Tackling Antenatal Health Care Delivery System in Nigeria through Persuasive Technology

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Abstract

The advent of various diseases and epidemics has made the health care system a major cause of concern for people all over the world recently. In Nigeria, the medical system is currently plagued by a dearth of quick, precise, and dependable software solutions that may aid medical professionals in making judgments that would address critical and, in some cases, complex medical issues in real-time. Furthermore, handling and analyzing massive amounts of data in a medical setting is costly and time consuming. In order to provide crucial health advice to expectant and nursing women in rural areas, this study will create and implement a novel hybrid persuasive technology. Object Oriented Analysis and Design Methodology (OOADM) were adopted in the design of the system. The system achieved integration of various patients' medical records from different hospitals.

Keyword: *Africa, Ante-natal health, Communication Technology, Health-care, Index Terms—component, formatting, style, styling, insert*

Introduction

Persuasive technologies (PTs) are interactive systems that are designed to encourage people to modify their behavior without resorting to coercion or deception. Antenatal care is the medical attention given to pregnant mothers to ensure a healthy pregnancy and newborn. Antenatal care is a major contributor to the high maternal mortality rate and one of and globally

Maternal health care is experiencing financial difficulties, and there are pressures to cut costs. A demographic shift is taking place in several countries, particularly in the Western world, with

economic and social ramifications. Ehealth systems have been viewed as a solution to health-care issues, yet many e-Health technologies fail to deliver long-term changes in health-care practices (Matthew, Harris, et al., 2016). Persuasive systems, it has been said, have the potential to aid in enhancing healthy living, lowering health-care costs, and allowing young moms to live more independently. Technology has the ability to give dynamic and unbiased information processing, allowing people to measure their own progress and stay informed about what's going on around them, as well as the dangers associated with changing environments. Because they are interactive and may adjust their persuasion methods based on the actions of users, systems have many advantages as persuaders. Traditional media, such as newspapers, television, and radio, have never been able to provide this kind of involvement. They also have a number of advantages over human persuaders, including persistence, confidentiality, the ability to manage massive volumes of data, the ability to influence people using several modalities, scalability, and accessibility. Support for behavior change can be found in e-Ante-natal Health systems. Support for lifestyle changes and thus lead to cost savings in health care as well as improvements in the quality of life. As a result, new approaches for designing and evaluating Behavior Change Support Systems (BCSSs) in the ante-natal Health sector are required. As a result, the focus of this research is on the development of persuasive systems. It introduces a paradigm for developing and assessing BCSSs, as well as their relevance to ante-natal healthcare.

Aim of the study

The aim of this study is to design and implement a novel and hybrid persuasive technology for antenatal health that will offer vital health tips to pregnant and nursing mothers in the rural areas.

Specific Objectives of the study

a. To develop a system that will withstand component failure and, at the same time, offer health information to rural women.

b. To tolerate the addition of new capabilities without major changes to the underlying architecture.

c. To provide a the critical understanding of what restricts information transfer among rural women in terms of health care practices and how it can be addressed by applying persuasive technology to the design of health information systems.

d. To increase their perceived behavioral control in the face of social beliefs of the user. The intervention program's goal is to promote positive change and/or improve and enhance knowledge, awareness, and comprehension through the dissemination of sound health related Information and the utilization of interactive web-based components.

Research Questions

1. What are the objectives and content of the persuasive technology for antenatal health care?

2. What are the architectural and software requirements specifications for the persuasive technology?

3. Develop a working persuasive app for the antenatal health-care system.

4. Test the developed persuasive technology. Functional Triad Persuasive Model:

This existing model has three categories of sources of intents since the computer has no intent of itself. These sources are:

i) Endogenous intent comes from the designer or producer of the system. An example would be the PISA tool, where the designers already have the intention to persuade;

ii) Exogenous intent comes from the distributor of the system: if one person gives a computer technology to another with the intent to persuade, this falls under the category of exogenous intent. An example would be educational software distributed by schools;

iii) Autogenous intent comes from the user itself. Examples of these would be fitness training programs that the user has started using from his/her own volition to become more. These motivations are not mutually exclusive but serve to put persuasive technologies in a context.

The Functional Triad by Fogg reasons that Persuasive Technologies come in three forms: as a tool, a medium or a social actor:

i) Tools enable and/or assist the user in performing a task. Examples of tools are calculators or word processors.

ii) Mediums convey" symbolic or sensory content" to the user. Examples are videos or simulators.

iii) Social Actors adopt animate characteristics, roles and/or social rules and dynamics. An example is electronic avatars/agents such as Microsoft Word's (in) famous paperclip.

Healthcare Persuasive Technology

In the field of healthcare, persuasion technology is used to persuade people. In Healthcare, Persuasive Technology is becoming more important in the design of mobile applications for healthcare (Wang, et al., 2018). Voice calls and text messages were the most common methods of communication for mobile health interventions. However, Greater smartphone access resulted in increased creation and use of smart phone applications (apps), and increased app availability and ease of use resulted in a large increase in the number of smartphone apps that can be used to modify health behavior(Wang, et al., 2018). Voice A review of the literature revealed an adaption of (Wang, et al., 2018). Voice and Fogg (2002). extended their capotology paradigm to cover healthcare subdomains. The relationship between technology for behavior modification, persuasive methods, and behavior theories that must be used, as well as the domains in health care where a combination of these components can have a positive impact, is depicted in this framework. See Figure 2 below

The essential components of maternal care on which mothers and babies rely for survival. Thus, ante-natal care is a critical component in improving maternal and child health. Inappropriate ante-natal care has been linked to negative outcomes in many studies. To reduce maternal morbidity and death, the World Health Organization's technical working committee recently suggested that women receive at least eight visits throughout their pregnancy.

Several studies conducted in various countries on demographic and socio-cultural factors influencing maternal health care service user have revealed that maternal age, number of living children, quality education, place of residence, occupation, religion, and ethnicity are all significantly associated with antenatal care use (Ali SA, Dero AA, Ali SA, et al.).

The availability of antenatal care (ANC) services is very poor. In many parts of the world, the risks and difficulties that can arise during pregnancy and childbirth are poorly known, and women continue to lack access to required medical care. Community health workers' major responsibility is to keep an eye on young children, improve their nutrition, and promote cognitive development. As a result, the current Nigerian health-care system employs a change-agent approach, with Community Health Workers monitoring and persuading people in their communities to enhance antenatal, maternal, and child health. E-Maternal Health refers to a new way of leveraging ICT to deliver services and improve health care locally and regionally.

Figure 2.0 Healthcare sub-domain:

Persuasive Technology in Healthcare (Fogg, 2002); similarly, Chatterjee and Price (2009) used the terms interactive behavior-change technologies (I.B.C. Ts) and Digital Behavior Change Interventions (D.B.C.I) to describe the use of digital technology to promote and maintain health through the prevention and management of health problems. Autistic healthcare and communication systems, as well as mobile, wearable, ambient sensors, and Internet of Things (I.O.T) devices, are among these

A. **Process Indicators in Maternal Health**

It is difficult and expensive to collect information and data on maternal mortality ratios and rates. Furthermore, the indicators frequently fail to detect change over a short period of time or to provide clear signals of what measures should be taken to remedy the situation. These include:

i) The proportion of women who receive antenatal care;
ii) The proportion of women who give birth in a hospital
iii) Percentage of women who have a skilled attendant at the time of delivery
iv) Caesarean section rate
v) Comprehensive and critical obstetric services per 500,000 peoples.

B. **Behavior Change Support Systems (BCSS)** can be characterized according to Yardley and Spring|(2016) as follows:. A behavior change support system (BCSS) is a socio-technical information system that uses psychological and behavioral consequences to establish, alter, or reinforce attitudes, behaviors, or an act of compliance without the use of coercion or fraud..As the state-of-the-art conceptualization for creating and developing BCSSs, the PSD model presented in this doctoral dissertation is related to the BCSS research model. BCSS offers information and features that encourage people to try new behaviors, make them simple to do, and assist them in their daily lives (Yardley & Spring, et al. (2016). Persuasive technologies were initially established

When behavior change and technological advancement were combined for the first time. The term captology was coined from the phrase "computers as persuasive technologies," and it referred to a field of study that focused on "the creation, investigation, and analysis of interactive computing products produced to change people's views or behaviors" (McKay and Cheng, 2016). The phrase" persuasive technology" quickly replaced the acronym" captology." Any new technology is not inherently compelling, just as not all communications are. Persuasive technology isn't concerned with any unintended changes in attitude or behavior, but rather with the results that are intended. As previously said, true persuasion necessitates the desire to alter one's views or behaviors, therefore not all behavior change is the product of persuasion (McKay, Cheng, et al (2016). When it comes to the invention, dissemination, or adoption of persuasive technology, there is always an element of intention (McKay, Cheng, et al., 2016). Because technologies do not have their own purposes, those who invent, distribute, or adopt them do so

with the intention of influencing people's views or behaviors. According to Fogg, there are three types of intents: endogenous (those who build the technology), exogenous (those who provide access or spread the technology), and endogenous (those who use the technology) (autogenous). Although the study of computers as persuasive technologies began in 1997, and various emergent gadgets, applications, and experimental projects debuted on the market in the decade following 1998, persuasive systems are not a completely new phenomenon (Fogg, 2002). According to Fogg (2002)., persuasive technologies can be split into four generations.

1. Prescriptive systems first became popular around the late 1960s and early 1970s. They facilitated communication between the doctor and the patient by using cell phones and computer-generated pamphlets.

2. In 1985, descriptive systems were first introduced. They first delivered information and educational content through text-based systems, then in multimedia format, which became popular once the Internet, the web, and PCs were introduced.

3. In the year 1999, environmental systems began. In the utilization of body-worn sensors, context-aware technology, and real-time information interchange, they were more advanced than their predecessors.

4. In the year 2012, automated systems became available. Advanced automation techniques with minimum human intervention characterize these futuristic systems. Because numerous underlying factors favor the establishment of BCSSs, it is projected that the fourth-generation systems would be able to reach a larger user audience than previous generations. To begin with, Internet availability and use have become more widespread. In 2013, 79 percent of European households had Internet access, 76 percent had broadband, and more than 60. The potential user population of web-based services has grown as internet access and use have become more popular. People are mobile in addition to being linked to the internet. Mobile data traffic is skyrocketing, and individuals are increasingly opting for smartphones and tablets over traditional phones. Smartphones are predicted to account for more than half of all handset shipments in Europe in 2013, and this number is expected to rise. This is due to their low prices as well as the mobile applications they provide. http://epp.euro stat.ec. Through application stores, which are digital distribution channels for software, people can easily access a large range of programs.

Every major smart phone manufacturer has an app store (e.g., Apple AppStore, Google Play, Windows Store). Individual developers, start-ups, and research groups can quickly draw a huge number of users through this new distribution channel, which is beneficial for end-users who can purchase software at a reasonable cost. Mobile applications that are easy to integrate into daily life are perceived to have increasing value by users. http://epp.euro stat.ec. the potential user population of web-based services has grown as internet access and use have become more popular. People are mobile in addition to being linked to the internet. Mobile data traffic is skyrocketing, and individuals are increasingly opting for smartphones and tablets over traditional phones. Smartphones are predicted to account for more than half of all handset shipments in Europe in 2013, and this number is expected to rise. This is due to their low prices as well as the mobile applications they provide. http://epp.euro stat.ec., through application stores, which are digital distribution channels for software, people can easily access a large range of programs. Every major smartphone manufacturer has an app store (e.g., Apple AppStore, Google Play, Windows Store). Individual developers, start-ups, and research groups can quickly draw a huge number of users through this new distribution channel, which is beneficial for end-users who can purchase software at a reasonable cost. Mobile applications that are easy to integrate into daily life are perceived to have increasing value by users. http://epp.euro stat.ec.

What is Antenatal Health?

Every pregnant woman and newborn should get optimal care during pregnancy, labor, and the postpartum period, according to the World Health Organization (WHO). Antenatal care (ANC) is a crucial component of the reproductive health care continuum because it offers a platform for crucial medical procedures such illness prevention, screening, and promotion of good health. It has been proven that ANC can save lives by employing timely and suitable evidence-based procedures. At a crucial juncture in a woman's life, ANC crucially gives women, families, and communities the chance to interact and support one another. The process of creating these ANC recommendations has brought to light the significance of effectively communicating with pregnant women about physiological, biomedical, behavioral, and sociocultural issues as well as effectively supporting them in a respectful manner with social, cultural, psychological and emotional, support. These communication and support functions of ANC are key, not only to

saving lives, but to improving lives, health-care utilization and quality of care. The basis for a good pregnancy can be laid by a woman's positive experiences throughout ANC and childbirth.

Antenatal Outcome Indicators architectural and software requirements specifications for the persuasive technology?

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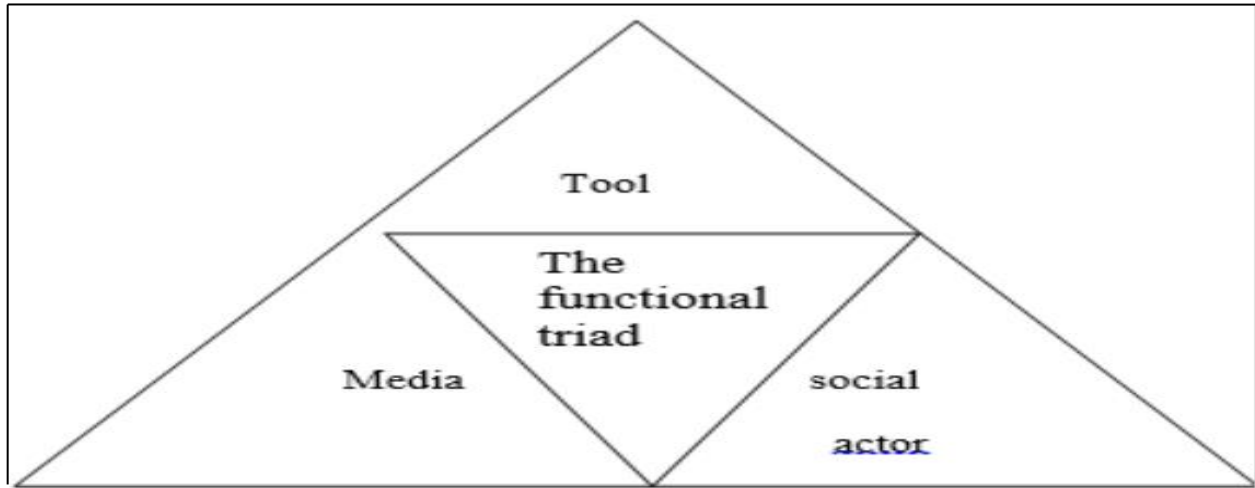
Fig 2.1The Functional Triad of Fogg (1997)

Persuasive Systems Design Model

The Persuasive Systems Design Model consists of two elements: a context analysis of the persuasive system and a classification of persuasive techniques that are in use or can be used by this system. The persuasion context consists of 3 elements: the intent (of the persuader), the event (that triggers the persuasion) and the strategy (by which the subject is persuaded). They are explained below:

i)   The Intent: This has to do with the persuader's intent and style. In the intent, the Persuader and the Change Type are distinguished:

ii)   Persuader: The person that tries to convey a persuasive message to the subject. This falls into the three categories described by Fogg in his Captology publications: Endogenous, Exogenous and Autogenous.

Change Type: These fall into the categories 'attitude' and 'behavior'. These correspond to the Theory of Reasoned Action's Attitude and behavior. As a result, attitudes are difficult to modify and have an impact on behavior.

i) The Event: The event is the context in which the persuasion takes place. This is considered by the authors to be an important part of the context analysis. The event consists of the use context, user context, and technology context. The problem is dependent on domain-dependent features of a system. Examples would be the features that should be present in a system that is developed

for reducing smoking specifically. In the context of PISA, this would be information security. Similar to the use context, the prospective or current users of a system should also be examined. Taking from the Elaboration Likelihood Model, some types of users have a low need for cognition while others have a high need. This would affect how messages are best presented to the user. A system utilizes specific technologies that offer features and impose restrictions on a system.

iii) The Strategy: Finally, the strategy examines how a persuasive system interacts with the user. As such, it considers two things, the message and the route: Message: The persuasive message's format and content are both addressed in the message. The message can use elements both of McGuire's Information Processing Model (i.e., describing how a message is structured and conveyed to the reader) and Cladding's Principles of Influence (i.e., using for example the principle of influence to structure the message).
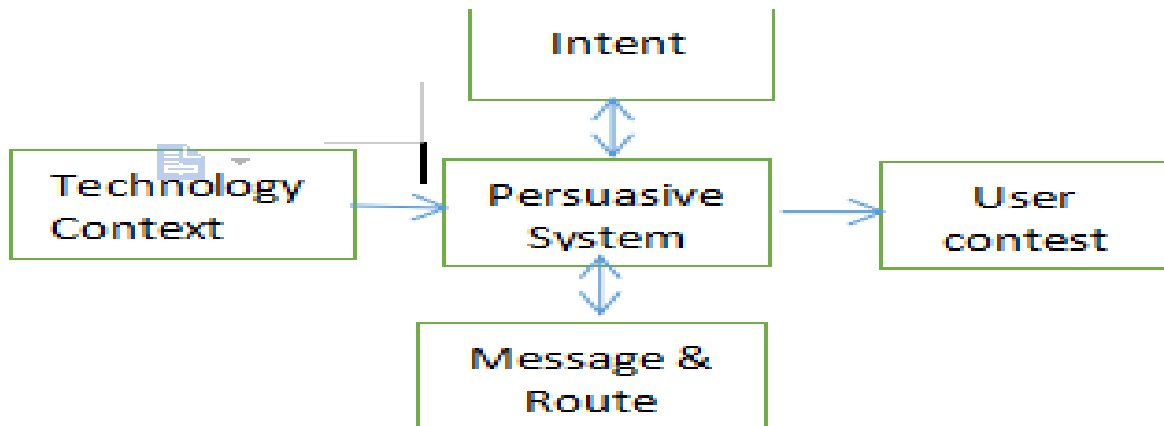
Fig. 2.3 Persuasive System Design Model

Source: Oina-kukkonen et al (2009)

High Level Model of the Proposed System features which may provide insight into user motivation that is independent of researcher bias. Likewise, sample sizing was a significant drawback identified while reviewing relevant research. Many studies failed to report on the sampling methods used and had sample sizes of less than or equal to 10 participants. The study by Blaauw, D., Penn-Kekana, L. (2010). featured only 19 participants while Foster Blaauw, D.,

Penn-Kekana, L. (2010). had only 10 participants. With sample sizes this small it is difficult to say that the results achieved are representative of a larger population. From our literature review and findings from the aims and objectives of the study, persuasive technology for antenatal health care was developed.
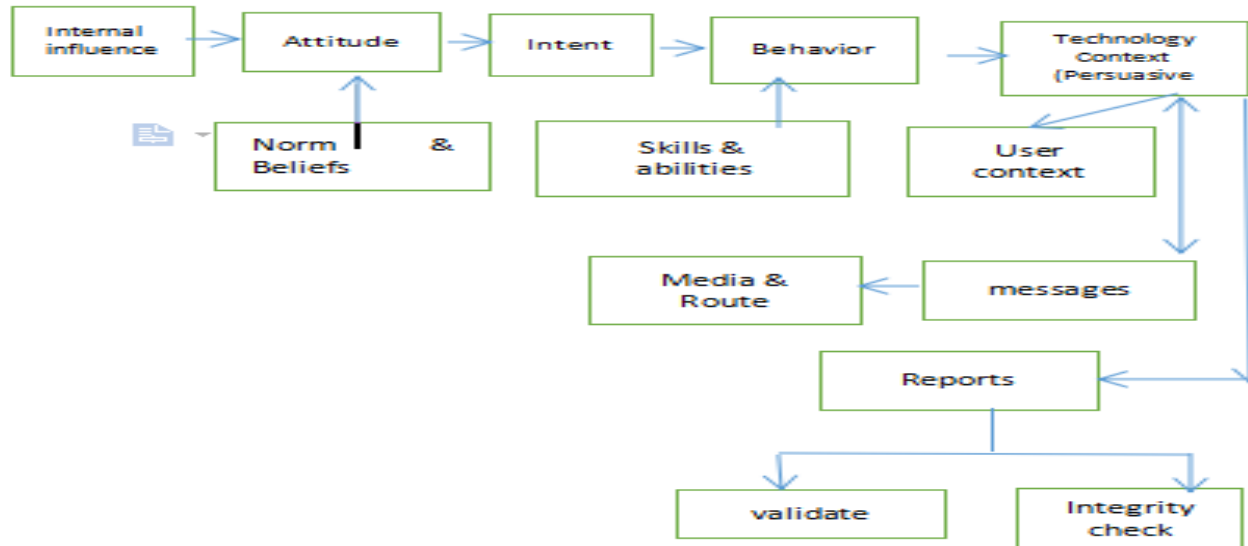

Fig.2.4: High Level Model of the proposed system.

Methodology

Two key methodologies have been adopted in this study:

1. Design Science Methodology:

2. Object-Oriented Analysis and Design Methodology

Design Science

The design science research approach has been chosen as the research approach of this doctoral dissertation, because it provides a methodology for finding solutions for a real-life BCSS development problem and producing research results that are relevant in practice. The design science research approach is well-suited to this task. Based on the Systems Development approach, design science research can be used as a means of better understanding a research domain and also to change the processes and products in the research domain. The practical relevance of the problem and the solution was defined.

The first activity in the design science research process is problem identification and motivation. During this activity it is important to define the specific research problem and to justify the value of a solution. It is important to study the state of the art of the problem and the importance of its solution. The second activity in the design science research process is the definition of the objectives of a solution. The objectives can be quantitative or qualitative. During this activity it is important to have knowledge of the state of the problems and possible current solutions and their efficacy the third activity in design science research process is design and development. The main objective during this activity is to create the artefact and to contribute to the research at the same time. These two activities of demonstration and evaluation are treated here as one activity, because the difference between them is open to interpretations. The objective of the demonstration is to show that the idea works and the artefact solves one or more instances of the problem. Several kinds of activities can be used in the demonstration, such as experimentation, simulation or case study. The sixth activity in the design science research process is the communication. Its goal is to "convey to academics and other relevant audiences, such as practicing professionals, where appropriate, the problem and its importance, the artefact, its utility and innovation, the rigor of its design, and its effectiveness.
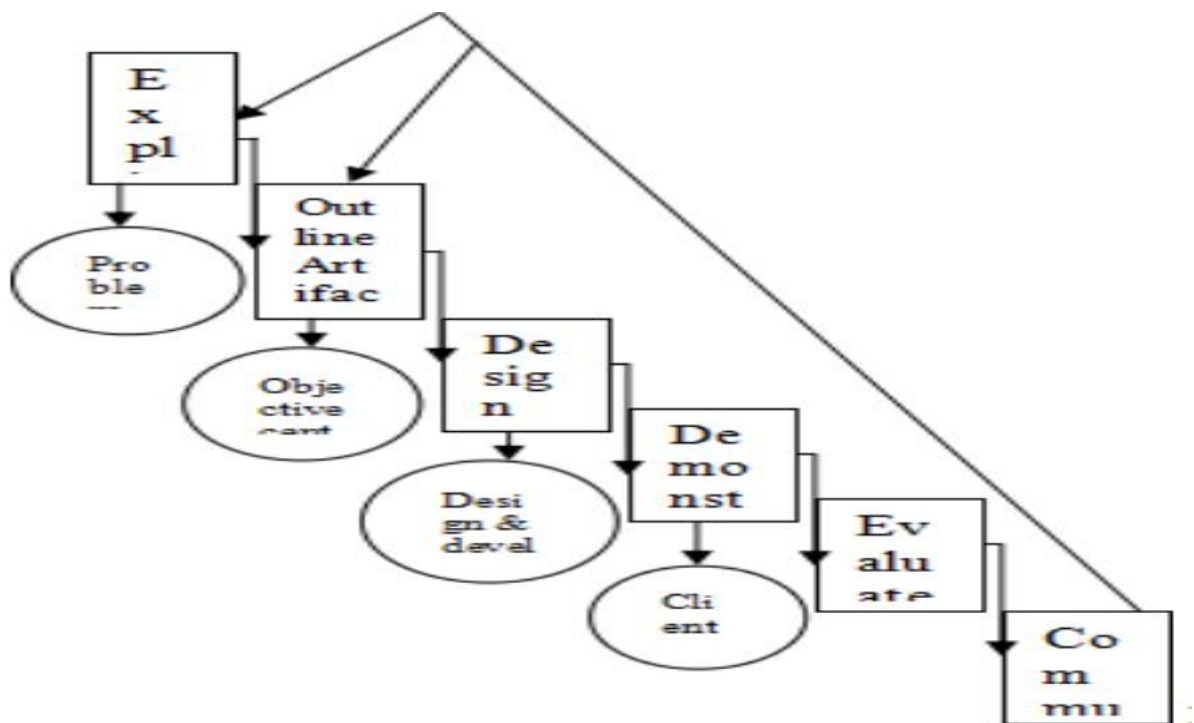
Fig 3.1: Design Science Research Process Model Source: Peffers, etal., (2007).

Object Oriented Analysis and Design Methodology Object-oriented analysis and design (OOADM) is a software engineering approach that models a system as a group of interacting objects. Each object represents some entity of interest in the system being modeled, and is characterized by its class, its state (data elements), and its behavior. These cooperating items' static structure, dynamic behavior, and run-time deployment can all be displayed using a variety of models. There are a number of different from our literature review and findings from the aims and objectives of the study, persuasive technology for antenatal health care was developed.

Objective of Design

The objective of the design of persuasive technology for antenatal health in Nigeria an innovative technology that can be used to monitor the maternal healthcare response of women in Nigeria and to integrate SMS-based persuasive messages that can serve as a reminder to women on the need to utilize the available healthcare services provided by the government to reduce the mortality rate in the country.

The objectives of the design include:

To implement an online electronic record of antenatal registrations of pregnant mothers with a unified medical record identification number. To model a relational database for storing and tracking antenatal visits of pregnant mothers with detailed documentation of tests carried out and observations. To electronically schedule the next visit date and monitor compliance through persuasive messages via SMS to remind the patient of the next appointment date To design a platform for recording child births for the purpose of tracking the immunization processes and dates To centrally profile mothers on their previous health records, child bearing, and various immunizations given to their children, Providers should provide online access to medical histories of mothers from any internet access point.
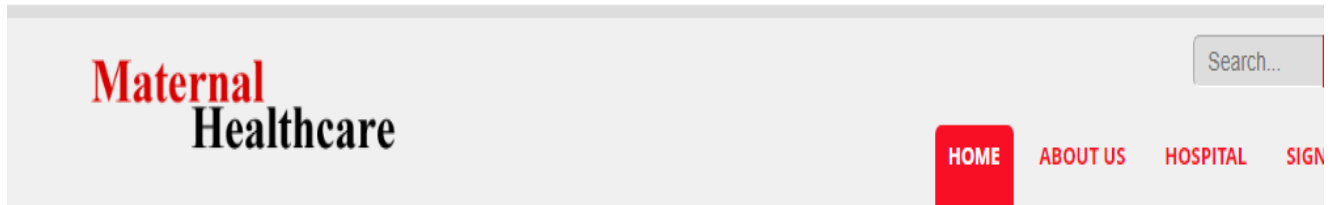
Database Design

The database schema was designed, preferring more tables in the database in favour of fewer columns in each table. By spreading data over more tables, it is hoped that more intricate correlations are possible. All table names start with the tbl prefix in order to avoid cluttering

other tables already defined in the current name space. Tables 4.1 to 4.9 show as can be observed by the types of the properties, the physical model is based on a real-world database product. During development, MySQL was used

Antenatal Registration Module

Hospitals register expectant mothers on the platform using this module. A unified medical identification number is generated during the patient's registration. All other information must be completed on the form before submission.

Fig. 4.0 Antenatal registration form

Antenatal Visit Module

This module is used to record activities or medical tests conducted during a patient's ante natal visit to the hospital. Only relevant tests for the day are expected to be recorded.

Persuasive Message Module

The module enables sending messages via a mobile phone to registered patients. It is necessary that the internet connections be turned on before the messages can be delivered.

Persuasive Message

Persuasive

Date

Time

Message

Recipients

Send

Close

Fig.4.1 Persuasive Message

Report Modules

The module enables users to select specified criteria for viewing reports on the platform. Most of the reports are retrieved using the card number of the patient. There are so many reports that can be accessed on the plat form, including antenatal

Records, birth registration records, immunization records, etc.

Registered Mothers Report

Phone	Surname	Firstname	Address	Email	Age	No of children	Occupation

Delete Module

The administrator can use this module to delete records from the database. The serial number is the access key for data deletion in the system. 4.2

fig 4.2 mot**hers output Report**

Input Format The input/output design for the persuasive technology for maternal health in Nigeria is as follows:

Login Form It also contains the login specifications for users on the platform, which include the username and the password. Once the specification is entered, clicking on the login button will validate the data before launching the user on the assigned subsystem. Persuasive message Form enables sending messages via a mobile phone to registered patients.

Login Form	
Login Form	
User Name	
Password	
Log In	Close

Fig.4.3 login form

Summary

The extension of information technology to modeling of the maternal healthcare system helped us to achieve the following:

1. Develop a database for each maternity center in Nigeria to record all the live and still births in the maternity.

2. Hospitals to register patients for antenatal online and keep track of antenatal visits before delivery. 3. Motivate mothers to go for antenatal visits or immunize their children by sending an SMS to them on a regular basis to remind them of their antenatal or immunization days and, by so doing, reduce mother-to-child mortality rate. It is expected that the system developed will assist in keeping track of all the records in maternity relating to the maternal healthcare system.

The records will also be made accessible to government and healthcare administrators so as to monitor and access the level of reduction or rate of mother-to-child mortality in a given region, state, or locality.

Results

Following the reviewed literature, it can be concluded that persuasive technologies are effective at promoting behavior change in relation to health sub-domains, as majority of reviewed studies reported positive outcomes. However, these studies placed more emphasis on effectiveness of persuasive technology in antenatal health-care during the period of study. None of the studies highlighted user motivation on factors that influenced mobile user engagement. 15 Most studies fail to provide insight into user motivation during the period of the study. For example, Blaauw and Penn-Kekana, (2010) admits that while 14 out of 19 participants continued and completed the study, participants enthusiasm in the health app decreased after the first two weeks of the game, with participants reporting that it became mundane and repetitive. No explanation was given on how participants were motivated or why they chose to continue the 14-week study, and no investigation was carried out in this regard. The reviewed studies were inconsistent or failed to name and classify the persuasive strategies employed by the health-care applications. This made it difficult to establish a clear relationship persuasive strategies and user motivation. Most of the literature reviewed did not account for the research bias in participant behavior which tends to make participants act differently because of the awareness that they are being observed. This raises the need for further research into contemporary persuasive health apps with self-monitoring features which may provide insight into user motivation that is independent of researcher bias. Likewise, sample sizing was a significant drawback identified while reviewing relevant research. Many studies failed to report on the sampling methods used and had sample sizes of less than or equal to 10 participants. The study by Blaauw and Penn-Kekana (2010).

featured only 19 participants while Foster and Penn-Kekana (2010), had only 10 participants. With sample sizes this small it is difficult to say that the results achieved are representative of a larger population. From our literature review and findings from the aims and objectives of the study, persuasive technology for antenatal health care was developed.

Conclusion

The model of maternal healthcare system as developed in this project is a work in progress that is expected to have a positive impact once it is implemented in any of the hospitals in Nigeria. Also, the use of electronic healthcare services makes it possible to reduce attention issues associated with the main causes of death (hypertension, hemorrhages, and other complications of delivery) that are much higher in maternity-infant care. The maternal healthcare system is a two part system developed both for antenatal record assessment from any hospital terminal and SMS to persuade women to utilize clinics for Medicare and immunizations. When such communication technology is made available in the hospitals, the design calls for the server to integrate with a wireless system that serves as a gateway for sending SMS to the women.

Recommendation

The model of the maternal health-care system is designed to use communication technology to persuade women to make use of clinics for birth and other maternal and child health related issues. Therefore, there are some limitations which can reduce our expected impact. First of all, the communication issue: the lack of proper communication means in rural areas is considered in the initial phase of the system. Communication technology depends on federal agencies' findings, which are out of scope of influence. Therefore, it is recommended that the government provide a communication network in various hospitals in the rural areas so as to enable rural women to benefit from the model developed in this project.

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