



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

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March 31, 2024

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

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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" describes the integration of smart technology concepts and tactics within the healthcare industry. Additionally, it makes use of information and communication technologies (ICT) to guarantee that health care delivery keeps up with technological advancements. By using a patient-centric 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 Nigeria health sector (both at Federal and State levels) is mandated to proffer precise health-related services to the citizens and global communities so as to satisfy their health needs. The health sector is one of the most important government establishments. The healthcare is also one of the essential human needs, which indicates significant ingredient of life in human.

Universal Health Coverage (UHC) is an important and noble objective enshrined in the Sustainable Development Goals (SDGs), and it aims to provide health security and universal access to essential care services without financial hardship to individuals, families and communities, thus enabling a transition to more productive and equitable societies and economies (WHO et al., 2018).

Despite Nigerian's strategic status in Africa, the country healthcare sector has experienced several downfalls. The country is greatly underserved in the healthcare sector. Health facilities (health centers, personnel, and medical equipment) are inadequate in the country, especially in rural areas. While various reforms have been put in place by the Nigerian government to address the wide-ranging issues in the healthcare system, they are yet to be implemented at the state and local government area levels. As a result, one would wonder the fate of such country in the era of COVID-19; a newly discovered coronavirus (Oyeniran et al., 2020).

2.0 Literature Review

Healthcare covers a large area, and this is a major reason why the contest among digital health industry experts may continue indefinitely, however, prior to dissecting the term e-health, we would consider the definition given by some authorities (Nwankwo, 2017).

It is noteworthy that the context of health is rapidly changing. Advanced technologies with quality network services enable individuals to improve healthcare delivery and make it available to more and more people (Haleem et al., 2021). In advanced economies, health care systems are deemed financially unstable, while in emerging economies, they are still being shaped (Schwab, 2013). These systemic changes result from the government pressure to contain the cost of health care (Anyika, 2014). The introduction of smart healthcare system addresses these challenges. This technology has several advantages for both patients and healthcare providers. Though there are still technical hurdles and critics, telemedicine can supplement and enhance the overall patient experience (Albahri et al., 2021; Bashshur, et al., 2009; Manchanda, 2020).

2.1 Healthcare in Nigeria and smart health

Healthcare delivery in Nigeria has faced major challenges toward achieving UHC. Health is central to the development of any country. Nigeria's gross domestic product is the largest in Africa, but its per capita income of about ₦770 000 (US\$2000) is low with a highly inequitable distribution of income, wealth, and therefore, health (Asakitikpi, 2019). It is a picture of poverty amidst plenty. Nigeria is both a wealthy country and a very poor one. About 40% of Nigerians live in poverty, in social conditions that create ill health, and with the ever-present risk of catastrophic expenditures from high out-of-pocket spending for health. Even compared with countries of similar income levels in Africa, Nigeria's population health outcomes are poor, with national statistics masking drastic differences between rich and poor, urban and rural populations, and different regions. Nigeria also holds great promise. It is Africa's most populous country with 206 million people and immense human talent; it has a diaspora spanning the globe, 374 ethnic groups and languages, and a

decentralized federal system of governance as enshrined in its 1999 Constitution (FRN, 1999). In this Commission, we present a positive outlook that is both possible and necessary for Nigeria to deliver equitable and optimal health outcomes (Abubakar et al., 2022).

The health care sector is a large industry which is an aggregation of both government and private bodies including the general public (Jerry & Sunday, 2016). In actual sense, the public should take the lead in service delivery.

In Nigeria, health sector is in different tiers/levels of service delivery; the primary, the secondary, and the tertiary levels. The second level, which is the middle tier, operates at the Secondary Health Care (SHC). The SHC includes government general hospitals and central hospitals and other private hospitals, they provide special medical care to patients. They treat general diseases and provide advance care compared to primary health care (PHC) centers. The health care providers have advanced degree, experience and training compared to PHC staff. The facilities used in SHC are advanced and it employed more staff than PHC. Many ailments can be diagnosed and treated in the facilities. When a disease cannot be treated or managed in SHC, they are referred to Tertiary Health Care (THC) (Hassan, n.d.).

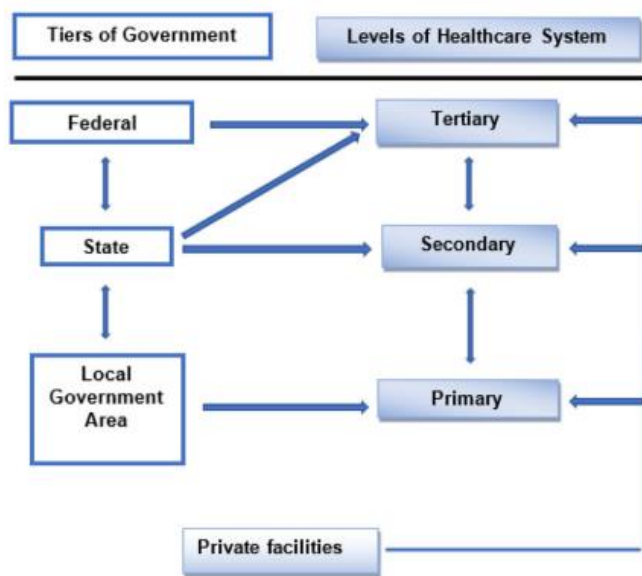


Fig. 1: Levels of Healthcare delivery in Nigeria (TWG-NSHDPF, 2009).

The central objective of the SHC is to accommodate and handle urgent issues such as fire, accident victims, trauma centers, children’s hospitals, rehabilitations, and geriatric for hospitals for coping with particular medical conditions such as psychiatric care, child birth delivery, and other several diseases categories as well as medical emergencies. They operate 24/7 render services in all units of specialty, such as emergency, neonatal care, obstetric acute care, etc. Patients can be admitted and stay in the hospital for many days, weeks, months or even years (Hassan, n.d.), depending on the health situation. It is also a source of revenue. Health services rendered at this level usually take place in the General Hospitals.

It paramount to note that, the provision of healthcare services by the general hospital 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 Information and Communication Technology (ICT) is playing vital roles in health service delivery for digitalized, informative and evidence-based service delivery.

Smart health refers to the integration of advanced technologies such as artificial intelligence, Internet of Things (IoT), data analytics, and mobile applications into healthcare systems and services to improve patient care, enhance clinical outcomes, optimize healthcare delivery, and empower individuals to manage their health proactively. Smart healthcare refers to the integration of advanced technologies, such as artificial intelligence, Internet of Things (IoT), and data analytics, into healthcare systems and processes to improve efficiency, accessibility, and patient outcomes. It involves leveraging technology to enable real-time monitoring, personalized treatment plans, predictive analytics, and remote patient management, ultimately leading to more effective and patient-centered healthcare delivery.

Smart healthcare uses a new generation of information technologies, such as the internet of things (IoT), big data, cloud computing, and artificial intelligence, to transform the traditional medical system in an all-round way, making healthcare more efficient, more convenient, and more personalized.

Smart healthcare was born out of the concept of “Smart Planet” proposed by IBM (Armonk, NY, USA) in 2009. Simply put, Smart Planet is an intelligent infrastructure that uses sensors to perceive information, transmits information through the internet of things (IoT), and processes the information using supercomputers and cloud computing (Martin et al., 2010). It can coordinate social systems and integrate them to realize the dynamic and refined management of human society. Smart healthcare is a health service system that uses technology such as wearable devices, IoT, and mobile internet to dynamically access information, connect people, materials and institutions related to healthcare, and then actively manages and responds to medical ecosystem needs in an intelligent manner (Gong et al., 2013). Smart healthcare can promote interaction between all parties in the healthcare field, ensure that participants get the services they need, help the parties make informed decisions, and facilitate the rational allocation of resources. In short, smart healthcare is a higher stage of information construction in the medical field (Tian et al., 2019).

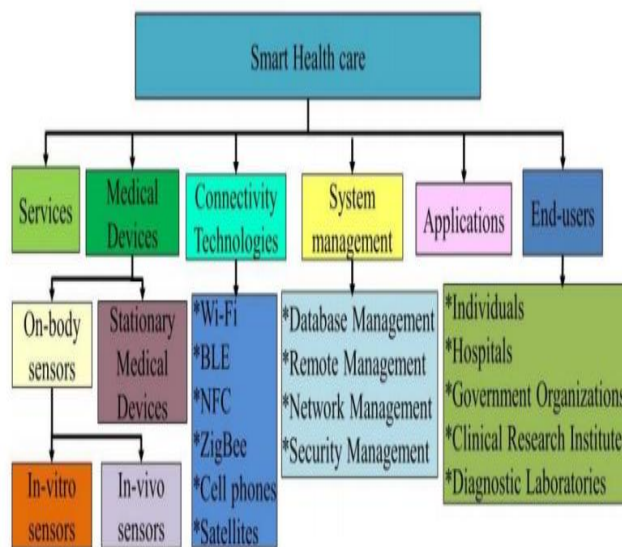


Fig. 2: Classification of smart healthcare (Sundaravadiel, 2018)

Following the consolidation of e-health, the generalized use of mobile devices with positioning capabilities (e.g., smartphones) opened the door to the idea of mobile health (m-health), which could be understood as the delivery of healthcare services via mobile communication devices. m-Health has extraordinary potential since it adds to the advantages of ehealth all the benefits related to the ubiquity

of mobile devices (i.e., global monitoring capabilities, wide availability, and immediacy) (Solanas et al., 2014). Smart Health also refers to Internet of Things (IoT) applications in medicine like e.g., connected (smart) dialysis machines or other devices, wearables for everyday use or applications inside manufacturing (Spiekermann, 2022).

In addition, smart healthcare is an emerging technological concept, integrating a new generation of information technology. It is more than a simple technical breakthrough for the health service delivery; it is a multi-level transformation informatization construction changes, medical management and treatment concept. In this context, smart healthcare service delivery is a health-care delivery system that utilizes wearable devices, the internet of things (IoT), and mobile internet to dynamically access information, link people, materials, and institutions in the healthcare industry, and then intelligently controls and reacts to medical ecosystem requirements, ensuring that patients get the services they need, assisting parties in making informed choices, and facilitating resource allocation. In a nutshell, smart healthcare delivery system is a higher level of medical information building and management.

Consequently, a smart health care service delivery system is suggested for secondary health care hospitals in order to help them efficiently manage the day-to-day operations of the system, improve administrative roles by getting rid of unnecessary bureaucracies, track cash receipts, improve the quality, efficacy, and outcome of health services by keeping medical staff vigilant, maintain and sustain proper patient documentation for continuity, and improve patient referrals for the hospitals at the secondary level.

The implementation of the smart health care delivery system used the software development spiral model, a risk management tool that combines waterfall-style that involves iterative development process models.

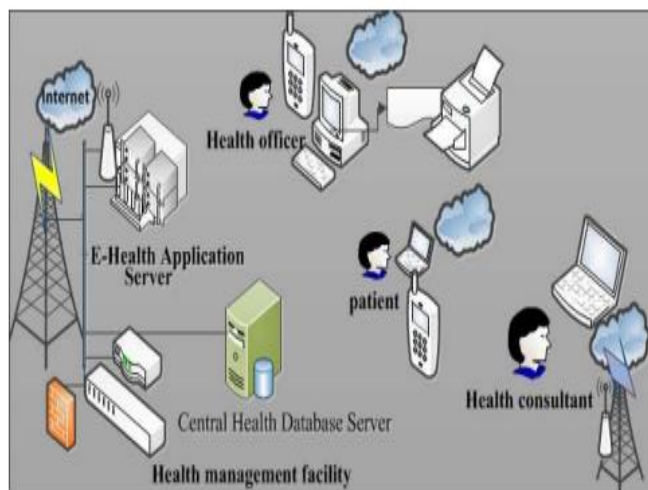


Fig. 3: A simple E-healthcare model (Nwankwo, 2017)

Itanyi et al. (2023) found that mobile health (mHealth) interventions such as patient-held smart cards have been proposed as effective solutions to improve maternal health outcomes. Their qualitative study, on the acceptability and user experiences of a patient-held smart card for antenatal services in Nigeria, further showed that, the most common positive perceptions about the smartcards were their ability to be used across multiple health facilities, the preference for storage of the women's medical information on the smartcards compared to the usual paper-based system, and shorter waiting times at the clinics. Notable facilitators to using the smartcards were its provision at the "Baby showers" which were already acceptable to the women, access to free medical screenings, and ease of storage and retrieval of health records from the cards.

Haleem et al. (2021), in their paper, aims to explore the significant capabilities, features with treatment workflow, and barriers to the adoption of telemedicine in Healthcare. The paper identified seventeen significant applications of telemedicine in Healthcare. The paper found that, using health apps for scheduled follow-up visits makes doctors and patients more effective and improves the probability of follow-up, reducing missing appointments and optimizing patient outcomes. Furthermore, as health practitioners need file management and a payment gateway system, telemedicine technologies allow patients and doctors both to review the treatment process.

Ogaji et al. (2020) assessed the responsiveness of primary health care services in Nigeria from the clients' perspective. A cross-sectional survey of 379 participants were randomly selected from 7 centers from a sample frame of 20 primary healthcare centers. Descriptive results were presented in frequencies and percentages. The associations between the importance and performance ranking were examined using the Spearman's ranked correlation coefficient. Multivariate logistic regression was used to identify predictors of responsiveness with p-values ≤ 0.05 considered statistically significant. There were equal proportion of respondents aged ≥ 30 years but more were female (95%), had attained less than the tertiary level of schooling (60.9%), and currently married (92.3%). The highest proportion of patients reported good responsiveness for dignity (81.8%) and least proportion for the choice of care provider (53.8%). Patient-level predictors of good responsiveness in relation to autonomy were younger age ($p = 0.003$) attainment of tertiary level of education ($p = 0.001$); tertiary education was associated with confidentiality ($p = 0.009$) and those who are not married with prompt attention ($p = 0.027$). Although, dignity, confidentiality, and prompt attention were identified as priority areas to focus in improving the responsiveness of primary healthcare services in Rivers State, the adoption of smart health technologies would enhance the responsiveness level of the patients.

The findings of Koce et al. (2019) in a study on "Understanding healthcare self-referral in Nigeria from the service users' perspective: A qualitative study of Niger State" call for an evaluation of the current healthcare referral system, particularly in developing settings like Nigeria and consequently the need for developing a contextual model as applicable to individual settings. Therefore, a multifaceted approach (such as the smart health) is needed to address the current concerns to ensure patients utilise the appropriate level of care. This will ensure the PHC and SHC facilities are not undermined and allow the referral levels of care to live up to their mandate.

Nwankwo (2017) worked on "Harnessing e-healthcare technologies for equitable healthcare delivery in Nigeria: The way forward. The paper discusses the right of the citizenry to healthcare, the place of, merits, and problems of e-healthcare in public healthcare delivery in Nigeria. Our aim is to expose the potentials of CIM, and how it could be made to contribute significantly towards solving the myriad of problems facing effective healthcare in Nigeria. We adopted a descriptive desk approach using standard databases on healthcare, legislations, relevant public documents from public health authorities in Nigeria, and experiential knowledge on CIM to put forward a simple objective solution. Our solution is greatly hinged on the government's political will to implement an e-healthcare infrastructure through the creation of an implementable policy document.

2.2 Why Smart Health?

From technologies that allow people to manage their health more effectively, to better ways of diagnosing disease, to

monitoring the impact of policies on population health, digital technologies for health, or digital health, are having a profound effect on how health services are delivered and how health systems are run. The impressive trend in national policies for digital health (Dzenowagis, 2018) (more than 120 countries by 2015) reflects the firm commitment to use digital technologies to advance the Sustainable Development Goals, support universal health coverage and shape the future of primary health care (Global Observatory for eHealth, 2018). eHealth was said to have revolutionized the practice of medicine via three distinct functions (Eysenbach, 2001); the use of eHealth technologies to observe and study health parameters (Owoeye et al., 2022); the use of eHealth to facilitate communication between all healthcare participants; and data utilization including referrals and medical data sources to inform medical decision-making and intervention development (Rianne et al., 2019). Hence, eHealth has become crucial for modern healthcare systems worldwide and covers a wide variety of applications and services. These include electronic health records to ensure continuity of patients care across time, consumer health informatics to support individuals in health research by health workers, tele-monitoring and telemedicine-related services.

Use of IT applications for enrollment and patient management at the provider level has benefited the National Health Insurance Scheme (NHIS), beginning with the smart cards similar to those used by NHIS in Nigeria. This has helped in the use of smart-card technology to identify families as beneficiaries to avoid the need for paper forms or procedures. Since most of the beneficiaries were functionally illiterate or semiliterate, this provision improve equity and also avoid any diversion of benefits. Once registered, members get a biometric-enabled card to ensure that only registered members benefit from the plan. The smart cards are delivered at the point of enrollment. The system leakage-free, as it is well protected from misuse by providers and users of services; a management information system monitors use, and government field officers authenticate smart cards before use (Arin & Hongoro, 2013). Smart health is indeed transforming the health system at various levels.

3.0 Methods

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 4 shows a graphical representation of how the 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 personnel.

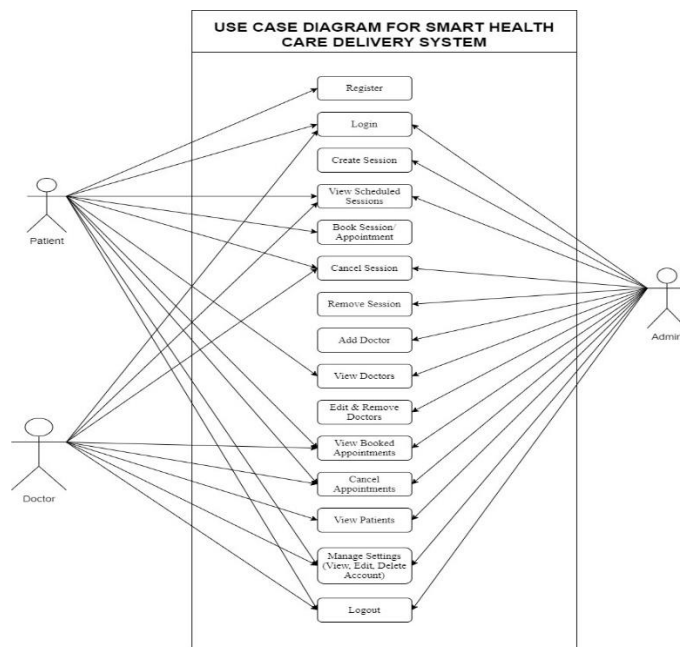


Fig. 4: Use case diagram for the health care delivery system. The administrative staff manages schedules, assigns doctors, and allows patients and doctors to schedule appointments, log in and out, view doctors, and communicate electronically.

3.2 Flowchart diagram

Fig. 5 illustrates the 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.

FLOWCHART FOR A SMART HEALTH CARE DELIVERY SYSTEM

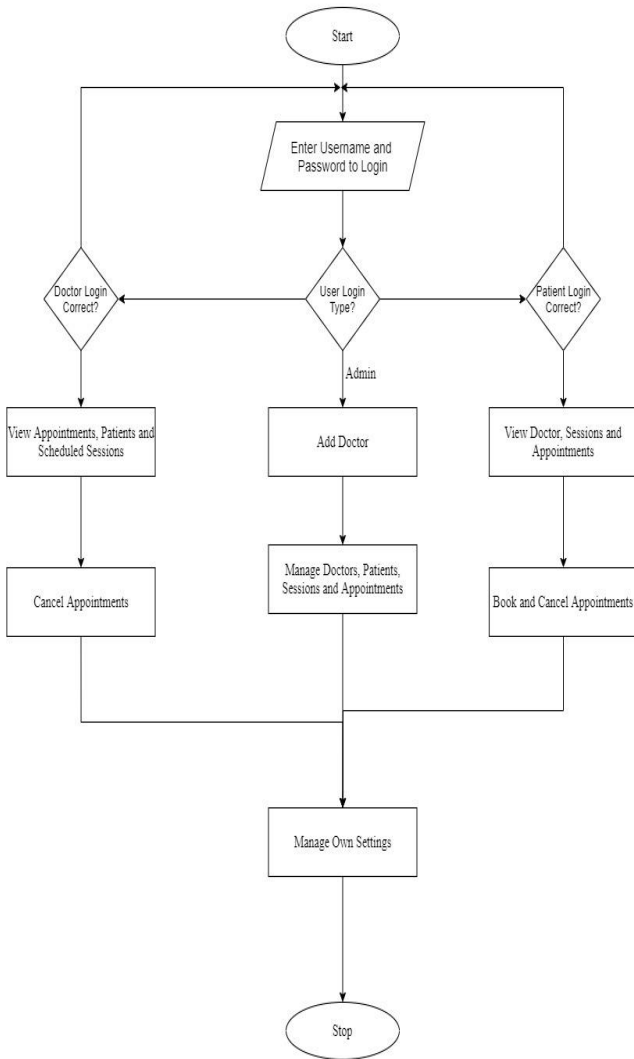


Fig. 5: Flowchart diagram for the health care delivery system

4.0 Results

The smart health system was developed and experimented. Experiments on the three Modules representing the Administrative, Doctors, and the Patients were successfully carried as prove of concept showing the roles of each module, as shown in Fig. 6, Fig. 7, and Fig. 8 respectively.

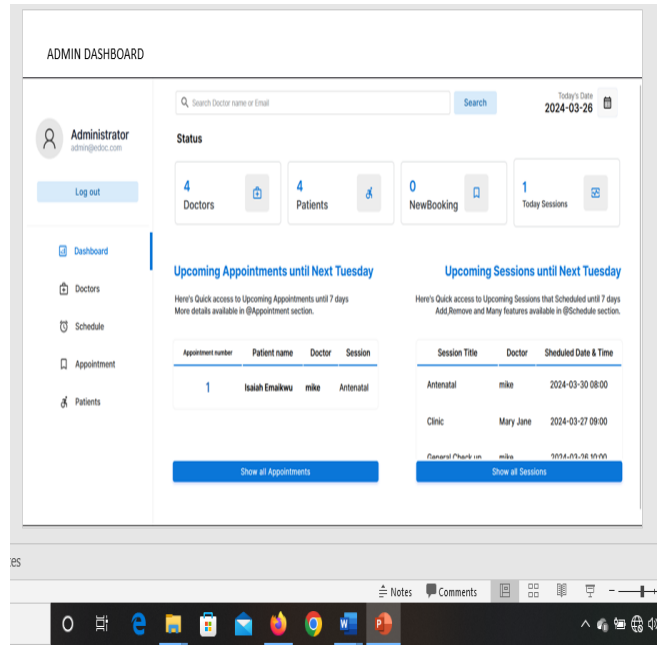


Fig. 6: The Administrative Personnel role dashboard

From Fig. 6, the administrative personnel can capture patients' data, assign them to doctors, determine next sessions, and monitor daily sessions for effective health service delivery.

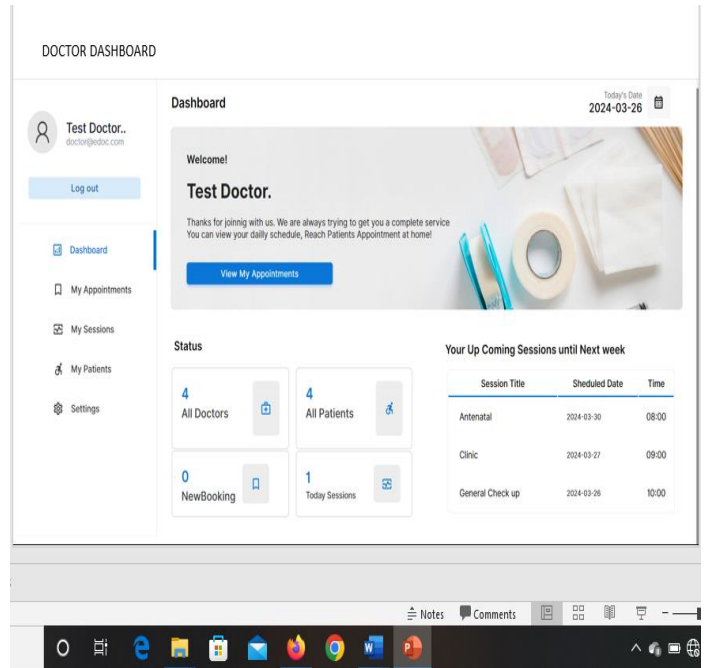


Fig. 7: The Medical Doctor role dashboard

Fig. 7 displays doctor's number of assigned patients, available sessions, upcoming appointments, and current sessions, enabling the doctor proper planning and management of patient session.

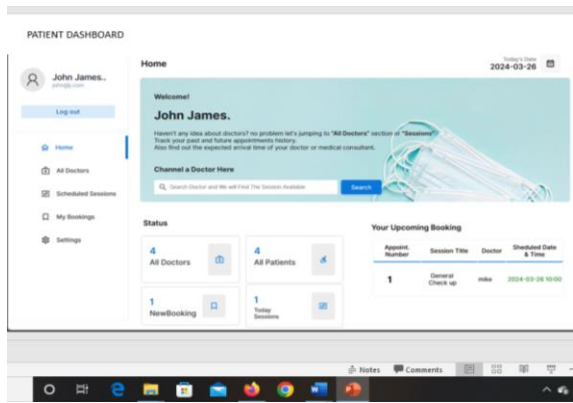


Fig. 8: The Patient dashboard

Fig. 8 demonstrates the patient booking, appointment with the doctor and the 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, the Medical Doctor module, and the Patient module. It was demonstrated that the administrative staff was able to assign roles, sessions, approve patients' appointments and manage all the activities of the health care delivery system. 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 also view their sessions 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 Recommendations

A feature of modern state administration is the need for closer contact between the individual, citizen and officialdom (Smith, 1985). In other words, it is imperative for state administration to maintain a closer interaction with the citizens. This is more so as citizens require accountability and responsiveness on the part of those who govern them (Quadri, 2017). 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.

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