A FRAMEWORK FOR MOBILE HEALTH CARE DELIVERY IN DEVELOPING NATIONS: A CASE STUDY OF NIGERIA

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Abstract
Health systems in developing nation especially low and low-middle income countries is characterised with numerous challenges which ranges from inefficient health information system, poor health delivery system, mortality and morbidity rate of disease and ailments, inadequate health manpower etc. The growth of ICT especially in developing nations has been on the increase bringing about a lot of invention amongst which mobile technology is one. Mobile technology as a significant ICT tool has the ability of penetrating into both the urban and rural areas and bringing about disruptive changes and development. The impact of technology has being seen in health system to bring across innovative inventions like telemedicine, telehealth, e-health, m-health and has provided solutions to diverse health challenges. This paper presents a mobile health (m-health) framework for providing promising sustainable healthcare services and health related information in developing countries using supporting technologies & tools support based on availability, ease to access, and affordability.

Keywords: m-health, mobile technology, USSD, mobile-app, SMS,

INTRODUCTION

The revolution through technological innovation has brought about a more effective means of delivering health care through the use of digital devices. The uptake of mobile technology in developing countries has been remarkable (Sife, 2010) this development has caused need to be exploited by several stakeholder ranging from health service providers to government and non government agencies in providing solution to challenges in both rural and urban areas of developing countries. This devices have been useful in many ways like providing interactive medium between patients and service providers like auxiliary health workers, medical professionals (Mahmud, 2010), reporting of emergency cases (Redha, 2015), awareness of health programs (Seebregts *et al.*, 2016), improving vaccination coverage (Uddin *et al.*, 2016) etc.

Mobile technologies have been incorporated into health services which gave rise to a term called m-health. M-health describes the utilisation of wireless technologies to transmit and enable various health data contents and services which are easily accessible through mobile

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devices such as mobile phones, Smartphone and other mobile devices (Kamsu-Foguem, 2014).

Health system in developing countries are plagued with several shortcoming like infrastructural deficiencies (Xiao, 2013), limited access to healthcare, medicare and health care workers (Scheffler, 2009). Considering other challenges facing Nigeria, it is obvious that health care is one of the major challenges considering healthcare indicator evaluation. This is practically evident in the rural areas which are susceptible to epidemics, lack of adequate healthcare infrastructure as well as other vulnerabilities (Senanu & Omatseyin, 2014). Nigeria as the most populous country in Africa (Worldometer, 2017) has some factors like ease of access to mobile phones by individuals, availability of network related service such as internet coverage, operator service etc that favours the use of m-health as a tool in providing solutions to health challenges in Nigeria.

LITERATURE REVIEW
There are several literatures on m-health but few would be reviewed in this study.
 Mobile Health (often shortened to m-health) according to the World Health Organization (W.HO., 2011) is the medical practice with support of mobile devices, like cell phones and other wireless devices, including the use of cell phones functions like audio, messages, Bluetooth and other services.

M-health emerged as a sub-segment of e-Health, which consists on the usage of information communication and technology to assist healthcare services (Albabtain, 2014). It also involves the delivery of healthcare services via mobile communication device (FNIH, 2012). M-health as a tool involves mobile technology e.g. Smartphone, PDAs, other handheld device, wireless technology e.g. internet, operator network and it is aimed at medical support and health care services. M-health is broadly defined as a service or mobile application for providing healthcare support to anyone, anytime, and anywhere (Varshney, 2014).

Also m-Health has presented a great medium of increasing access to care, decreasing costs, improving quality of health services, engaging the patient through the use of mobile technology (West, 2012). M-health application area includes education and awareness, remote data collection, remote monitoring, communication and training for healthcare workers, disease and epidemic outbreak tracking, diagnostic and treatment support etc.

M-Health Innovation
The rapid development of ICT (information and communication technologies) has brought about advancement or development cutting across different sector ranging from business, agriculture, transport etc. The advance of mobile technologies is very much on the increase bringing about the advent of dominant handheld technologies that includes mobile devices like mobile phones, tablets, portable PCs. Mobile technologies have been incorporated into health services which gave rise to a term called m-health. M-health area is on the increase, because of advances in mobile devices technology. The proliferation of mobile technology has demonstrated strength of breaking the barrier of penetration into service-deprived area.

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M-health has provided medium for consumers, responsive to individual profiles combined with internet opportunities for new types of innovations that are consumer-oriented and enable new forms of community-based provision, this has engendered innovations in the ways healthy lifestyles and well-being can be supported, while linking technologies for health, health professional and individuals in social care systems (Hwang, 2016).

M-Health Services

M-health services includes services that can be offered via m-health framework ranging from health call centres, emergency toll free telephone services, managing emergencies and disease outbreak, treatment compliance, mobile patient record and information issues etc.

M-health services involves coping with various need and demands of a population, providing healthcare to individuals and community with preventive and curative activities also utilizing healthcare workers (Sharma, 2015). M-health services could be preventive, curative, restorative and promotive (Stevens' model of health delivery, 1952). M-health services could be deployed through various channels e.g. web, mobile-app, SMS, USSD, sensor enabled garment or device etc.

M-Health Ecosystem

There are wide varieties of health care system around the world, but it is paramount to note that the design and development of health care systems should in accordance to a nation's needs and available resources. M-health ecosystem shows the concept of interaction between different stakeholders bringing about mutual benefit relationship. The stakeholder includes health care provider like medical doctors, nurses, pharmacists, rural health workers etc; service providers e.g. operator network, internet providers, insurance bodies software developers; government and non government organizations. The ecosystem helps to create a sense of understanding the challenges with healthcare needs, delivery of healthcare services and the creation of suitable business models. It also helps to create a multi-sector partnership of adopting and creating m-health innovations, improving the quality of healthcare delivery, fostering of partnership in achieving health goals and objectives of a nation.
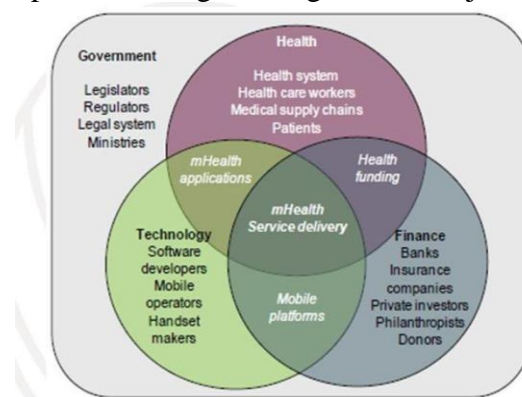

Fig 1: Diagram showing m-health ecosystem of interacting stakeholders and the goal of healthcare delivery (**ITU Experts Group Meeting on m-Health: Towards Better Care, Cure and Prevention in Europe**, Geneva, Switzerland)
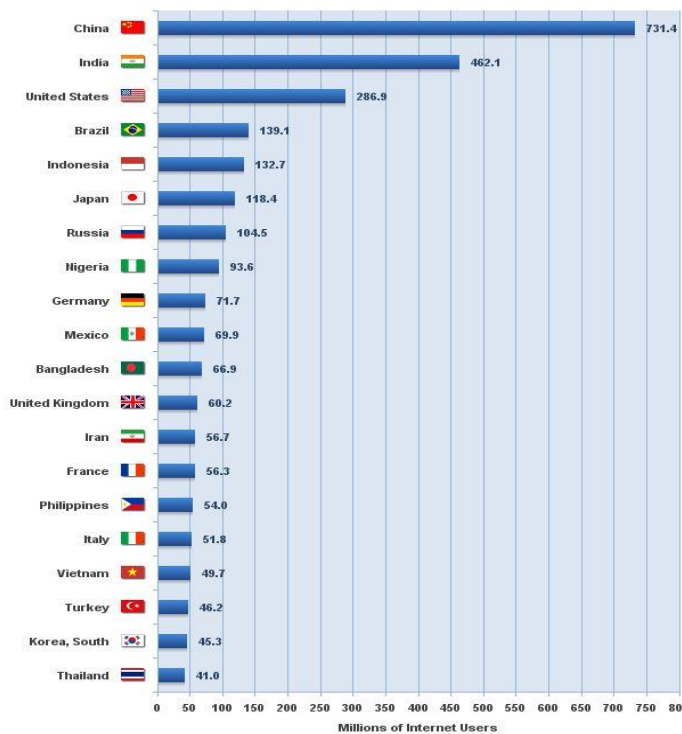
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Motivation for m-Health
There are several factors that favour the need for m-health use in Nigeria. The availability and accessibility to mobile phones, the penetration of mobile phone networks in many low- and middle-income countries surpasses other social infrastructure such as paved roads and electricity (W.H.O, 2011).

The Nigerian communication commission report in the first quarter of year 2016 and 2017 showed that active phone lines usage increased from 148.78 million in the first quarter of the year 2016 to 151.999 million in the first quarter of the year 2017 which is about 102.2% increase.

	OPERATOR	Mar'17	Feb '17	Jan '17	Dec '16	
Connected Lines	Mobile (GSM)	235,941,553	235,532,689	234,599,704	231,601,485	2
	Mobile (CDMA)	3,586,095	3,586,095	3,586,095	3,586,095	
	Fixed Wired/Wireless	340,895	340,566	340,465	352,045	
	VoIP	139,483	126,962	116,647	59,236	
	Total	240,008,026	239,586,312	238,642,911	235,598,861	2
Active Lines	Mobile (GSM)	151,999,197	153,661,547	154,660,446	154,124,602	1
	Mobile (CDMA)	217,566	217,566	217,566	217,566	
	Fixed Wired/Wireless	152,500	151,500	151,088	154,513	
	VoIP	97,935	89,871	84,447	33,099	
	Total	154,467,198	154,120,484	155,113,547	154,529,780	1
	Teledensity	108.91	110.09	110.80	110.38	

Fig 2: showing NCC monthly subscriber technology data from Dec 2016 - Mar 2017
(www.ncc.gov.ng/stakeholder/statistics-reports/subscriber-data)

Secondly, daily increase in the number of internet users; the internet world stats in the year 2017 rated Nigeria amongst the first top 20 countries with the highest internet usage.

Country	Millions of Internet Users
China	731.4
India	462.1
United States	286.9
Brazil	139.1
Indonesia	132.7
Japan	118.4
Russia	104.5
Nigeria	93.6
Germany	71.7
Mexico	69.9
Bangladesh	66.9
United Kingdom	60.2
Iran	56.7
France	56.3
Philippines	54.0
Italy	51.8
Vietnam	49.7
Turkey	46.2
Korea, South	45.3
Thailand	41.0

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Fig 3: showing world internet usage as of 31ˢᵗ march, 2017 (Internet world Stats – www.internetworldstats.com/top20.htm)

Overview of Healthcare System in Nigeria

The structure of healthcare system in Nigeria is controlled and engaged by three groups namely the federal government tier, state government tier and the local government tier. The structure allows various tier of the structure to address designated roles and responsibilities. The 774 local governments oversee the operations of primary health care facilities within their geographic areas forming the basic means of delivering health care. This includes the provision of basic health services, community health hygiene and sanitation and other health initiatives.

Health Care SERVICES

Could be primary care which includes preventive and wellness care e.g. patient education, vaccination programmes etc, secondary care which includes curative, diagnosis, early treatment to prevent further havoc by disease e.g. medical scan, surgery, mammograms etc, and tertiary care which is aimed at restorative, rehabilitative to restore individual to optimal level of health e.g. therapy programmes. In spite of efforts shown by the Nigerian government to provide healthcare solutions across the tier of health system; this involves health initiatives like NMCP (Nigeria malaria control programme), PMI (President Malaria initiative), NPHCDA (Primary Health Care Development Agency), PHCUOR (Primary Health Care Under One Roof), NHACT (National Health act) and many more, the performance of this programmes show that there is still a need for optimization of healthcare services.

Need for m-Health in Nigeria

There are different needs for m-health structure in Nigeria. This paper makes some review on some identified gap in the health system.

Health system in Nigeria is characterized with

Inadequate healthcare delivery platform: this involves the use of platform that gives access to health informatics, inefficient administrative and health management system especially in rural areas of Nigeria. Some general hospitals (secondary level of facilities) managed by some state governments across the country are unable to effectively deliver even primary health care services on a 24-hour basis, let alone serve as referral centres to lower level facilities (Ijadunola, 2012).

Inadequate m-Health platform to cater for the deficiency caused by low health-care force in the utilization and sharing of available medical resources and information The average health centre that offers delivery services in any part of Nigeria employs one or no midwifes large number of unskilled attendants and aids (cleaners and health assistants) who man the facilities and continue to provide supposedly technical services without the necessary training and expertise (Ijadunola, 2012; Omoluabi, 2014).

Attainment of health related Millennium Development Goals

There is a global need to achieve health related Millennium Development Goals (MDGs) by 2015 when actually at the current pace of their services, the MDG targets

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cannot be met in 2050 (Women deliver conference., 2007). Also there is a global need to achieve sustainable development goal (goal 3) which is to ensure healthy lives and promote well being for all at all ages (Lim *et al.,* 2016).

The health part of the Nigerian vision 2020 states that there will be a need to enhance access to quality and affordable healthcare through the establishment of at least one general hospital in each of the 774 local government areas in the country with each hospital having specialists in surgery, paediatrics, medicine, obstetrics and gynaecology. Teaching hospitals, federal medical centres, specialist and general hospitals will also be well equipped and the vision elaborates its possibility by the use of information & communication technology.
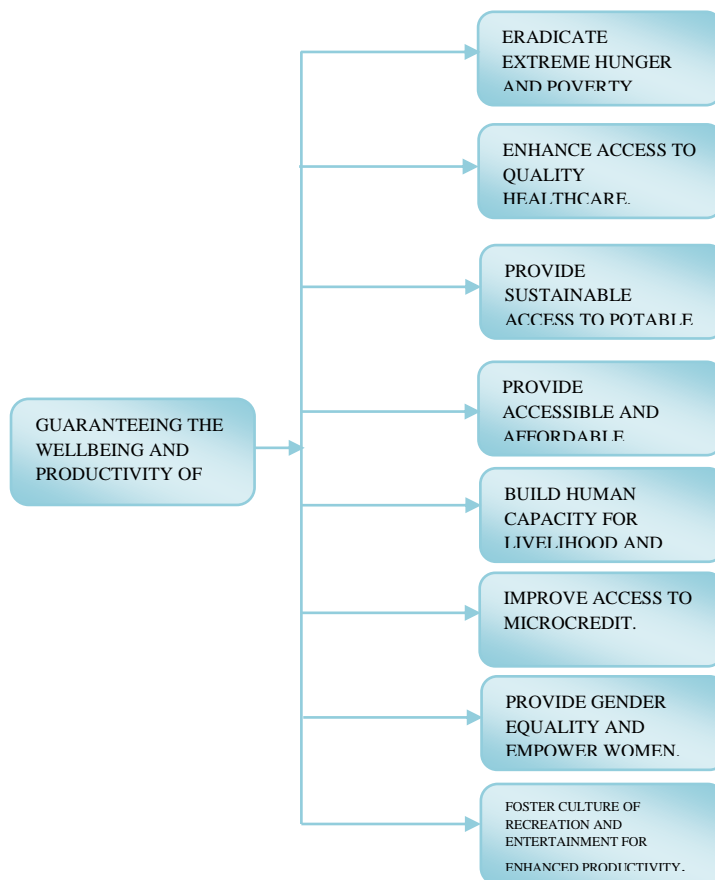

FIG 5: Diagram showing the main goal and aims of Nigeria's Vision 20:2020
(National Planning Commission. (2009). Nigeria Vision 20: 2020. Abuja: NPC)

Lastly, Nigeria is not doing too fine based on performance of health indicators by world health organization (Emuakpo *et al.,* 2010).

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Table 1: Compiled stats from world health organization report between 2015-2017

Health indicator	Mortality rate
Maternal mortality (Per 100 000 live births (lb)) year 2015.	814 Per 100 000 live Births.
Infant mortality (2016).	68.86 Per 1000 births.
Infant mortality (under -Age 5 2016).	127.10 Per 1000 births.
Life expectancy (2016).	Life Expectancy 53.67 years. Male: 50.48 years. Female: 57.06 years.
Cancer mortality (2017).	80,000 death cases in Nigeria.
Malaria mortality (2017).	300,000 death cases in Nigeria.

Table 2: Similar m-Health Intervention in Developing Nations

Project	Method or Technology used	Summary
Safer Mom (Nigeria)	• Web App. • Mobile App. • SMS. • Voice service.	• Platform that monitors and track pregnancy and babies' development.
Mom Connect (South Africa)	• SMS. • USSD. • Mobile website.	• Platform to meet M.D.G 4 and 5. • Platform allows pregnant women to reach out with pressing questions and get feedback. • Was used as platform to improve service at health care facilities.
MTrac (Uganda)	• Toll free MTrac SMS hotline 8200.	• SMS based technology connecting hospital to the national drug chain. • Inadequate health personnel and drug shortages.
MSos (Kenya)	• SMS. • Web portal.	• Text message facility that allows real-time communication between health facility workers and disease surveillance coordinators at sub-county, county and national levels.
Medic network (Malawi)	• Frontline SMS.	• Facilitate two way communication interactions between CHW.
Project Masilukeke (South Africa)	• SMS	• Health education and awareness programme (one million messages per day to subscribers to encourage HIV/AIDS testing.)

METHOD

The proposed framework for m-health in Nigeria would consist of the following:

SMS platform: SMS stands as an acronym for Short Message Service. It is also commonly referred to as a text message. It is a platform for no or low cost method for information

delivery. This platform would be mainly for the users. When users receive general broadcast messages like education and awareness system, medical response to user's enquiry etc; it would be a free service, but when users are making enquiries for some particular service like consultancy they would be charged.

USSD platform: USSD stands for Unstructured Supplementary Services Data. It is a telecom standard that provides a platform for users or subscribers to communicate with operator nodes for services. The USSD platform would also be for both users in the urban and rural areas. It is a complementary service to the use of SMS; it is a menu based and more interactive platform for delivery health care services to users.

Mobile web Application platform: The mobile web functions through rendering html web pages and are run by a browser on mobile or handheld devices and are accessible to users through the unique URL via internet. They are similar to native applications installed through distribution application store such as Google Play or Apple's App Store on the device. The mobile web platform provides the rich interface of varieties of health care service for users. It can also be accessed by rural dwellers where there is internet coverage. It includes the users and medical personnel's portal.

Web Application platform: very similar to mobile web application platform, but differs in that it is built majorly for PCs. This channel can also be accessed through browser on computers through the unique URL via internet. It also includes the users and medical personnel's portal.

Voice platform: This includes service to cater for the rural dwellers with low illiteracy level with the inability to use other platforms. It would cater for real-time interaction for emergency or disaster scenario e.g. accident cases. It could be toll free or not; depends on the service providers.

The user of this platform includes the patient, rural and urban health workers and health professionals, while stakeholders include government and non government agencies, operator service providers, voluntary groups etc, as seen in fig 1.

PROPOSED FRAMEWORK

The proposed m-health framework is illustrated in Figure 6. The framework is divided into three parts: the Client layer, the application layer and the data layer.

The client layer consists of users' available medium of connectivity such as phone, PC, tablets and the users involved. The application layer consists of the access layer and the m-health application function such as e-consultation, education and awareness, moderator whose responsibility is to ensure effective coordination etc. Finally, the layer consisting of repository of data. In between the client layer and the application layer is the medium of access between the devices and the application servers.
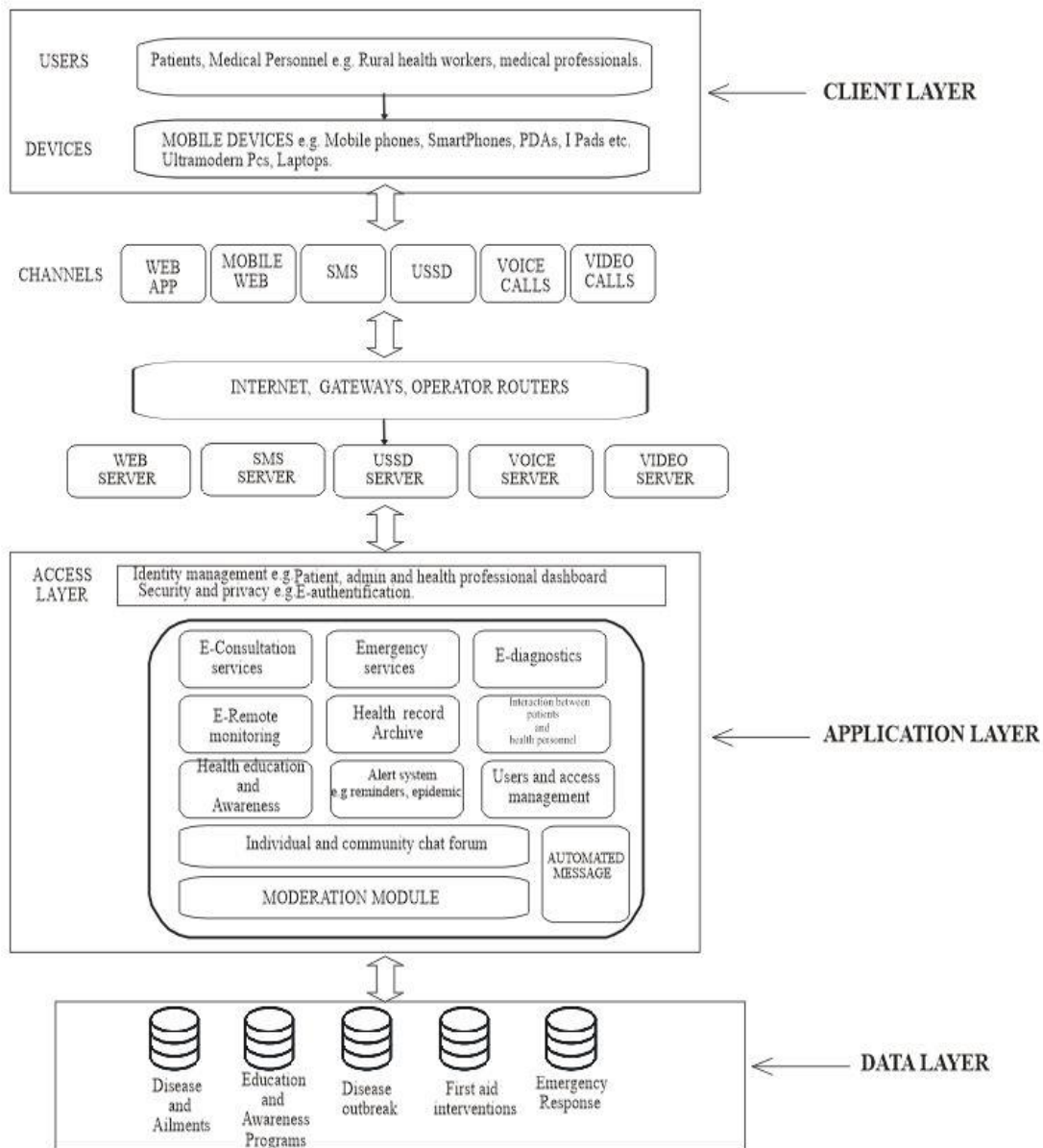
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FIG 6: diagram showing a proposed m-health Framework.

Overview of the steps involved in the actualization of this framework prototype.
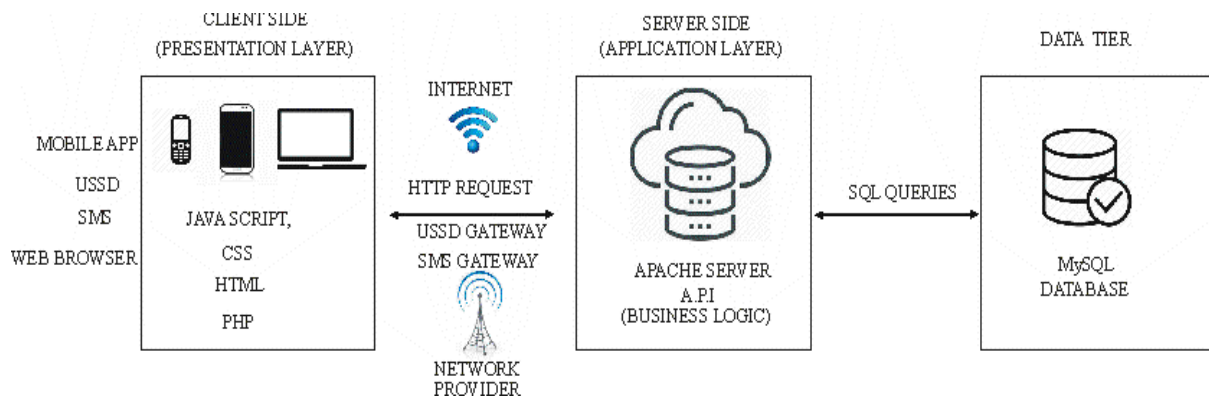
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Fig 7: A three Tier architecture of the proposed system
Adapted from Mobile based primary health care system for rural India (Rahar, 2011).

Mobile App development
The mobile application could either be the native application or mobile web. It involves the use of technologies or tool like JAVA on android platform or the hybrid application development.

Web App development
It involves the use of tools like HTML, CSS, PHP, JAVASCRIPT, AJAX etc. HTML is a language for describing web pages. HTML stands for Hyper Text Markup Language, HTML is not a programming language it is a markup language containing set of markup tags used to describe web pages. CSS is comprised of statements that control the styling of HTML documents. JavaScript is a scripting language designed to add interactivity to HTML pages.
A JavaScript is usually embedded directly into HTML tags. Ajax (Asynchronous JavaScript and XML) is a web development technique for creating interactive web applications. It helps to make web pages more responsive. PHP is a server-side html-embedded scripting language that fits into HTML with tools for creating dynamic websites.

SMS, USSD and Voice platform development
This process is either of two steps: the developer could build the interface and the gateway interaction or both be implemented by the operator service provider.

CONCLUSION
Following the factors that drives the deployment of m-health in Nigeria; factors include wide penetration of the mobile phone network, availability of mobile devices, also the need for m-health and identified health care inadequacies in the health system of Nigeria. M-health has been used to proffer solution as seen in similar healthcare interventions in developing nations; therefore it has the potential to help address the health gaps in Nigeria and especially for addressing patients and health workers in remote locations.

M-health can bring about a paradigm change and increase in the potential of health workers to improve the quality of health care service delivery through timely health intervention,

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information dispersal, facilitating interaction means with medical professionals etc in achieving healthy lifestyle. Also m-health offers a promising structure and solution in the health sector therefore it would be a wise choice to consider its implementation in building a smarter and healthier society.

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