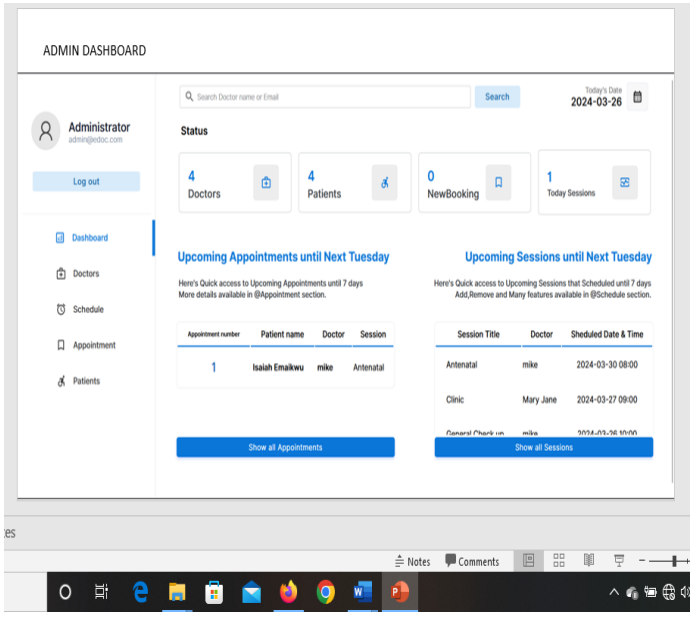

Figure 5: Showing The Dashboard of The Administrative personnel Role.

From figure 5, the administrative personnel can capture patients' data, assign them to doctors, determine next

sessions, and monitor daily sessions for effective health service delivery.

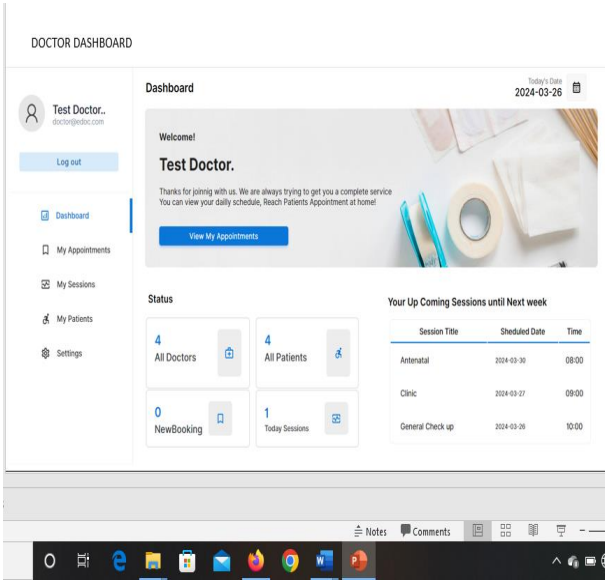

Figure 6: **Showing The Dashboard of The Medical Doctor Role.**

Figure 6; Displays doctor's number of assigned patients, Available sessions, upcoming appointments, and current sessions, enabling the doctor proper planning and management of patient session.

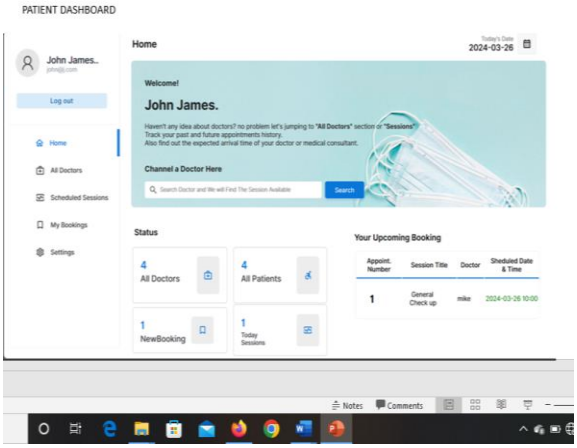

Figure 7: **Showing The Dashboard of patient**

Figure 7; demonstrated the patient booking, appointment with the doctor and kind of medical session. It also reminds the patient about medical appointment as at when due.

5.0 Discussion

The health care delivery system was developed using the spiral model of software development and implemented using JavaScript, Html, MySQL and PHP. The system embraces three modules representing the administrative module as capture in figure 5, the medical Doctor module; as capture in figure 6 and the patient module; as capture in figure 7. It was demonstrated that the administrative staff was able to assign roles, sessions, approve patients' appointments and manage all the activities of the system for delivering healthcare. Also, the medical doctor module was able to view number of patients assign to him, when to have medical session with patients and various patients' sessions. The patients can view their session with doctors, reminder for session and appointments.

6.0 Conclusion

The system has demonstrated its resilience, efficacy, and efficiency in removing superfluous red tape from hospital administrators, reminding patients about their scheduled appointments, gathering data for informed decision-making, and managing the organization's workforce. Additionally, making sure that poor medical staff, corruption, and inadequate patient care are decreased will enhance secondary hospitals' ability to make referral decisions and make better decisions.

7.0 Recommendation

Thus, for secondary hospital to work effectively, the Nigeria government has to put all infrastructure and related resources in place. Also, the relationship between state administration and citizens is key. Corroborating this fact and due to the system robustness and effectiveness, the smart health care delivery system should be accommodated to both private and public health care hospitals at the secondary level, as this will enable the aforementioned hospitals to carry out their services with ease.

8.0 Reference

Anyika, E. N. (2014). Challenges of implementing sustainable health care delivery in Nigeria under environmental uncertainty. *Journal of Hospital Administration,* 3(6), 113–126. DOI: 10.5430/jha.v3n6p113.

Arin, D., & Hongoro, C. (2013). Scaling Up National Health Insurance in Nigeria: Learning from Case Studies of India, Colombia, and Thailand. Washington, DC: Futures Group, Health Policy Project.

Dzenowagis, J. (2018). Digital technologies: Shaping the future of primary health care. Technical Series on Primary Health Care. World Health Organization (WHO) Headquarters, Geneva. WHO/HIS/SDS/2018.55

E-health, Trade, Foreign Policy, Diplomacy and Health. Retrieved 28th March, 2024 from http://www.who.int/trade/glossary/story021/en/

Eysenbach, G. (2001). What is e-health? *Journal of Medicine and Internet Resources,* 3, e20.

Global Observatory for eHealth. (2018). Directory of eHealth policies. World Health Organization. Retrieved 28th March, 2024 from http://www.who.int/goe/policies/en/

Haleem, A., Javaid, M., Singh, R. P., & Suman, R. (2021). Telemedicine for healthcare: Capabilities, features, barriers, and applications *Sensors International* 2, 1–12. https://doi.org/10.1016/j.sintl.2021.100117

Hassan, A. I. (n.d.). HED106: Healthcare delivery system in Nigeria. National Open University of Nigeria. F. B. Adeyanju (Ed.). Abuja. 1–84.

Itanyi, I. U., Iwelunmor, J., Olawepo, J. O., Gbadamosi, S., Ezeonu, A., Okoli, A., Ogidi, A. G., Conserve, D., Powell, B., Onoka, C. A., & Ezeanolue, E. E. (2023). Acceptability and user experiences of a patient-held smart card for antenatal services in Nigeria: a qualitative study. *BMC Pregnancy and Childbirth*, 23(198), 1–9. https://doi.org/10.1186/s12884-023-05494-9

Jerry, S., & Sunday, I. (2016). Implementation of an efficient digital health care delivery system in Nigeria. *World Wide Journal of Multidisciplinary Research and Development*, *2*(7), 1–5.

Koce, F., Randhawa, G., & Ochieng, B. (2019). Understanding healthcare self-referral in Nigeria from the service users' perspective: A qualitative study of Niger State. *BMC Health Services Research*, *19*(209), 1–14. https://doi.org/10.1186/s12913-019-4046-9

Nwankwo, W. (2017). Harnessing E-healthcare Technologies for Equitable Healthcare Delivery in Nigeria: The Way Forward. *International Journal of Science and Research (IJSR)*, *6*(3), 2319–7064.

Ogaji, D. S., Egu, E. B., Nwakor-osaji, M., Smart, A. C., Anyiam, E. F., & Diorgu, F. C. (2020). Responsiveness of primary health care services in Nigeria: The patients' perspective. *Patient Experience Journal Volume 7*(3), 146–154. DOI: 10.35680/2372-0247.1458.

Oyeniran, O. A., Oyeniran, S. T., Oyeniyi, J. O., Ojo, A. O., Ogundele, R. A., Oyeniran, A., et al. (2020). Effective and Efficient Smart Healthy Care System Aimd Covid-19 Pandemic. *International Journal of Multidisciplinary Sciences and Advanced Technology*, *1*(3). 1–7.

Quadri, M. O. (2017). Decentralisation of Health Care Delivery in Nigeria: Issues in Governance and Citizens' Participation in Local Health Care. *Unilag Journal of Humanities (UJH)*, *4*(2), 135–153.

Schwab, K. (2013). Health care industry. Sustainable health systems. Visions, strategies, critical uncertainties and scenarios. A report from the World Economic Forum prepared in collaboration with McKinsey and Company. 2013. www.sciedu.ca/jha

Sundaravadivel, P., Kougianos, E., Mohanty, P., & Ganapathiraju, M. (2018). Everything You Wanted to Know about Smart Health Care: Evaluating the Different Technologies and Components of the Internet of Things for Better Health. *IEEE Consumer Electronics Magazine,* *7*(1), 18–28. 10.1109/MCE.2017.2755378

TWG-NSHDPF. (2009). Technical working group (TWG)-National Strategic Health Development Plan Framework. The National Strategic Health Development Plan Framework (2009-2015). Retrieved March 28, 2024 from http://www.internationalhealthpartnership.net/fileadmin/uploads/ihp/Documents/Country_Pages/Nigeria/Nigeria%20National%20Strategic%20Health%20Development%20Plan%20Framework%202009-2015.pdf

WHO, OECD, & The World Bank. (2018). Delivering quality health services: A global imperative for universal health coverage. Retrieved March 29, 2024 from http://apps.who.int/iris