



Analysis of Persuasive Technology for Positive Maternal Health Behaviour among Rural Women in Nigeria

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ABSTRACT

Computer technology is changing what we think and do; and persuasive technology is rapidly changing the way and manner in which human beings do things and is designed to change attitudes or behaviours of users through persuasion and social influence. New born deaths can be highly reduced through increased use of simple, low cost interventions such as breastfeeding, keeping new born babies warm and dry and treating severe new born infections. This creates the need to develop a web-based persuasive technology application that will initiate a positive change on maternal health behaviour among rural women in Nigeria. This study is guided by methodological triangulation research methodology and optimizes the benefits of data collection from questionnaire survey, persuasive system design strategies and model view controller in the development of the persuasive system for maternal health. The study contributes to research by showing how persuasive technology and its strategies can be applied in maternal healthcare to promote health and information seeking behaviours amongst rural women for the purpose of their unborn children, suckling children and themselves. The research focused on analysing and assessing the impact of persuasive strategies on maternal health behaviour of rural women to generate a final maternal health behaviour model. The study employs three persuasive strategies from the final maternal behaviour model in the design of the application aimed at initiating the adoption of regular and timely antenatal, intra-partum and post-partum behaviours amongst rural women in Nigeria. This new persuasive system will provide avenues for expectant mothers to observe and learn appropriate maternal health behaviours, compare their performances with other women's performances, imbibe healthier and safer maternal lifestyles and receive some form of rewards or trophies for performing the targeted maternal health behaviour. Findings from this study showed that economic factors, religious factors, traditional and other social cultural beliefs are some the factors that militate against rural women from performing maternal health behaviours in Nigeria. Further findings and results from using multi ordinal logistic regression model showed that a unit increase in the independent variable called rewards increases the odds of having antenatal care visit dependent variable by 0.703 and for every one-unit increase in the independent variable called social comparison, there is a corresponding positive increase in Antenatal care visits behavior variable by an odds ratio of 0.079. This implied that the persuasive strategies in the final maternal health model are best suitable for the design and development of the web based application for positive maternal health behavior.

Keywords: Persuasive Strategies, Persuasive Technology, Social Learning, Social Comparison, Trustworthiness, HCI, Captology and ICT4

1. Introduction

Persuasive Technology is a wide and rapidly growing field of study. It encompasses a whole lot of concepts which includes but not limited to four recognized key computer based fields of research, namely; human-computer interaction (HCI), computer-mediated computing, information systems and affective computing. Others include captology, ubiquitous and mobile computing, human-centred computing, interaction design and just to mention but a few. Persuasive technology is rapidly changing the way and manner in which human beings do things. According to Fogg (2015), computer technology is changing what we think and do. Persuasive Technology can, therefore, be broadly defined as technology that is designed to change attitudes or behaviours of users through persuasion and social influence. Persuasive technology leverages on the fundamental theories, methods and results of experimental human psychology, rhetoric and human-computer interaction. It has brought the needed psychological expertise and fundamental theories of behavioural change into computing. This research serves as a bridge for integrating the dynamics of persuasive technology models, principles, designs and operations with fundamental theories of experimental psychology on maternal health to ascertain positive behavioural change among rural women. The research leverages on new ways of persuading citizens to change their attitudes and behaviour towards maternal health. The whole essence is to improve maternal and child health through the power of persuasive computer web-based technology without any form of coercion or compulsion.

Maternal Health is the health of women during pregnancy, childbirth and the postpartum period. It deals with all the dimensions of health care with respect to family planning, pre-conception, pre-natal and post-natal care. Some schools of thought have proven that the concept of maternal health also talks of health of children and extends to the whole family. A healthy child needs a healthy mother. According to UNICEF report (2019), maternal mortality rates are two (2) to four (4) times higher among African women than white women; Sub-Saharan Africa and South Asia account for 87% of maternal deaths. Sub-Saharan Africa has the highest maternal mortality ratio of 68% of all maternal deaths worldwide. South Asia follows by 19%.

Darrel (2015) in his research paper titled "Using Mobile Technology to Improve Maternal Health and Fight Ebola: A case of mobile innovation in Nigeria" reported that 60% of maternal deaths are preventable. For example, injecting oxytocin after childbirth effectively reduces the risk of bleeding. Practicing good hygiene, recognizing and treating early signs of maternal health complications can lower the risk of infections. Administering drugs such as magnesium sulphate for pre-eclampsia can reduce the risk of developing eclampsia. It is also important for women to have access to contraception services to avoid unwanted pregnancies which may lead to abortion and possibly maternal death if not properly handled. This research presented the challenges of prevalence of high level of maternal mortality and other obvious negative consequences of inadequate maternal and child health care arising from negative health behaviour among women. This has remained the disturbing issues in provision of maternal health care. Poor and careless behavior towards maternal health through complete absence from attending mere antenatal classes can lead to serious and avoidable maternal health complications like bleeding during labor, still birth, miscarriage, total loss of pregnancy and even death of the pregnant mother. Most cases of maternal deaths, infant mortality and other challenges of maternal health can be prevented if certain positive behaviour is adopted (Sageer et al, 2019). While concerted efforts are being made to address this menace of poor behaviour towards maternal health through the use of persuasive technology and social influence; the magnitude, alongside depth of myriads of maternal health decadence and challenges stemming from negative maternal health behaviour has remained an issue of concern to maternal healthcare providers and experts. According to Amsa, (2019), the good news is that most of these complications are preventable and treatable.

The research aim at developing a web-based persuasive technology application for positive maternal health behaviour among rural women in Nigeria. In more specific terms, the objectives of this of this research are to answer important questions regarding the challenges, implementation and effectiveness of persuasive technology for maternal health behaviour.; to develop a hybrid model that will be applied in the application system design for enhancement of positive maternal health practices.; to develop an application that will run on cross platforms. The significance of this work is to develop a persuasive technology-based web application for adoption of high level of positive behaviour towards maternal health care among women in Nigeria. We contribute to research by showing how persuasive technology and its strategies can be applied in maternal healthcare to promote health and information seeking behaviours amongst local women for the purpose of their unborn children, suckling children and themselves.

In more specific terms, the result of the study will be of significant contribution to knowledge in the following areas. The research will help to improve maternal and child health by identifying some of the factors and challenges that militate against the adoption of positive maternal health behavior among women. The identification of these militating factors will also help researchers in persuasive system design; to encourage users (expectant women) to embark on healthy maternal health behaviors, like attending antenatal sessions during pregnancy.; It will be useful to hospitals, government agencies, non-governmental organizations (NGOs) and other public spirited philanthropists to raise maternal and child health awareness in Rural areas and beyond; and the persuasive system model of this study can be emulated, adopted and modified by other researchers to build robust persuasive systems in other disciplines.

According to Fogg (2015), Persuasive technology can be defined as any interactive computing system designed to change people's attitudes and behaviours. Furthermore, computerized software or information systems are designed to reinforce, change or shape attitudes or behaviours or both without using coercion or deception. Persuasive technology, therefore, can be described as a technology that is designed to make users change their attitudes or behaviours through persuasion and social influence. This change of attitude is not by coercion or by compulsion. The work of several researchers were reviewed in the course of this study; only a few is highlighted as follow. Fogg (2015) explained that behaviour is a product of motivation, ability, and triggers and developed a model (FBM) for understanding human behaviour and showed that the same model; expressed in eight step process, is useful in analysis and design of persuasive technologies.

Harri-Kukkonen (2017) presented conceptual and theoretical framework for Persuasive Systems Design (PSD). He described what kind of content and software functionality may be found in the final product; consisting primary task, dialogue, system credibility, and social support. Oyibo *et al* (2018) investigated the level of susceptibility of Nigerians to Cialdini's six persuasive strategies and how gender moderates the responsiveness of Nigerians to these strategies. The results showed that Nigerians are susceptible to all six strategies. Busch *et al* (2013) developed and validated an inventory for measuring persuadability. They explained that this can help system designers to develop good P.T models. Nkwo *et al.* (2018) employed social learning and social comparison to design a persuasive system for promoting clean and sustainable environment. Harjumaa *et al* (2009) implemented trustworthiness strategy in the "Polar FT60" heart rate monitor because Polar is a trustworthy source of information. They also implemented virtual trophy or stars in "Polar FT60" system as rewards strategy.

In this research employed the systematic review of related literatures conducted by Aldenaini *et al*, (2020) with persuasive system designs of Fogg (2015) and Oinas-Kukkonen *et al* (2009); where we identified four persuasive strategies and discovered that these strategies have been effectively utilized to design and motivate positive behavior in several disciplines. The four strategies are social learning, rewards, social comparison and trustworthiness

Harjumaa *et al* (2009) implemented trustworthiness strategy in the "Polar FT60" heart rate monitor because Polar is a trustworthy source of information. He also implemented rewards strategy as virtual trophy or stars used in the "Polar FT60" system. Another typical example where reward was used as a persuasive strategy is gold, bronze and silver badges on an online learning website called edX. Reward strategy was also exemplified as badges in the "BunnyBolt" game application. Intelligent musical stairs known as "Social Stairs" were implemented as a reward strategy by triggering music corresponding to the user's steps on stairs. Seven visual growth levels for the virtual fish in the "Fish in Steps" desktop game were used as tracking/self-monitoring strategies for users. A happy facial expression of virtual fish was used as reward in the same "Fish in Steps" desktop game. Social comparison and social learning were used in the "WragaFit" smartphone application. social learning strategy was the "Pediluma" shoe activity tracker device that monitored the wearer's movements by providing varying intensities of a lighted cage.

1.1 Persuasive Model

For the purpose of this work, a hybrid model is hereby being proposed for positive behaviour change in maternal health domain. This novel model leverages on Fogg's Behavioural Model (FBM) and Harri-Oinas Kukkonen Persuasive System Design (PSD) Model. The components of this hybrid model form the persuasive strategies to be employed in achieving expected positive behavioural change in maternal health web application. The Components of the hybrid model above form the persuasive strategies to be used in effecting change behaviour in an e-health application that bothers on maternal health.

1.2 Behaviour Change Support Systems (BCSS)

Behavioural Change Support System (BCSS) is any information and communications technology (ICT) tool, web platform or gamified environment which targets behavioural changes in its end-users. They are built upon persuasive systems design techniques. According to Kukkonen (2010), a behaviour change support system (BCSS) is an information system designed to form, alter or reinforce attitudes, behaviours or an act of complying without using deception, coercion or inducements.

Application of Persuasive Technology

The very essence of persuasive technology is positive behavioural change without coercion or deception. The application of Persuasive Technology cuts across several aspects of human endeavour namely; product design, interaction design, software and web application development, e-commerce and online markets, domain base application. Domain based application of persuasive technology includes, but not limited to, the following domains; e-Health, Energy consumption and conservation, transportation (driving), environmental conservation, Education and research development. This research is on the application of persuasive technology to maternal health. The expected outcome of positive change in behaviour or attitude leverages on the persuasive strategies discussed in the previous sections. It is, therefore, pertinent to note that when the knowledge and principles of persuasive strategies and persuasive models are applied on any digital information system; such a system can be regarded as a Behavioural Change Support System (BCSS).

1.3 Maternal Health Behaviours

According World Health Organisation (WHO) maternal health survey (2019), most maternal deaths arising from obstetric complications in developing countries do not occur in hospitals. The majority of such occur either at home or native delivery rooms. Studies have shown that maternal health is essential to ensure the health of children.

Maternal child health can be improved based on key interventions that reduce the risk posed by maternal mortality include skilled care at birth and emergency obstetric care. New born deaths can be highly reduced through increased use of simple, low cost interventions such as breastfeeding, keeping new born babies warm and dry and treating severe new born infections. Good maternal and child health behaviour can greatly be improved through the knowledge of what to do, when to do and how to do it. This knowledge comes from access to intervention information and awareness. This is what the significance of this research seeks to achieve; to enable and enhance good maternal and child health seeking behaviour, through the use of technology.

Maternal Mortality

This refers to deaths due to complications from child birth or pregnancy. The most common complications include severe bleeding, infections, high blood pressure, unsafe abortions, drug overdose and complications from delivery. The good news is that most of these complications are preventable and treatable. (Amsa, 2019). According to Zoreed (/2020), when you hear of maternal mortality; you may think of it as a foreign concept that occurs in Asia and other parts of the world.

Some of the major causes of maternity death faced **my** many developing nations lack adequate and proper health care and family planning. The major causes of death of mothers from one week to one year after giving birth are amniotic fluid embolism and problems arising from weakened heart muscles called cardiomyopathy. Other causes include but not limited to the following; Postpartum haemorrhage; Eclampsia; Obstructed labor; Sepsis.

2. Summary Related Works

Table 1-1 show the Summary of related work on persuasive health maternity.

In Table 1-1 shows the Author, title and what was done in achievements. Other literatures related were discussed in in the introduction part.

Author	Title	Achievements
Oyibo1 et al (2018)	The Susceptibility of Africans to Persuasive Strategies: A Case Study of Nigeria.	They investigated the level of susceptibility of Nigerians to Cialdini's six persuasive strategies and how gender moderates the responsiveness of Nigerians to these strategies. The results showed that Nigerians are susceptible to all six strategies.

Busch et al (2013)	Personalized Persuasive Technology: Development and Validation of Scales for Measuring Persuadability	They developed and validated an inventory for measuring persuadability. They explained that this can help system designers to develop good P.T models.
Kukkonen and Harjumaa (2008)	Persuasive system design	He presented conceptual and theoretical framework for Persuasive Systems Design (PSD). He described what kind of content and software functionality may be found in the final product; consisting primary task, dialogue, system credibility, and social support.
B.J Fogg (2015)	A Behaviour Model for Persuasive Design	He explained that behaviour is a product of motivation, ability, and triggers and developed a model (FBM) for understanding human behaviour and showed that the same model; expressed in eight step process, is useful in analysis and design of persuasive technologies

3. Methodology

The research methodology is based on the principles of methodological triangulation; which is a blend of three methodologies. In this research, we combine the following three methods, namely; Questionnaire Survey method, Model View Controller (MVC) design method and Persuasive system design (PSD) model. This hybrid methodology was chosen to optimize the benefits of each component methods in the development of an improved system for positive maternal health intervention.

Data were gathered from two communities in Port Harcourt, Rivers state in the user study. The two communities are Nvuiigwe - woji in Obio/Akpo and Ikpo village. Ikpo village is located a few kilometers away from the Port Harcourt International Airport, Omagwa in Ikwerre local government areas. Ikpo Village People are predominantly farmers and traders. Nvuiigwe is a semi urban area but has a downtown area of rural dwellers who live in batchers and tarsh houses. Questionnaire was used for the survey to collect data from expectant mothers and other women.

The questionnaire; which was designed to be in tandem with persuadability inventory of Busch et al (2013) was modified to match our area of study being positive maternal health behavior. This modification was made to be able to decipher users' preferences on persuasion strategies to be adopted; and to construct a simple persuasion profile for each expectant mother (woman) in the survey.

Data Reliability Test/Analysis (Cronbach Alpha Test)

Data reliability analyses/tests were done on SPSS version 26. The reliability of our scaled or ranked data was tested to investigate the level of internal consistency of the latent variables using Cronbach Alpha. The formula for calculating Cronbach Alpha Coefficient is shown below as

$$\alpha = \frac{N\epsilon}{\sigma + (N - 1)} \quad (1)$$

Where;

$\bar{\alpha}$ = Cronbach Alpha Coefficient

N = the Number of Items

$\bar{\sigma}$ = Average variance

\hat{c} = Inter-item covariance between items

Cronbach Alpha coefficient of 0.7 or above is acceptable for internal consistency. This means that an item variable is said to have acceptable reliability of 70% internal consistency. According to George and Mallery (2003), the following table can be used as rule of the thumb to interpret Cronbach's alpha. Table 1-2 shows the values

Table 1-Cronbach’s alpha Interpretation

Cronbach’s alpha	Interpretation
> .09	Excellent
> 0.8	Good
> 07	Acceptable
>0.6	Questionable
>0.5	Poor
<0.5	Unacceptable

Values much higher than 0.9 are again considered critical, as this indicates that some characteristics are too similar and thus thing comes out.

According to Busch et al. (2013), “respondents or participants that have higher scores in one or more of the scales are expected to be more susceptible to these specific persuasive strategies.” This means that there are greater users’ preferences for persuasive strategy ranked variables that have higher Cronbach’s Alpha Coefficients. On SPSS application, we calculated Cronbach alpha for internal consistency Fig. 1 and 2. Shows the Statistical Package for Social Science (SPSS) Image using Cronbach’s alpha reliability steps as shown in Fig. 1 and 2

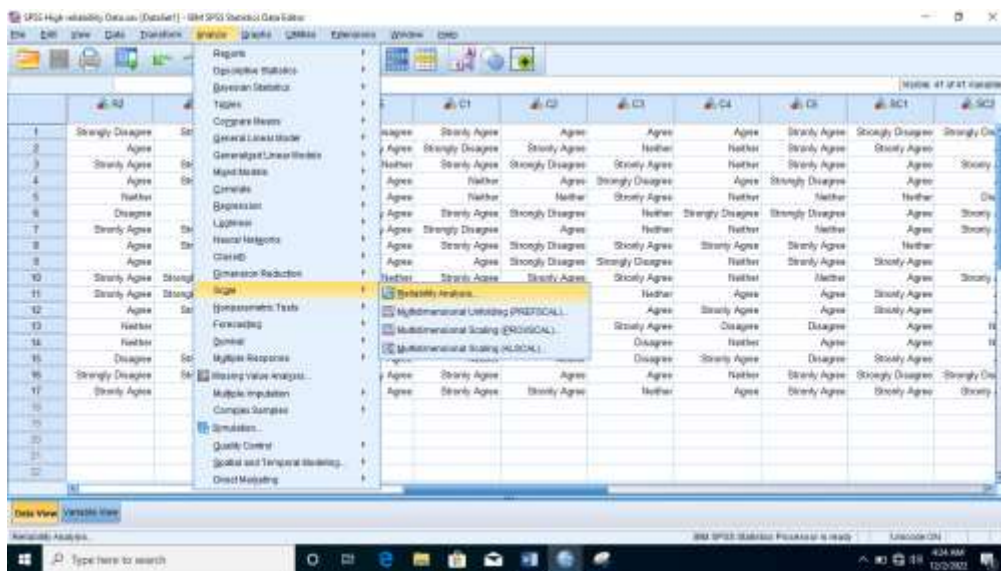


Fig. 1 - SPSS Image showing Cronbach’s alpha reliability steps

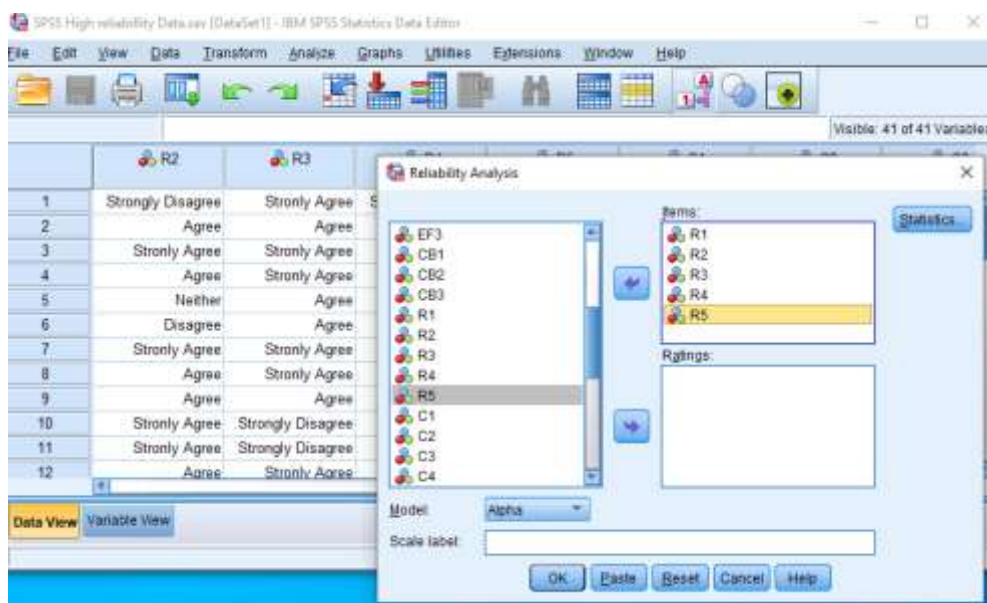


Fig. 2 - SPSS Image showing the various Likert items during analysis of this Study

Results from our studies showed that many socio-cultural factors pose as constraints that affect the adoption of positive maternal and child health behaviors amongst women. Some of these constraints include but not limited to the following; avoidance of caesarean sections during complication, religious beliefs, cultural beliefs, high rate of hospital bills, poverty, mindset of some women towards medical hospitals and outright ignorance. For instance, many of the respondents have the belief that that safe delivery is only a question of having firm faith in the Almighty God and God has promised them that they shall have safe deliveries like the Holy Bible Hebrew women. On the other hand, some of the respondents ignorantly hate to attend antenatal classes due to the belief or myth that their traditional mothers had good and safe deliveries in traditional delivery centers. Some would rather prefer to go to churches or assignment homes (spiritual homes) for anointing oil, prayers and prophecies only; without actually going to hospital when they are having cases of fibroid, ovarian cyst and even child-birth. Because of these myopic traditional beliefs, some of them completely avoid antenatal classes when they are pregnant and would not want to engage in proper maternal health behaviors or even seek for proper health information from hospitals and clinics.

Other constraints identified are outright carelessness, lack of attention to one's health and lack of time to health. These observations pose as deterrent factor to seeking proper medical check-up during pregnancy and other maternal health complications.

The findings and submission in our study can be attested to and confirmed by a report of World Health Organisation (WHO) maternal health survey (2019) that "most maternal deaths arising from obstetric complications in developing countries do not occur in hospitals. The majority of such occur either at home or native delivery rooms. Studies have shown that maternal health is essential to ensure the health of women and children". Little wonder there is a high rate of pregnancy and childbirth-related deaths in developing African nations. This also confirms our research findings.

3.1 Persuasive Design for the Web-Based Application System

In the system design, we employed Fogg's eight-step processes in developing the application system of this research; which is persuasive technology based application for positive maternal health behavior. We decided to choose the Fogg's persuasive design steps owing to the fact that it provides the needed opportunity to iteratively design a maternal healthcare intervention that will be suitable for delivering healthcare services to our target population. Fogg (2009) designed an eight process for creating persuasive technologies.

Fogg's Persuasive Design Steps

Fogg's eight step Processes as follows:

- 1). Target a simple behavior.
- 2). Know the target audience
- 3). Discover obstacles to performing the target behavior
- 4). Use technology channel familiar to users
- 5). Identify appropriate persuasive technology examples,
- 6). Emulate effective examples
- 7). Evaluate and repeat fast
- 8). Expand on success.

3.2 System Design

The questionnaire items were ranked so as to be able to measure respondents' preferences for persuasive strategies in this case are the latent or observed variables using participants' agreement to a five (5) Likert scale with range "1 = Strongly Disagree to 5 = Strongly Agree". Seventy-nine (79) respondents participated in the survey from the two rural settlements. The questionnaire had other categorical dummy independent variables or pseudo-predictors that were also ranked as dichotomous and ordinal variables After the women had submitted the questionnaire responses back to us by the women, sixty-five (65) copies of answered questionnaire out of a total of Seventy-nine (79) copies issued to 79 respondents were certified to be valid. These valid questionnaire responses were entered in Microsoft Excel 2016 application software for data cleaning and coding. The records were imported into Statistical Packages for Social Sciences (SPSS) application software version-26 for further data coding, data validation. The system application design is based on the principle of model-view controller (MVC) technique. This consists of relational database tables embedded in a relational database management system (RDBMS) and graphical user interfaces that interact with the relational database tables using structured query language (sql) embedded in the program logic that controls C.R.U.D operation transversal up and down the database tables. From our web based application design, the database represents the model in MVC technology while graphical user interfaces and program logic respectively represent the view and controller in the MVC design pattern.

Health data/Records of the mother: ANC Registration date, Age of Pregnancy at ANC Registration (One, two, three weeks/months or above six months), Number of Pregnancies (to include current Pregnancy), Number of Children, Number of Successful Birth, number of Still Births, number of Caesarean Sections (C.S), number of Miscarriage (Spontaneous or missed Abortion), Family History of Terminal Diseases/Ailments (High Blood Pressure - HBP,

Diabetes, hepatitis, Cancer, Tuberculosis, etc), Complications during Labor or Child Birth? (Mention it). Other database objects are users table, user_log table, etc.

Observation and Result

Descriptive statistics of Religious Beliefs as ranked factor variables in the survey showed that 83.0% of the women believe that safe delivery is only a function of belief in God as shown RB1 table and RB1 bar chart below, which indicate that 21.5% and 61.5% agree and strongly agree respectively to the assertion in RB1.

Table 2-Frequency Table for RB1 Likert Item

Scale	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly Disagree	2	3.1	3.1	3.1
Disagree	5	7.7	7.7	10.8
Neither	4	6.2	6.2	16.9
Agree	14	21.5	21.5	38.5
Strongly Agree	40	61.5	61.5	100.0
Total	65	100.0	100.0	

Note. RB1: Religious Belief 1 is as show in Fig. 3 showing the responses analysis

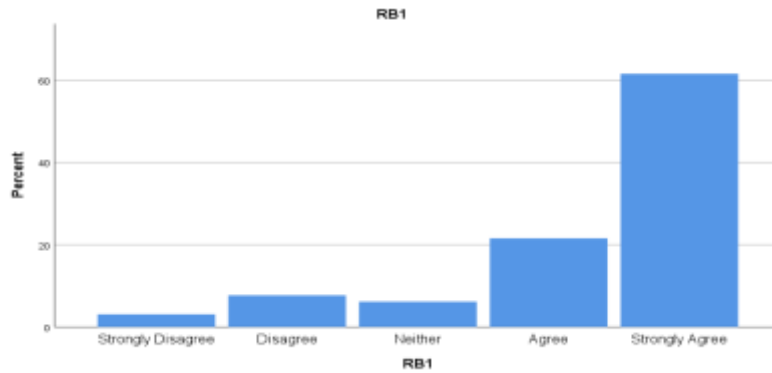


Fig. 3- RB1: Religious belief 1 Likert Item Bar Chart

RB1 83.1% believe that God has promised they shall deliver their babies like the Hebrew women in the bible as shown on RB2 table and bar chart below. 12.3% agree and 70.8% strongly agree on the Likert scale. This represents 54 out of the 65 respondents on the frequency column in the table below.

Table 3- Frequency Table for Rb2 Likert Item

Scale	Frequency	Percent	Valid Percent	Cumulative Percent
Disagree	3	4.6	4.6	4.6
Neither	8	12.3	12.3	16.9
Agree	8	12.3	12.3	29.2
Strongly Agree	46	70.8	70.8	100.0
Total	65	100.0	100.0	

Note. RB2: Religious Belief 2, is as show in Fig. 4. The responses are represented as contained in below in Fig. 4

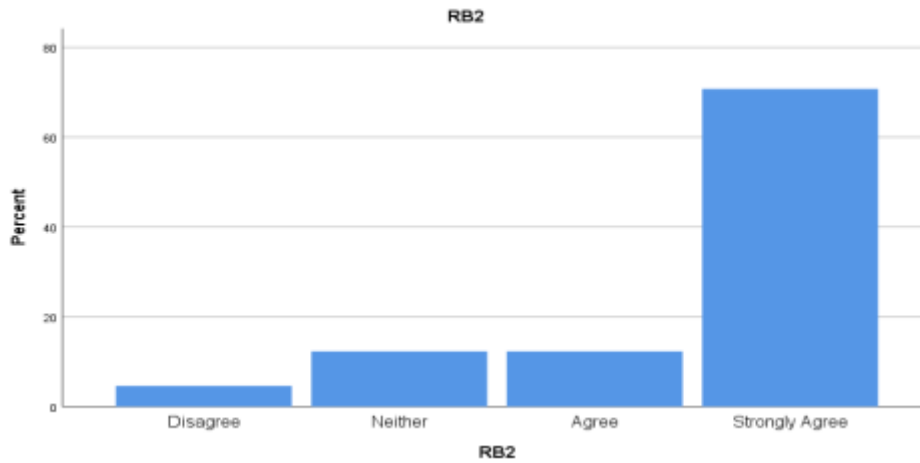


Fig. 4- RB2 Bar Chart

Based on the scale, 13.8% and 46.2% respectively agree and strongly agree that “what will be will be” according to RB3 item frequency table below. This represents a total of 60.0% of the population.

Table 4-Frequency Table for RB3 Likert Item

Scale	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly Disagree	10	15.4	15.4	15.4
Disagree	14	21.5	21.5	36.9
Neither	2	3.1	3.1	40.0
Agree	9	13.8	13.8	53.8
Strongly Agree	30	46.2	46.2	100.0
Total	65	100.0	100.0	

Note. RB3: Religious Belief 3 responses is as shown in fig. 5

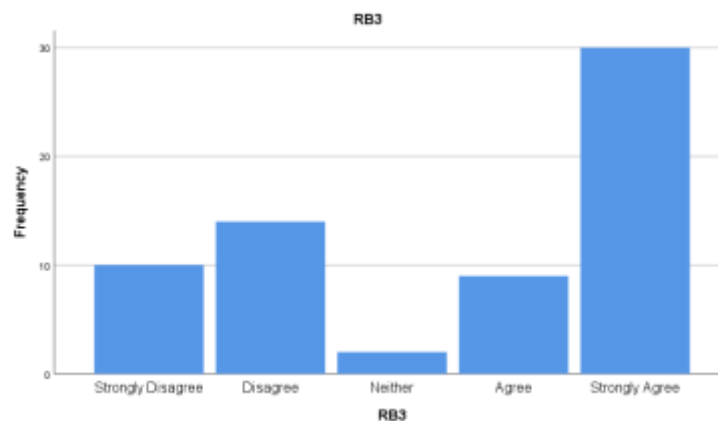


Fig.5- RB3 Bar Chart

Cumulative percentages of strongly disagree, disagree and neither for RB1, RB2 and RB3 are 16.9%, 16.9% and 40.0% respectively as shown on the RB tables above. These belief factors hinder them from having any need to visit any health center for when they are pregnant.

The mode value of 5 for all the Likert items; namely, RB1, RB2 and RB3 on the statistics table below showed that respondents who strongly agree that religious belief factors are real obstacles and challenges to their antenatal care visits are far more than those who disagree.

Table 5- Statistics of Religious beliefs 1, 2 and 3

	RB1	RB2	RB3
N	65	65	65
Missing	0	0	0
Mean	4.31	4.49	3.54
Mode	5	5	5
Skewness	-1.623	-1.575	-.472
Std. Error of Skewness	.297	.297	.297

Note. RB1: Religious Belief 1; RB2: Religious Belief 2; RB3: Religious Belief 3; N: Number of Participants.

In fact, the cumulative percentages of these items' scales from strongly disagree, disagree and neither signify that the respondents yield to RB1, RB2 and RB3 as militating factors against positive maternal health behavior to be imbibed.

RB1, RB2 and RB3 bar charts also give a visual display of very strong agreements to the null hypotheses 1.

4.1.2 Cultural Beliefs (CB1, CB2 and CB3)

Questionnaire Likert items for CB1, CB2 and CB3 are as follows:

CB1: I use traditional delivery center just to avoid caesarean sections when I am pregnant.

CB2: I don't like to attend antenatal sessions

CB3: I seldom attend antenatal sessions when I am pregnant

Table 6- Frequency Table for CB1

Scale	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly Disagree	1	1.5	1.5	1.5
Neither	22	33.8	33.8	35.4
Agree	19	29.2	29.2	64.6
Strongly Agree	23	35.4	35.4	100.0
Total	65	100.0	100.0	

Table 7- Frequency Table for CB2

Scale	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly Disagree	1	1.5	1.5	1.5
Disagree	1	1.5	1.5	3.1
Neither	4	6.2	6.2	9.2
Agree	35	53.8	53.8	63.1
Strongly Agree	24	36.9	36.9	100.0
Total	65	100.0	100.0	

Table 8- Frequency Table for CB2

Scale	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly Disagree	7	10.8	10.8	10.8
Disagree	10	15.4	15.4	26.2
Neither	6	9.2	9.2	35.4
Agree	4	6.2	6.2	41.5
Strongly Agree	38	58.5	58.5	100.0
Total	65	100.0	100.0	

From the CB frequency tables above, 29.2% and 35.4% agree and strongly agree to CB1 respectively. 53.8% and 36.9% respectively agree and strongly agree to CB2 while 6.2% and 58.5 agree and strongly agree to CB3 respectively; giving a total of 64.6%, 90.7% and 64.7% that agree to CB1, CB2 and CB3 respectively. This means that antenatal care visits are usually avoided due cultural beliefs. Most of the women prefer to use traditional delivery centers.

Economic Factors (EF1, EF2 and EF3)

Questionnaire Likert items for EF1, EF2 and EF3 are as follows:

EF1: Hospital bills are very high

EF2: I prefer native pregnancy medicine because I have no money to register for antenatal class and buy pregnancy care drugs which are usually very expensive.

EF3: Cost of transportation to medical centers are not easy to come by.

Table 9-Frequency Table for EF1

Scale	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly Disagree	4	6.2	6.2	6.2
Disagree	12	18.5	18.5	24.6
Neither	14	21.5	21.5	46.2
Agree	11	16.9	16.9	63.1
Strongly Agree	24	36.9	36.9	100.0
Total	65	100.0	100.0	

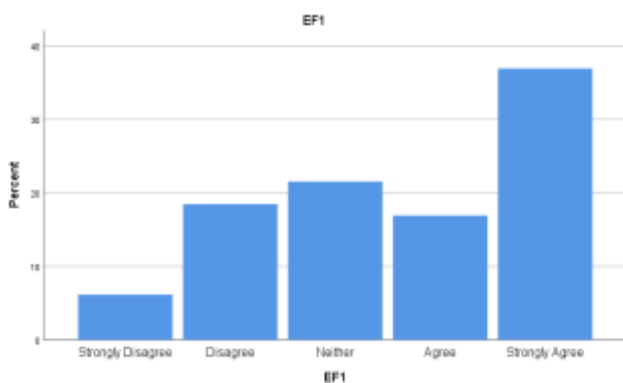
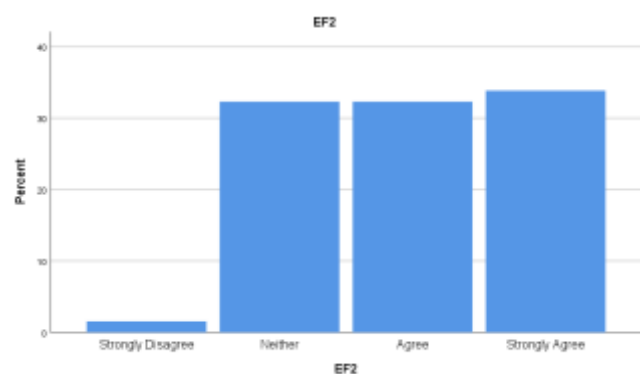
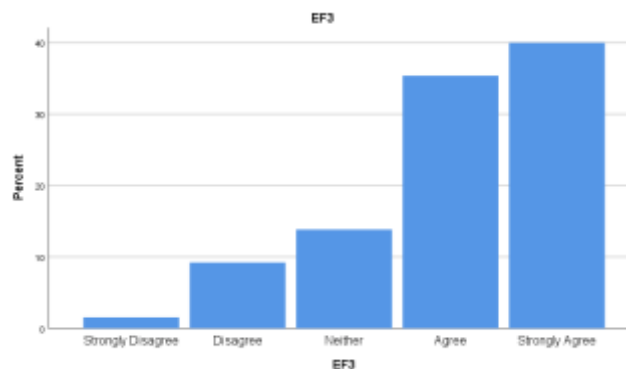
Table 10-Frequency Table for EF2

Scale	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly Disagree	1	1.5	1.5	1.5
Neither	21	32.3	32.3	33.8
Agree	21	32.3	32.3	66.2
Strongly Agree	22	33.8	33.8	100.0
Total	65	100.0	100.0	

Table 11- Frequency Table for EF3

Scale	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly Disagree	1	1.5	1.5	1.5
Disagree	6	9.2	9.2	10.8
Neither	9	13.8	13.8	24.6
Agree	23	35.4	35.4	60.0
Strongly Agree	26	40.0	40.0	100.0
Total	65	100.0	100.0	

36.9%, 33.8% and 40.0% strongly agree to EF1, EF2 and EF3 respectively; over 30% of the responds equally agree to EF1 and EF2. These indicate that economic factors have a strong negative correlation impact on participant's antenatal care visits.

**Fig. 6-** Economic Factor 1 (EF1)**Fig. 7- Economic Factor 2 (EF2)****Fig. 8-** Economic Factor 3 (EF3)

ICT Awareness

Questionnaire item for dichotomous ICT_Awareness Variable , this **Answer to Research Question 2**

At this juncture, we may also wish to recall the research question 2 as “How can relevant persuasive strategies be implemented in a web-based application program to influence potential users to imbibe appropriate maternal information and positive maternal health behaviors amongst Nigerian women?”

The result of research question 2 was achieved in two ways: (a) through reliability test and (b) using multi ordinal logistic regression model analysis to investigate the interplay and impact of the predictors on the dependent variables.

Reliability (Internal Consistency) Analysis Test Result

We have a total of 65 respondents (participants) in the survey. There are no missing items (no exclusions); meaning that 100% of the participants' responses were used in the reliability analyses as shown on the case processing summary table below.

Table 12- New Cronbach’s Alpha Item-Total Statistics for Deleting ANC-V3

	Scale Mean if Deleted	ItemScale Variance if Deleted	ItemCorrected Correlation	Item-TotalSquared Correlation	MultipleCronbach's Alpha if Item Deleted
ANC_V1	16.14	10.309	.643	.644	.529
ANC_V2	16.37	10.518	.450	.302	.607
ANC_V3	16.02	14.734	.108	.104	.715
ANC_V4	16.66	7.977	.660	.611	.483
ANC_V5	16.91	11.460	.294	.129	.683

The Cronbach Alpha Coefficient for Antenatal Care Visit is 0.670. This simply means 67% internal consistency for the Antenatal Care Visit variable. This is not acceptable; because we need a C.A coefficient of 0.70 and above for data reliability. So, if we delete the Cronbach alpha for ANC_V3 item, we will have a Cronbach Alpha coefficient of 0.715 for the ranked variable.

4.Scale: Cronbach Alpha for Trustworthiness

From the reliability statistics table above, Social Learning ranked variable is highly reliable with an internal consistency Cronbach alpha coefficient of 0.706 (70.6%). This shows an acceptable level of preference for social learning persuasive strategy within our study population. Hence, this strategy will immensely enhance our application program design for adequate adoption of proper and positive maternal health behavior.

Table 13-Internal Consistency Summary of Expected Cronbach’s Alpha Coefficients After Item Deletion

S/N	ITEMS TESTED	CRONBACH ALPHA	NO. OF ITEMS	DELETED ITEM
1	Antenatal Care Visit ANC_V1, ANC_V2, ANC_V4, ANC_V5	.715	4	ANC_V3
2	Rewards (R1, R2, R3 and R4)	.715	4	R5
3	Social Comparison (SC1,SC2, SC3, SC4 and SC5	.708	5	NIL
4	Trustworthiness	.710	4	TW5
5	Social Learning	.706	5	NIL
6	Competition	Deleted	Deleted	5

From the Table 13, it can be seen that we are left with four independent variables with acceptable internal consistency above 0.700. Competition variable with C.A coefficient of 0.322 (32.2%) was completely deleted (dropped). This can be represented in Fig.9



Fig.9- Preliminary Maternal Health Behavior Model

Table 14-Breakdown of Skewness and Kurtosis Division by Standard Error

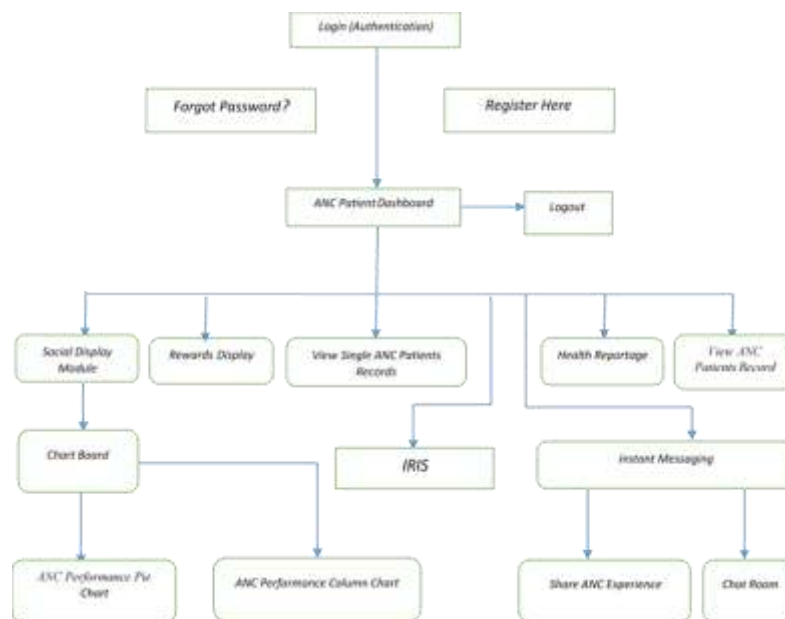
1. Variable	2. Skewness	3. Std Error	4. Division Result	5. Kurtosis	6. Std Error	7. Division result
8. Antenatal Care Visits	9. -0.636	10. 0.297	11. -2.141	12. -0.889	13. 0.586	14. -1.517
15. Rewards	16. -0.2156	17. 0.297	18. -0.7259	19. 3.523	20. 0.586	21. 6.012

22. Trustworthiness	23. -1.702	24. 0.297	25. -5.7306	26. 3.523	27. 0.586	28. 6.012
29. Social Comparison	30. -0.828	31. 0.297	32. -2.7879	33. -0.224	34. 0.586	35. -4.758
36. Social Learning	37. -1.884	38. 0.297	39. -6.3434	40. 5.372	41. 0.586	42. 9.167

Table 15-: Normality test Using Shapiro-Wilk P-value Method

	<i>Kolmogorov-Smirnov</i>			<i>Shapiro-Wilk</i>		
	<i>Statistic</i>	<i>df</i>	<i>Sig.</i>	<i>Statistic</i>	<i>df</i>	<i>Sig.</i>
<i>Antenatal_Care_Visit</i>	.150	65	.001	.864	65	.000
<i>Rewards</i>	.230	65	.000	.760	65	.000
<i>Trustworthiness</i>	.176	65	.000	.822	65	.000
<i>Social_Comparison</i>	.171	65	.000	.897	65	.000
<i>Social_Learning</i>	.172	65	.000	.838	65	.000

Based on Shapiro Wilk Probability Value method, a population/data set is said to be normally distributed if the p-value is not statistically significant. That is if the p-value is greater than 0.05 (5%) within 95% confidence interval. Our normality test result showed that our data set is not normally distributed because there is a statistical significance of p-value less than 0.05. In this case, we have a p-value < 0.001 with degree of freedom (df) Of 65 for all tested variables under Shapiro-Wilk. Note that for Normality test using p-value in a dataset with total number of N less than 100 is preferably done with Shapiro-Wilk method. Fig. 10 show the dataflow diagram for participants user group in ANC Dashboard, it describes how the persuasive work.

*Figure 4.10b: Data flow diagram for participants user group (ANC Dashboard)*

Implementation of Persuasive Strategies on the Application System Design

Social Learning Display: This strategy is implemented in such a way that users will be able to observe other's performances, learn new things and find out best practices which they could passively learn from. This strategy is implemented to show a graphical view of the number of pregnant women and the points earned for timely and frequent attendance to antenatal cares each month.

Social Comparison Display: This provides a means for comparing performance with the performance of other users. We implement this strategy using an instant messaging feature in the application design by making users share and compare information in line with their maternal health behavior via share button. A user who logs into the system will see her real name and her own maternal healthcare progress information shared on the application. However, the user is also able to see the maternal healthcare progress information of other registered pregnant women.

Rewards Display: This strategy provides virtual rewards for the application system users in order to give credit for performing the target behavior. It is implemented on our web based application as trophies and awards given to only users who meet a certain levels of antenatal care attendance and other positive performance. The application shows how persuasive technology will serve maternal health behavior.



Fig. 4.11a: Developed PT system Authentication Page (Index Page)

Fig. 4.11b Chat room (Instant Messaging Module)

4. Conclusion

Results from our studies showed that there are many socio-cultural factors which pose as constraints that affect the adoption of positive maternal and child health behaviors amongst women. Some of these constraints include but are not limited to the following; avoidance of caesarean sections during complication, religious beliefs, cultural beliefs, high rate of hospital bills, poverty, mindset of some women towards medical help and outright ignorance. Other constraints identified are outright carelessness, lack of attention to one's health and lack of time to health. These observations pose as deterring factors against proper medical help and check-up during pregnancy and other maternal health complications. Harri-Kukonem model and Fogg's eight design process were employed in line with several mathematical and statistical methods in the research. Further result proved that Social Learning, trustworthiness and rewards are most suitable persuasive strategies for designing a web based application system for adoption of maternal health and information seeking behavior. Specifically, this was achieved through the use of questionnaire for data gathering, use of SPSS for data cleaning. Internal consistency or reliability, normality and multi-ordinal logistic regression analyses/tests were carried out to achieve the results. In conclusion the aim and objective of this research were met and delivered; as important questions regarding the challenges, implementation and effectiveness of persuasive technology for maternal health behaviour were asked and answered in the research. Trends in persuasive technology design, research methods, motivational strategies, theories, and maternal health behaviours were discovered in the sections above. An analysis of persuasive technology model was developed and applied to the application system design; intentionally built to run on cross platforms. Based on the findings and conclusions the work presents, the following recommendations are suggested; Maternal health behavior model should be implemented in the design of all health based intervention systems by software developers in an effort to continually improve maternal and child health., Pt designers, UX/UI designers, software product designers and academic researchers should conduct usability evaluation of the result of this study with individual users to get a feedback about the effectiveness and value of the design concepts in this research. Government and health care practitioners should create continuous persuasive technology awareness campaign to inform citizens and awaken the consciousness of women on the dangers of irregular attendance or total absence from antenatal care sessions. This will inspire users to adopt positive maternal and child health behaviors; researchers should compare the findings of this study against the current maternal healthcare practices to show its obvious benefits. Software developers and researchers should evaluate a clickable prototype of the system by testing it with the potential users (expectant mothers and health worker

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