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An AI Tracking and Delivery System for the Distribution of Maternity Kits. Case study: The Health Sector – Nigeria.

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Abstract:

Artificial intelligence is being used in the health sector of developed countries and it has improved the lives of humans greatly such as detecting cancers and different types of brain tumours and diagnosing cardiovascular diseases within a short period. AI has been used to make decisions for humans based on some observed symptoms identified in the human body. AI is also used in speech technology for healthcare to process human speech in order to identify languages, gender and age and also for the purpose of detecting some physical and mental disease which have been known to cause changes in human speech. For example, the Automatic Speech Recognition (ASR) technology has been used in the healthcare sector to fix speech and hearing impairments of patients. AI is also used to study the emotions of humans and it has been used to handle complex situations difficult for health specialists, such as tracking and detecting patients with corona virus through an application and the development of vaccines.

On the other hand, developing countries are still struggling to keep up with the use of AI in their health sectors. Embedding AI in improving the services provided by the health sector

in Nigeria is a long-overdue transformation. Most especially in the maternity section. Pregnant women ought to be given proper health care attention irrespective of whether they live in the urban area, metropolitan area, semi-rural area, or rural area. It is based on this that this research was carried to compare the present distribution system of maternity kits to pregnant women and a designed proposed model.

This research work focused on identifying the issues related to the distribution of maternity kits in Nigeria and the design and development of an AI system that would help to ensure the effective distribution of maternity kits to pregnant women. Two types of questionnaires were administered. The use of online questionnaires and paper-based questionnaires enabled participants of this study to state the issues they face as regards the collection of maternity kits in government hospitals. It was discovered that many of the participants believed that services in the health sector of Nigeria need to be improved. Based on the survey carried out, about 50% of the participants were willing to share their addresses to be used for maternity kit distribution and about a quarter of the participants were willing to share their photos and fingerprints to be used in the AI system for maternity kit distribution. Participants' opinions varied in the information they were willing to share with the government hospitals and Non-governmental Organisations (NGOs) as regards the use of text, voice, and fingerprints for AI purposes.

In the design and development of the system, the pregnant woman's due date was predicted by the Machine Leaning Algorithm. Photos were detected to determine if she has been registered in the system. Google Map API was used to navigate to her location, and Twilio messaging API was used to send her messages to inform her of the maternity kit distribution date.

In the development of a proposed model, AI for facial detection was used. It was discovered that the facial recognition model was not 100% efficient in identifying people of the black race especially people from the same family because they have similar facial features.

Several strategies are recommended for the full functioning of the proposed model. Firstly, it is important to note that only one researcher carried out this design hence some other

technical skills which the researcher did not possess is required for full deployment and implementation of the model. Secondly, most of the APIs used were the free versions, for a more efficient model, paid versions may be required.

Keywords: Artificial Intelligence, Machine Learning, AI Tracking, Delivery, Maternity Kits, Health, Nigeria.

Preface

In a nutshell, I love children. I love to see women carry their children after nine months of pregnancy. Hence, I have always participated in activities that promote the care of pregnant women and their children. I have also researched the effective use of a computer-based record system, that is, a database system in Nigeria to keep track of the health records of pregnant women. The lives of pregnant women matter because they bring forth children and this keeps the world growing. My motivation for this research was to look for a way to combine AI and how women can be assisted in terms of effective delivery of their newborn.

This research was carried out by me in about 7 months despite the challenges I faced. Firstly, as regards the process, initially I was not getting participants to fill the survey because they were not sure if the link was a scam link. However, I sent the link constantly with the help of family and friends to re-broadcast it. Secondly, despite my efforts to reach out to an NGO for an interview, the interview was not granted even though it was promised. Thirdly, the focus area of this research had no exact related work as regards AI and maternity kit distribution, so it was a challenge to get literature review sources. However, with a constant search using google scholar and other research databases some resources proofed to be useful. Also, I was not too sure of my ability to develop the proposed model to perfection, nevertheless, I acknowledged my strength and I was able to identify my weaknesses and I developed the research to the best of my ability within the given time. Furthermore, there were times I wanted to travel to meet my family during the pandemic period, this period slowed down my research, but I kept my mind on the goal and I wrote the research with zeal.

In writing this research, I am entirely grateful to God who gave me the wisdom to start this master's program and to finish it in due time. He gave me peace and rest. To Him be all the praise. I bless God for giving me this research idea even before I started the master's program. I also want to specially appreciate my parents Mr. And Mrs. E. A. Ibironke for supporting and encouraging me right from the very moment I informed them that I was applying for studies in Finland. I want to thank my Mum for distributing the paper-based questionnaire for me in Nigeria despite the pandemic situation. I also want to appreciate my dad for re-

Glossary

AI	Artificial Intelligence
API	Application Programming Interface
CDKs	Clean Delivery Kits
CHE	Current Health Expenditure
E-Health	Electronic Health
GUI	Graphic User Interface
LMICs	Low- and Middle-Income Countries
ML	Machine Learning
NGO	Non-Governmental Organisation
PED	Portable Electronic Devices

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1 Introduction

According to Li et al. (2020), Artificial Intelligence (AI) has generated a large amount of excitement in healthcare because it is driven by the evolution of developing machine learning (ML) models. In recent times, several diseases are being cured fast because their symptoms can be detected rapidly with the use of AI. For example, using AI to detect brain tumours and cancer and as well to predict heart attacks (Alqudah et al., 2019; Collins, 2020; Holmes & Jain, 2012). However, AI is yet to deliver scalable and sustainable value for patient care in the real world. Efforts have to be made to ensure that the delivery of AI is accurate. Developed countries are constantly experimenting with new AI technologies. However, developing countries consisting of low and middle income countries (LMICs) such as The Federal Republic of Nigeria (conventional short form- Nigeria) lag behind in the use of AI in healthcare. Hence, several health issues remain unsolved or slow to be solved because of the lack of AI experts and tools to perform the jobs.

In Nigeria, Oluremi et al. (2020) observed that several diseases have been found to cause maternal mortality amongst pregnant women, and at child delivery infants are infected increasing the neonatal mortality rate. For example, Sepsis. Often, some of these deaths occur as a result of the kits used in the delivery process. The question to be asked is, how are these kits delivered especially to pregnant women in the rural areas. Sometimes, these women do not receive any delivery kit, hence they make use of locally available delivery items, which are not hygienically recommended for delivery. Most times the women in rural areas deliver through traditional means, using unsterilized equipment, by village mothers or village women heads.

According to the World Health Organization (2016), globally, about 303 000 women die during pregnancy and childbirth, 2.7 million babies die during the first 28 days of life and 2.6 million babies are still born. It has also been observed that in the year 2019, 94% of all maternal mortality deaths occured in low and lower-middle income countries of which Nigeria is one of them (World Health Organization, 2019). Nigeria has a maternal mortality

rate of 917 per 100 000 live births. The deaths of women and children are caused by infections contracted during childbirth (Leight et al., 2018). To prevent these, certain non-governmental organisations have involved themselves in ensuring that pregnant women receive good and safe maternity kits to prevent neonatal mortality. For example, according to Leight et al. (2018), a study conducted in a health centre in Egypt revealed that women who used birth kits were less likely to have puerperal sepsis and their babies were less likely to develop cord infection. In Nigeria, these NGOs find it difficult to contact or locate these pregnant women or the communities they live in. In the effort to access some of these communities, they encounter bad roads and even the problem of identifying locations to deliver effectively.

According to Abdulkadir and Rainis (2020), Clean Delivery Kits (CDKs) are used to improve the care standard in the delivery at home and in health facilities where health delivery equipment is not available. Abdulkadir and Rainis (2020) also stated that in Jigawa State, in the northern part of Nigeria, pregnant women are monitored using reports from text messages which are sent to the ministry of health. However, the world has advanced, health records should no longer be managed via text messages only. This system is inadequate to ensure that health services are delivered optimally. Different researches have been carried out but less attention has been paid to how AI services can be delivered optimally. Specifically, there are few or no publications as to how AI can be used to improve the distribution of maternity kits in the rural areas of developing countries.

This research aims to address the issue relating to health care by Abdulkadir and Rainis (2020) and the advantages of having better healthcare distribution services of pregnancy kits to pregnant women using AI. Also, this research aims at advancing the researcher's previous master's thesis on the use of computer-based maternity and newborn birth record to enhance health delivery in Nigeria. In the researcher's previous study, in 2017, it was recommended that a web-based system with a friendly graphical interface, where data can be stored, can be designed and used by developing countries (Ibironke, 2017). This research also focuses on ensuring that maternity kits are delivered to expectant mothers using improved technological methods. With an effective method for delivering health materials, we can help to decrease the maternal mortality rate and neonatal mortality rate in Nigeria, especially in the

rural areas. Introducing a capable and intelligent technology can help to achieve a good health delivery system.

Jimenez in the World Economic Forum (2021) stated that leveraging on digital technologies is one of the three ways that healthcare can be improved in Africa. This will involve the use of an AI tracking and Delivery System by the community health workers in charge of the distribution of the maternity kits. To accomplish this using AI, the facial recognition or voice recognition of pregnant women or individuals who are registered to collect the maternity kits will be used. The proposed system will be designed with Flask using python and cognitive services such as facial recognition and detection, voice recognition, and location detection. The researcher aims to make use of different cognitive platforms such as Google Map Location, IBM Speech to Text, Microsoft Azure Face API, and Amazon translate to make this project AI-driven. The researcher will also attempt to embed in this study Natural Language Processing (NLP) tool and Amazon Comprehend which was developed to be used in the health sector.

1.1 Research Question

This study aims in answering the question below:

"To what extent can an artificial intelligent tracking and delivery system be used in effective distribution of maternity kits (Clean Delivery Kits- CDKs) to pregnant women in Nigeria?

1.2 Research Objectives

The objectives of this research include:

- To identify issues relating to the distribution of maternity kits by government and non-governmental organisations.

- To design a system that helps in the effective delivery of maternity kits in urban and rural areas.

- To compare the existing distribution system to the new proposed model.

- To analyse the design of the system using the top-down approach and the bottom-up approach of AI system design.

- To determine if the proposed system can be self-managed.

- To make recommendations regarding the future abilities of the designed system.

The concept of delivery discussed in this research can be categorized into two types. The first concept is delivery as a mode of transportation, whereas the second concept is delivery as a way of giving birth to a child by a woman. Great effort has been put in place while writing this research to ensure that the reader understands the concept in each sentence when the word delivery has been used.

In this research, a novel approach was used to determine how the use of AI can benefit pregnant women in the distribution of maternity kits. The method is called design science research. First, the problem of the present delivery system was identified by participants; secondly, a definite solution was proposed; an artefact was developed, and a demonstration may be made if required.

In this study, the researcher reports that most participants and intending users of the proposed system suggested that maternity kits could be delivered to them in their houses. This research also showed that participants were willing to disclose some of their basic information for the delivery process. However, very few participants would give their fingerprints, voice sample, and photographs to enhance an AI-driven system in maternity kit distribution, regardless of whether it is been delivered by the government or a Non-Governmental Organisation. (NGO). The quantitative report showed that even though a majority of the participants in this research indicated that they were comfortable receiving a maternity package from a delivery person, they were not comfortable giving out specific AI-driven details of themselves to enhance the AI approach.

1.3 Methodology

This sub-section explains how the research was conducted. It describes the type of research that was done and the limitations identified as a result of using the method indicated. It also

states the research question and a brief mention of the research aims that have been listed in Chapter One of this document. Also, it mentions the methods used in analysing the data gotten from the research survey.

This research is a qualitative case study research. It attempts to be descriptive and exploratory in nature. This case study method was selected because it helped to achieve my research objectives. It is also an empirical research that utilizes an interpretivism theoretical framework. It is based on an inductive qualitative method. Been inductive in nature, data was collected and then the research objectives were achieved, and recommendations were made. This research required the participation and involvement on the part of the researcher; hence a hypothesis was not needed. To answer the research question, a detailed study was made on the current means of delivering maternity kits to pregnant women both in the urban and rural areas of Nigeria. The literature review chapter enlightened the researcher on recent sources of data; however, these data were secondary sources. As a result of the ongoing pandemic, all the data were derived from structured online questionnaires or surveys, and structured paper-based questionnaires. This implies that the researcher's physical presence to administer questionnaires or perform a face-to-face interview or focus group interview which is always effective was not possible.

Also, based on the researcher's previous experience in the health sector as a result of carrying out a previous master's thesis in this field of study in the year 2017, most especially in the Maternity Department of Government Hospitals, previous data would be used in designing the proposed system. In the previous research five government hospitals, three primary health centres, and two private hospitals were visited by the researcher. A total number of 10 study sites were visited all in the urban areas and semi-rural areas.

To get more recent data, a structured questionnaire was designed which was distributed electronically. This questionnaire was designed using google forms, it did not incur any cost and it was easy to use. In addition, it provided ways to segment questions intended for participants classified as having children and participants who are involved in the delivery of maternity kits. Also, a paper-based questionnaire was designed for those who do not live in the

city centres and those who did not have access to internet services. The questionnaire contained both closed and open-ended questions to enable the participants to choose from a range of selections and to allow them to express their views. The questionnaire focused on the medium at which pregnant women have access to maternity kits. It was also used to determine the rate of effectiveness and timeliness of the current distribution system. It explored the technology involved in the delivery system if any was used. The question also attempted to propose the new model to be designed and get findings to determine if the system will be of good advantage to pregnant women. Interview with a Non-Governmental Organization (NGO) was scheduled early in February 2021 but as a result of time constraints, the representative could not make the interview and promised to be available for another online meeting. This is a qualitative research approach method.

In conducting the study, structured questionnaires were administered to a probability sampling and purposive sampling of about 50 pregnant women who have had children within the last three to five years in Nigeria. Presently, 75 participants filled the questionnaire. This however was more than the estimated participants that was projected while proposing this research. This showed that pregnant women are interested in seeing changes in the health delivery system in Nigeria. This helped to determine how they got their maternity kits, if at all any was made available to them. As a result of time, focus was made on women who reside in the urban areas, where traffic to hospitals may be high and where the number of pregnant mothers to be attended to are numerous, especially during maternity check-up days. This aspect of this research was carried out in the South-Western part of Nigeria, however, participants from across Nigeria were also be considered. Not neglecting the rural areas, data from secondary sources were used to validate how pregnant women in rural areas have access to maternity kits and effort was also made to access information from first-hand sources.

In addition, efforts were made to contact about 3 Non-Governmental Organisations (NGOs) and private individuals and foundations whose sole aim is in delivering maternity kits and medical relief materials to pregnant mothers, especially those in the rural areas. There was an attempt to conduct an online interview with a representative of one of the NGOs, however, it was not granted as a result of time constraints. This research was carried out from November 2020 to April 2021.

In conducting this research using the above pattern, an interpretivist research method has been applied. The primary data collected from the questionnaires was used in analysing and design the proposed distribution system. Furthermore, the qualitative method is an inductive approach that draws out facts from the answered questionnaires. However, if there was an existing intelligent distribution system while carrying out this research, information about this existing system will be studied and compared to the system to be proposed. Also, the questionnaire enabled the researcher to make recommendations for the system.

An important aspect of the case study method is that it is not bounded by a single piece of evidence or data (Yin, 2004). Both qualitative and quantitative data can be derived. As a result of using different kinds of evidence, this study becomes stronger to justify (Francisco et al., 2001). Also, according to Yin (2003) with questionnaires, it is possible to control any unexpected behaviour of the participants.

Ethically, for the interview, a self-introduction was given and the focus of my research was explained briefly. Also, the consent of the participant was required before the interview can be carried out and permission to record was requested. For the research questions, the aim of the research has been written at the beginning so the participants are well informed about what the questionnaire entails. Also, their identity will be kept anonymous and their answers confidential during and after the study process (Connolly & Begg, 2015).

In order to utilize the knowledge learnt while studying this master's degree program, a system had to be designed thus making this research applied in characteristics, while also tending towards design-science research. The research topic worked on describes how AI can be used in the tracking and distribution of maternity kits in Nigeria. This research was done because I wanted to find out how effective AI can be used in the effective delivery of maternity kits. I also wanted to find out how pregnancy kits are currently delivered. With this, an AI system can be developed to improve the distribution process, thereby making life easier for pregnant women and the distributors. The proposed system is to be designed using a combination of the top-down approach and the bottom-up approach of artificial intelligent agent design. This will also be determined based on the answers from the questionnaires.

Open-source tools and freely available cognitive services platforms were used in designing the system. The programming language used at the back-end design was python because it supports projects in machine learning. The tool used in designing the front-end was Flask. SQLAlchemy served as the database storage. The project was hosted on a free cloud-based service that supports all the tools used to avoid any cost implication. The project has been made available via GitHub. The platform used in the design of the backend was Visual Studio Code and PyCharm Community Edition. During the development phase, caution was made to ensure that usage of APIs did not exceed the given limit for the free cost. The free versions of all the above-mentioned technological tools were used so no cost would be incurred.

The study has its limitations. The main limitation was the unwillingness of some participants to be involved in the study as a result of fear that the link to the questionnaire was a scam and the unavailability of time by the NGO representative to attend any scheduled interview.

Two methods were used in analysing the data obtained from participants. Quantitative data were analysed using graphs and charts while qualitative data were analysed using thematic analysis. Google forms provided a breakdown of answers to the questions in graphs and charts. It was easy to analyse and it helped in ensuring that the deadline in analysing the questionnaires was met. The system was designed using the bottom-up approach rather than the top-bottom approach. This is as a result of the complex nature of the top-bottom approach. Also, a comparison between the existing system and the proposed system was observed and analysed.

1.4 Thesis Structure

This research is divided into the following sections: Chapter One introduces the importance of this research, the previous research conducted in this field, the research question and objectives, and the methodology used in carrying out this entire project. Chapter Two entails a detailed description of AI in the distribution of goods and services in reference to the distribution of maternity kits. This chapter also discusses the issues relating to the current distribution system of maternity kits; the benefits of maternity kits; and the advantages of using

AI in the distribution process. Chapter Three discusses how humans can be tracked. Chapter Four contains the research data and the analysis of the data gotten from the methodology carried out. Chapter Five explains the system architecture of the proposed design/model. It also explains the two ways in which this AI distribution of maternity kits can be carried out. Chapter Five also gives a description of the Use Case scenarios of the proposed system. This chapter also explains the Minimum Viable Product (MVP) of the proposed system. It states a comparison between the old system and the proposed system. Chapter Six discusses AI approaches as regards the proposed system. It that covered topics such as Map Location, Facial Recognition, ML, Twilio messaging API, Speech-to-Text, Voice Recognition and Language Translation.Chapter Seven explores the bottom-up approach and top-bottom approach to AI. Chapter Eight discusses if this proposed system can be self-managed. Chapter Nine highlights the research outcomes. Chapter Ten gives a breakdown of the conclusion, motivation for carrying out the research, and proposed recommendations.

1.5 Definition of terms

AI (Artificial Intelligence): refers to the set of technologies that allow machines and computers to simulate human intelligence.

Maternity kit: According to the Basic Delivery Kit guide created by Program for Appropriate Technology in Health (Path, 2001), a maternity kit or basic delivery kit is a single-use, disposable delivery kit containing essential components for the clean delivery of a baby. These kits are given to pregnant women before the conception of their child, and they can be used by untrained and trained birth attendants. Some of the contents in this kit include disinfectant, sterile gloves, a scalpel to cut the umbilical cord, a mat to lie on during labour and tablets to reduce bleeding after birth, adhesive pads to control bleeding, and a mucus extractor used to prevent asphyxia in new-born (Ndukwe, 2018 cited in BBC news; Rotinwa, 2018).

2 Related Work

There are three necessities for humans to survive, food, clothing, and shelter. The food sectors have involved the use of AI to serve millions of people better in the area of food delivery, however, in this pandemic period, health care is now becoming a major necessity for humans especially access to a good healthcare system. It is based on this that humans can eat, think of shelter, and even clothing. It is only a healthy person that can think of surviving each day. Hence, healthcare is important in the lives of humans. Terrorism, war, insecurity are all factors that have contributed to the lack of maternal healthcare resources especially in the Northern part of Nigeria. For those who at one point have been abused sexually, if not well managed by a supportive family and community, an increase in the risk of maternal mortality will be inevitable.

The pandemic period has not made good health care any easier rather it has challenged the operations of several health systems and practices worldwide. Without moving away from the focus of this research, pregnant mothers are one of the most vulnerable sets of humans in today's world prone to contracting diseases and losing their unborn child. International organisations such as WHO (World Health Organisation) and UNICEF are focused on ensuring that maternity care is given at its best and ultimate state, especially to those living in developing countries who do not have access to a good health system. Despite these, Izugbara and Wekesah (2018) believed that there are currently few studies that research on the priorities of women as regards been the beneficiaries of quality maternity care.

2.1 Maternal health in developing countries

Developing countries are also currently having a share of the facets of the pandemic, maternity kits are lacking or proved to be difficult to access as a result of the shortage of supply or lack of means of effectively delivering them to expectant mothers. We cannot but emphasize that pregnant women need all the good care that can be given irrespective of their background, income, location, or standard of living. Several NGOs have made it a responsibility and objective to ensure that these categories of humans (pregnant women) receive the desired

care that is expected. Most NGOs believe that no woman or child should die as a result of lack of proper health care.

Over the years, maternal mortality has been reduced across the world especially in developing countries. There has been a decline by 38 percent between 2000 to 2017 (United Nations Children's Fund- UNICEF, 2019). However, maternal mortality and neonatal mortality remain high in Nigeria, most especially in northern Nigeria (Abdulkadir & Rainis, 2020; Central Intelligence Agency, 2021). This idea expands on the fact that women need special care and attention (Knight, cited in Medicompare, 2018). This idea involves creating a tracking system that can help non-profit organisations effectively disburse pregnancy kits to expecting mothers. In past and recent times focus is made on just ensuring that the maternity kits are given to expectant mothers, however, the mode of delivery is usually not emphasized. In other studies, focus is made to ensure that the delivery kits are clean and still intact with all the items at the point of delivery, but it is not clear if the delivery was distributed in time or if it was effective and how the pregnant women were identified.

Figure 1. The contents of a maternity kit

A report by Knight (cited in Medicompare, 2018) stated that as a result of technology, healthcare can be delivered in a whole new way. Technologies have enabled the development of AI-assisted approaches to healthcare (Wang & Preininger, 2019). Lives have been saved faster than they were 100 years ago. Africa as a continent has been able to make use of the technology recommended by the western world, although we still have a long way to go (Knight, cited in Medicompare, 2018). Also, in the last ten years, there has been increasing interest in the application of AI technology in drug delivery system design. Neural networks, fuzzy logic, integrators, and differentiators have been applied to design the control system (Hassanzadeh et al., 2019). According to Gartner (cited in Gettman, 2019), the adoption of AI is still emerging across all industries. Nevertheless, with the exposure to advanced technology, it is now possible for those living in remote and rural areas to access better healthcare.

2.2 Some Technologies Used for Improving Maternal Health

Across the world, NGOs and private organisations, whose focus is on the health care of pregnant mothers, have developed equipment to help pregnant mothers in developing countries, who do not have access to a good healthcare system, deliver their children safely.

Support items and equipment have been made available to be included in the maternity kits for mothers. The support comes in the form of a downloadable mobile-friendly and easy-to-use application or a physical device. Most times, the focus is always on pregnant women who live in rural areas of developing countries. Research institutes such as Grand challenges Canada (2018) have developed technology-focused equipment to aid in the effective childbirth process for women. Some examples include:

- The University of Saskatchewan is providing a cloud-based digital registration and funds transfer management platform called SCOPE to help pregnant women access Maternity Waiting Homes due to barriers in transportation, distance, money, and lack of information to women in Mozambique.

- Sanyu Africa Research Institute in Uganda developed the BabySaver Tray that helps to assist mothers whose babies require resuscitation.

- Makere University developed a Maternal Post-Partum Haemorrhage (PPH) wrap that helps to control the PPH before professional intervention is available.

- The Canadian Network for International surgery developed a Maternal Expert Thinking Analyzer (META) which is a point-of-care diagnostic, training, and outreach app that provides a way by which midwives in Nigeria can enhance care to expectant mothers through sending of texts about the information on obstetrical dangers and a risk-based management plan to solve the danger. This app makes use of patients' data.

- CIPHER, managed by MicroFuse Technologies in Nigeria is also discovering a way by which a 3-D printed image from a smart-phone camera can be used to detect and diagnose malaria retinopathy, this is been researched because of the high death rate as a result of malaria in children below 5 years.

2.3 The Health System and Maternity Kit distribution in Nigeria: The current System

According to the World Bank (2021) and Central Intelligence Agency (2021), The Federal Republic of Nigeria has an estimated population of 200 million people. It is the largest population of any African nation. It is the fourth most populous country in the world, with a thriving youth population and with a rapidly increasing birthrate. Nigeria has 34.38 births per 1000 population, 8.89 deaths per 1,000 population, and a maternal mortality rate of 917 deaths per 100, 000 live births as estimate by the Central Intelligence Agency (2021). It is significant to note that Nigeria has 36 states with a Federal Capital Territory. About 52.7% of Nigeria's population live in urban areas while others live in semi-rural areas or rural areas.

The National Health System in Nigeria according to Adebayo and Ofoegbu (2014), is decentralized into a three-tier structure. It consists of the Federal Government, the State Government, and the Local Government levels. This structure is synonymous to the pyramid suggested by World Health Organization, (1996).

	Three-Tier Health System	Major Functions	Example
↑	Tertiary Level	Consultative care based on referral	Federal Government Hospital
	Secondary Level	Specialist in recognised health field	State Government Hospitals
	Primary Level	First point of contact with health professionals	Primary Health Centres

Table 1. Three-tier structure of the Nigerian Health System

Source: (Ibironke, 2017)

As seen in the Table 1 above, most of the population of Nigeria fully depend on the secondary level and Primary levels in the health structure. The primary health services in Nigeria which consists of maternity clinics, dispensaries, and health centres are mostly located in residential areas. Hence, mostly used by women and their children. However, most of the facilities provided are either not functioning appropriately or there is shortage of staff, but also most of these centres lack the installation of modern technological facilities.

As of 2018, the current health expenditure (CHE) in relation to the size of the economy of Nigeria was 3.9%, indicating that not much is spent on healthcare despite having many population when compared to countries like Ghana with a population of about 32 million people where 3.5% was spent on healthcare by the Ghanaian Government in 2018; and Finland with a population of about 5 million people where 9% was spent on healthcare by the Finnish government in 2018 (Central Intelligence Agency, 2021).

To support the shortfalls of the healthcare services provided by the government, certain NGOs (both international and local) and private individual organisations have been founded to ensure that adequate care is provided, specially for women and children. Focus is mostly on pregnant women. This is due to the fact that Nigeria ranks 4th on the lists of countries with a high maternal mortality rate in the world, despite been an oil-rich country (Abdulkadir & Rainis, 2020; Central Intelligence Agency, 2021; Leight et al., 2018).

In order to reduce this maternal mortality rate in Nigeria, NGOs and private individuals who have either lost a loved one due to pregnancy complications that could have been avoided if the right equipment were available at the point of delivery, have started packaging maternity delivery items in kits, in thousands of numbers, so that they can be used by pregnant women. These kits are mostly distributed in fairly low-income communities. Most especially in communities that do not have access to good healthcare systems. Nevertheless, many health centres and modern Nigerian hospitals also make use of these maternity kits (ONE, 2016). The cost of the kit is an estimated amount of N1,700 (US$5.30 or 4.06€). Maternity kits are mostly used by health workers and traditional birth attendants (TBAs).

One of the NGOs, named Mothers Delivery Kit (2021), located in the south-western part of Nigeria, has made a great effort in distributing about 512, 000 sterile birthing kits which aid hygienic deliveries in 189 different communities. The kits are also sold to hospitals, individuals, health centres, traditional birthing homes at an affordable price.
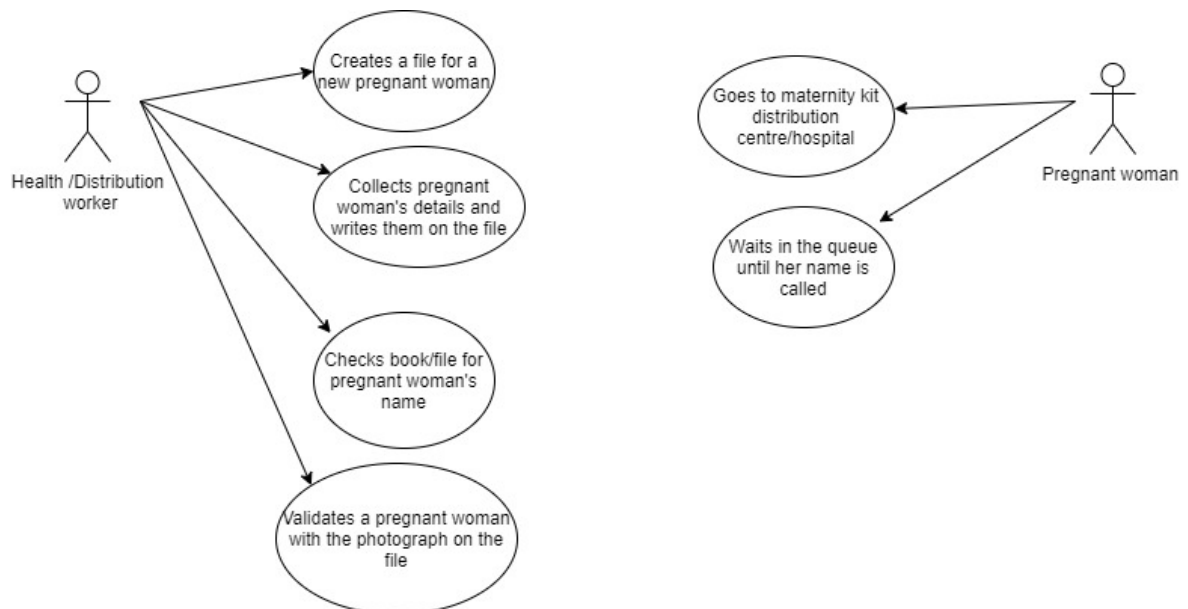
2.4 Use Case of the Current System

Figure 2. The Use Case design of the current distribution system.

2.5 Maternity Kit Delivery and Covid-19 impacts

The coronavirus pandemic will put a strain on how maternity kits are being received or delivered to pregnant women across Nigeria. In hospitals, there would certainly be more preventive and protective measures while disbursing these kits. With the shortage of health personnel in rural areas in Nigeria (Nigeria Medical Devices Report 2021 by Fitch Solutions, 2020), maternity kits may not be delivered to some expectant mothers at all.

2.6 Artificial Intelligence Tracking and maternity kit distribution

The history of Artificial Intelligence dates back to the vision and work of mathematician and computer scientist Alan Turing. AI applications are usually developed to reduce human biases and errors. Sometimes humans make poor decisions as a result of internal or external factors (Lumb et al., 2020). Jan Kleijssen the director of Information Society Action against Crime stated in his interview with the Council of Europe, that AI technologies continue to play vital roles in the world today most especially in sharing information about the pandemic such as how Corona developed and clinic trials (Council of Europe, 2021). AI has also currently been used in tracking individuals to ascertain who they have been in contact with as regards the spread of Covid-19.

Artificial Intelligence tracking has a broad scope and can be discussed under several headings. However, for this research, focus is made on how AI can be used to track pregnant women in the distribution of maternity kits. It was however not easy to get a narrow scope of this focus. Tracking humans can be seen as both legal and illegal. However, in this 21st century, humans are being tracked by devices and applications on their phones without them being aware of it. Tracking has been done mostly by using cameras or other object detection mechanisms. Tracking of humans in complex situations is challenging according to Zhao and Nevatia (2004). Humans are mostly tracked in closed controlled environments. Convolutional Neural Networks (CNN) which involved tracking by detection has been implemented as an AI strategy to track humans in a closed environment (Fan et al., 2010). To track humans in an open environment, surveillance cameras with static cameras are usually used and their movements are detected (Zajdel et al., 2005). Tracking humans with cameras for

the distribution of maternity kits will require lots of infrastructure and cost and may not be the best solution. In the bid to track pregnant women interested in getting maternity kits, we would be considering a different approach. This will be further discussed in Chapter Three. These different options include:

- Tracking by Phone Number
- Tracking by location

2.7   Issues Relating to the current distribution of maternity kits in Nigeria.

The following are the issues relating to the distribution of maternity kits in Nigeria. These attempt to answer the first objective of this research.

- Bureaucracy in delivering healthcare materials to pregnant women.
- Delay in delivery.
- Lack of accurate record for the delivery process
- The attitude of some health workers
- Poor infrastructure development

2.8   Benefits of Maternity kits

The following are the benefits of maternity kits when given on time to pregnant women, especially those in the rural areas:

- It can be used to save the lives of pregnant women who live in rural communities that lack modern hospitals and facilities for childbirth.
- It prevents post-delivery infections and bleeding. For example, the kit contains misoprostol, a drug used to stop postpartum haemorrhage. This drug may not be available in the local communities, but it is packed in the maternity kits supplied to them.

- It can be used to save the lives of babies that are to be born, thereby reducing neonatal mortality rate in Nigeria. This is most useful for those mothers who started the delivery through traditional means and their lives and babies are at risk.

2.9 Advantages of using AI in the distribution of maternity kits.

The following are the advantages of using AI in the distribution of maternity kits most especially in a developing country such as Nigeria:

- It will encourage the purposeful and systematic distribution of maternity kits to the expected target users. For example, this will help to solve the problem identified by Leight et al. (2018) in their finding in Jigawa state, located in the northern part of Nigeria, that the kits were not targeted at the right people.

- It is useful for developing countries in ensuring that pregnant women can be identified and given the maternity kits and other needed support. For example, this will help solve the problem of no evidence of receipt of kits delivered in Jigawa State, identified by Leight et al. (2018).

- Using AI will also help to support pregnant women with special needs so that they are not left out in the distribution process.

- It removes the problem of bureaucracy and lobbying in delivering good healthcare materials to women. This problem was identified by one of the NGOs in Nigeria.

- It helps in the analyses and decision-making process based on the records available.

- Using AI can help to solve problems that require human intelligence when planning for the distribution of maternity kits. For example, the best route.

- If Natural Language Processing is used, information can be analysed quickly, and languages can be translated. For example, the application can be programmed to have multiple Nigerian languages such as Yoruba, Igbo, and Hausa.

- It will enable distributors to cut down on logistics costs if the routes are planned effectively.

- Other AI systems can easily be added to the system in the future as the operation widens.

2.10 Stakeholders who would benefit from the AI distribution system.

The following stakeholders would benefit immensely from the effective distribution of maternity kits:

- Pregnant women
- Non-governmental organisation
- Government Organisations interested in the care of pregnant women.

2.11 The proposed Model for effective distribution of maternity kits

AI is changing the way healthcare is being delivered and this change is a rapidly progressive one. This model proposes that data used in the delivery of maternity kits can be accessed in real-time. This implies that any maternity kit distributor is capable of accessing the stored data from anywhere in the world. They can also draw conclusions from the data and access the latest insights within minutes. However, this can not be possible without the use of AI.

This study proposes the AI framework that enables the fast creation of AI applications. The framework used in this research is the Machine Learning framework, Facial Recognition Model, and Location Detection.

2.12 Design Process

The design process will involve the following:

- Getting basic information from users: name, location, age, stage of pregnancy (this will help to know the materials to be delivered), photo (the system can be advanced to facial recognition)

- Design of a basic database for the users and delivery personnel

- Design of the system architecture: including the use of external services such as location detection.

- Research on the appropriate top-down and bottom-up approach in solving the delivery issue.

3   How can Humans be tracked?

This chapter will be focusing on how humans can be tracked. To track a person means to have a description of the person's location in relation to a reference point. The concept tracking means "*the plotting of a trail, or a sequence of locations, within a space that is followed by an entity over a period of time*" (Clarke, 2001). The location of a person or an object can be determined with a varying degree of precision (Clarke, 2001). For inanimate objects, it is possible to know the exact location they are located such as the location of Automated Teller Machines (ATMs). However, for humans, a mode of technology or a technological device such as phones, portable computers that are mobile and other information will be required to infer their location at a specific point in time. Most often, the location of humans need to be within a moderately sized geographical area.   Humans can be tracked majorly with the help of technology. If technology is not involved, then it can only be done through other ways which can be seen as spiritual and not scientific. At the evolvement of the phone technology, the tracking system became more developed as technology became more complicated. When a person has a mobile device that can receive calls and SMS then there is an opportunity for humans to be traced.

Shortfalls of the phone number technology for tracking human is that, if the phone number of the person changes, then it is difficult to monitor or track them (Sundaramoorthy et al., 2017).

A relevant technology that can be used in tracking humans is the global positioning system (GPS). This radio-navigation technology has been in operation worldwide since 1980. The technology makes use of the positions of satellites as reference points. GPS detects, processes, and computes three dimensions of locations which are latitude, longitude, and altitude (Clarke, 2001). In order to be able to track humans with their cell phones using the Global Positioning Solution-based system, it is important that the user's location is kept active. This will enable the users' global coordinates to be detected. However, if only the user's phone number is known without the GPS, only the country or region of the user can be known.

Based on this research work, the focus is not to track the users' daily life as regards the messages or calls they receive, only the location of the pregnant women is needed so that the maternity kits can be delivered to them. However, some employers make use of the former to track their employees as regards the input and output of their work process.

According to Clarke (2001), it was suggested that location and tracking activities are dependent on pattern recognition and pattern matching technologies. Hence, it is based on this suggestion that the next chapters will be discussed based on the data collected from participants and the AI approaches that will be suggested. Chapter Six, states all the technologies that will be used in tracking pregnant women. However, the Map Location API will be used to actually direct the maternity kit distributor to the location of the pregnant women.

4 Research Data and Analysis

Data from the questionnaires was used for the research analysis. Also, data from secondary sources helped in analysing the research process. A sample of the paper-based questionnaire can be seen in appendix B of this document while the link to the online questionnaire can be seen in appendix A of this document. The online survey and paper-based questionnaire were the dominant forms of data collection used for this research (Gavin, 2008). This helped to provide information regarding the issues relating to the distribution of maternity kits. This was important in achieving the first, second, third, and sixth research objectives of this study. The entire research questionnaire gathered both qualitative and quantitative data. The participants were also allowed to write a free text answer without limitation to the number of characters. This implies that they were able to express themselves adequately. Analysis of the free-text answers or open-ended questions which are classified as qualitative data were analysed using the thematic analysis approach. This analysis was based on common patterns of answers by participants or regularly occurring themes (Blaxter et al., 2010; Bryman, 2012; Gavin, 2008).

S/N	Participant Analysis	Number
1.	Total Number of participants for the online questionnaire	64
2.	Total Number of participants for the paper-based questionnaire	11
	Overall Total Number of Participants	**75**

Table 2. Total Number of all participants

4.1 Primary Research Results and analysis

The following sections are the analysis of each of the subsections from the questionnaire. It is important to note that some sections will be differentiated based on whether they were filled online or filled on paper. This was differentiated because the online was updated with

new questions during administration. However, the paper-based question could not be updated because it had already been sent to the participants and could no longer be retrieved. For instance, the paper-based question did not contain options such as Fingerprint, Photograph, or Voice recognition for AI purposes as regards the information a participant is willing to provide to either the government or an NGO for the collection of maternity kits.

Furthermore, the paper-based questionnaire was distributed in the suburbs of the major city, that is they were distributed by hand in areas classified as a semi-rural area and not a proper rural area as a result of the limitation of the distributor as regards to time and the pandemic rules in the country as at the time of distribution.

4.1.1 Analysis of the paper-based questionnaire

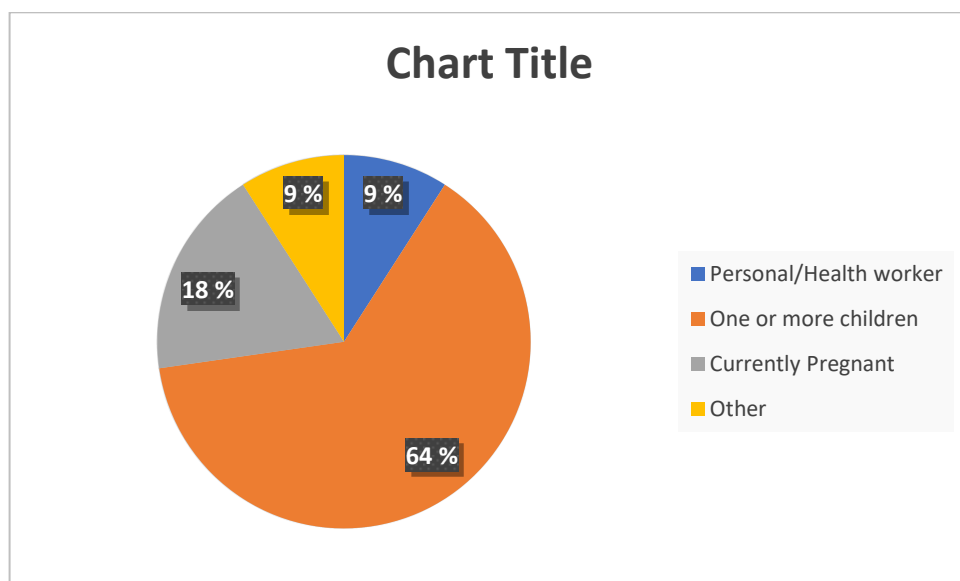
Figure 3. Participants for the paper-based questionnaire

- The first question in the paper-based questionnaire asked participants the category they fall into. 64% have one or more children, 18% were currently pregnant, 9% were health workers. This indicated that the paper-based questionnaire was able to target a moderate sample of participants, most especially those currently pregnant. It can

be seen that based on this, the paper-based method for questionnaire distribution attempted to be effective in locating health workers involved in maternity kit distribution.

- The second question in the paper-based questionnaire asked if they have had access to maternity kits. 55% of the participants did not have access to maternity kits, 36% had access and 9% of the participants were hearing about maternity kits for the first time. This further justifies that accessibility is on a low level as regards maternity kit usage. 36% had access to maternity kits. This justifies the need for AI in maternity kit distribution.

- The following question asked participants if they received maternity kits from the government. 64% indicated that they did not receive, while 27% indicated that they received. 9% indicated that they did not know. This further justifies the need for AI in maternity kit distribution by the government.

- The following question asked participants how they collected the maternity kits from the government. Only three (27%) participants out of the 11 participants for the paper-based survey indicated that they physically collected the kit from the hospital. Eight (73%) participants did not answer the question.

- The following question asked participants how the government delivered the maternity kits to their houses. However, since no maternity kits were delivered, this question was not answered by any participant.

- The following question asked how comfortable it was for participants to receive the maternity kits from the government. Based on a thematic analysis it was comfortable for the three participants.

- The following question asked participants if they received maternity kits from any NGO. 91% indicated that they did not receive any kit while 9% indicated that they did.

- The following question asked participants how they received the maternity kits from the NGO. 9% indicated that it was collected from the hospital while 9% indicated that it was collected from a designated place. 82% of the participants did not answer this question.

- The following question asked participants the means of transportation used by the NGO to deliver maternity kits to their houses. Since no delivery was made this question was not answered by any participant

- The following question asked participants how comfortable it was to collect the maternity kit by themselves from the NGO. Based on a thematic analysis, participants indicated that it was comfortable even though they had to be in a queue.

- The following question asked participants if they got the maternity kit from any other source. 73% indicated "No" while 9% indicated "Yes". 18% did not answer the question.

- The following question asked the participants to mention the source. Only one participant indicated that the maternity kit was from "self" meaning they bought the kit themselves.

- The following question asked the participant for the collection means of the other source. The participants indicated that they had to buy it themselves using the means of transportation they had.

- The following question asked participants if the maternity kits were safe to use and intact at the point of collection. Only 36% of the participants indicated "Yes". 64% did not answer the question.

The next set of seven questions were targeted at personnel or health workers involved in the distribution of maternity kits. It is important to note here that some of these questions were also answered by those who did not indicate that they were health workers.

- The following question asked health workers the kinds of facilities used in the distribution of maternity kits to pregnant women. The majority of the participants indicated that government-approved facilities were used.

- The following question asked participants if they felt that the appropriate means of transportation was used for the maternity kit delivery. Only 3 (27%) participants indicated "Yes". 73% did not answer the question.

- The following question asked participants about their preferred mode of delivery. Participants thematically mentioned house delivery and collection from hospitals

- The following question asked participants who are expected to be health workers how information on pregnant women is been accessed. Participants indicated that information is accessed individually from pregnant women. This further justifies the need for AI in maternity kit distribution.
- The following question asked the participants how easy it was to access the information based on a scale of 1-5. Only 18% of the participants indicated that it was not easy (Scale: 1) while 82% did not answer the question. This further justifies the need for AI in maternity kit distribution.
- The following question asked participants to rate the entire delivery process. Only 18% of the participants rated it 5 (Scale: 5 which implies very easy) while 82% did not answer the question.
- The following questions asked health workers issues faced while delivering the maternity kits. Thematically, the answers ranged from insufficient maternity kits, rowdiness, lack of cooperation from the pregnant women, illiteracy, and inadequate information. This question was targeted at answering the first objective of this research. This further justifies the need for AI in maternity kit distribution.

The next set of questions were general questions for all participants.

- The following question asked participants if they would prefer that maternity kits were delivered in their houses by the government. 91% indicated "Yes" while 9% did not answer the question.
- The following question asked if participants would prefer that the kit is delivered to them by an NGO. 73% indicated "Yes", 18% did not answer and 9% indicated "Maybe".
- The following question asked participants if they were comfortable sharing their basic information with an NGO. 64% indicated "Yes", 27% did not answer while 9% indicated "No".
- The following question asked participants for the information they were willing to share with an NGO: 22% were willing to share their phone number, 7% their names, 14% their email address, 57% their house address.

- The following question asked participants if they were comfortable sharing their basic information with the government. 91% indicated "Yes" while 9% did not answer.
- The following question asked participants for the information they were willing to share with the government: 21% were willing to share their phone number, 7% their names, and 72% their house address.
- The following question asked participants if they would be comfortable receiving delivery kits from a delivery person. 64% of the participants indicated "Yes", 18% indicated "No" while 18% did not answer the question.

4.1.2 Analysis of the online questionnaire

Figure 4: Participants for the online questionnaire

- The first questionnaire asked participants the category they fall into. It is worth pointing out that the online questionnaire did not have any health workers involved in the distribution of maternity kits. 85.9% had one or more children, 10.9% were currently pregnant. This further justifies the act that distribution of maternity kits is not adequately carried out in Nigeria and more health workers are needed in the health sector.

- The second question in the online survey asked if they have had access to maternity kits. 35.9% of the participants did not have access to maternity kits, 32.8% had access and 31.3% of the participants were hearing about maternity kits for the first time. This further justifies that accessibility is on a low level as regards maternity kit usage. 32.8% had access to maternity kits. This further justifies the need for AI in maternity kit distribution.

- The following question asked participants if they received maternity kits from the government. 90.5% indicated that they did not receive, while 9.5% indicated that they received. This points out that maternity kits are not effectively distributed by the government.

- The following question asked participants how they collected the maternity kits from the government. 50% of them indicated that they physically collected the kit from the hospital while 50% indicated that they did not remember.

- The following question asked participants how the government delivered the maternity kits to their houses. However, since no maternity kits were delivered, this question was not answered by any participant.

- The following question asked how comfortable it was for participants to receive the maternity kits from the government. Based on a thematic analysis it was comfortable for only one participant.

- The following question asked participants if they received maternity kits from any NGO. 95.2% indicated that they did not receive any kit while 4.8% indicated that they did.

- The following question asked participants how they received the maternity kits from the NGO. Only 1 participant indicated that it was collected from the hospital. The other participants did not answer this question.

- The following question asked participants the means of transportation used by the NGO to deliver maternity kits to their houses. Since no delivery was made this question was not answered by any participant

- The following question asked participants how comfortable it was to collect the maternity kit by themselves from the NGO. No online participant answered this question.

- The following question asked participants if they got the maternity kit from any other source. No online participant answered this question.
- The following question asked the participants to mention the source. No online participant answered this question.
- The following question asked the participant for the collection means of the other source. No online participant answered this question.
- The following question asked participants if the maternity kits were safe to use and intact at the point of collection. Only one participant who received the maternity indicated that it was safe. The other participants did not answer the question.

The next set of seven questions were targeted at personnel or health workers involved in the distribution of maternity kits.

- The following question asked health workers the kinds of facilities used in the distribution of maternity kits to pregnant women. No online participant answered this question because non was involved in the delivery of maternity kits.
- The following question asked participants if they felt that the appropriate means of transportation was used for the maternity kit delivery. No online participant answered this question.
- The following question asked participants about their preferred mode of delivery. No online participant answered this question.
- The following question asked participants who are expected to be health workers how information on pregnant women is been accessed. No online participant answered this question.
- The following question asked the participants how easy it was to access the information based on a scale of 1-5. No online participant answered this question.
- The following question asked participants to rate the entire delivery process. No online participant answered this question.
- The following questions asked health workers issues faced while delivering the maternity kits. No online participant answered this question.

The next set of questions were general questions for all online participants.

- The following question asked participants if they would prefer that maternity kits were delivered in their houses by the government. 48.4% indicated "Yes" while 18.8% indicated "No" while 32.8% "Maybe".

- The following questions asked if participants would prefer that the kit is delivered to them by an NGO. 35.9% indicated "Yes", 17.2% indicated "No" and 46.9% indicated "Maybe".

- The following question asked participants if they were comfortable sharing their basic information with an NGO. 60.9% indicated "Yes", 12.5% indicated "No" while 26.6% indicated "Maybe".

- The following question asked participants for the information they were willing to share with an NGO: 69.8% were willing to share their names, 73% were willing to share their phone number, 54% their email address, 52.4% their house address, 36.5% their location, 46% their age, 31.7% their pregnancy stage, 34.9% their marital status, 19% their fingerprint, 19.9% their photograph, and 4.8% their voice sample.

- The following question asked participants if they were comfortable sharing their basic information with the government. 59.4% indicated "Yes", 18.8% indicated "No" while 21.9% indicated "Maybe".

- The following question asked participants for the information they were willing to share with the government: 69.8% were willing to share their names, 77.8% were willing to share their phone number, 52.4% their email address, 58.7% their house address, 42.9% their location, 41.3% their age, 34.9% their pregnancy stage, 38.1% their marital status, 15.9% their fingerprint, 12.7% their photograph, and 7.9% their voice sample.

- The following questions asked participants if they would be comfortable receiving delivery kits from a delivery person. 73.4% of the participants indicated "Yes", 7.8% indicated "No" while 18.8% indicated "Maybe".

4.2 Thematic Analysis Approach to analyse participants' data:

4.2.1 Major Themes

Open-ended questionnaires for both the online survey and the paper-based question were analysed using the thematic analysis approach. The themes below highlight the responses of participants as regards the recommendations that should be implemented in the maternity section of the healthcare sector in Nigeria. This aspect seeks to provide answers to the sixth objective of this research. Although the certain of the answers point to the first objective of the research as well.

Usage of Technology

Some participants indicated that advanced technology should be used in advancing the health sector in Nigeria. Some of the technology mentioned is:

- Biometric Data Processing
- Use of computers
- Use of AI
- Teleconferencing tools for doctors
- Ultrasound imaging System

Better and Improved Healthcare

The responses of the majority of the participants pointed to the fact that better and improved healthcare is needed in the maternity section of the healthcare sector in Nigeria. A large portion of the free-text answers was related to recommending better ways by which the healthcare sector can be improved. Some of the major points are:

- Provision of medical insurance.
- Efficient working health system for maternity distribution.
- A better and comfortable delivery system for women.
- Better standards of materials used for the maternity kits.

- Increase in professional healthcare personnel in the maternity sector.
- Focus on improved healthcare in rural areas.
- Provision of constant electricity supply

Availability and Accessibility of healthcare

Certain solutions were provided by participants in response to the recommendation that the availability and accessibility of good healthcare can not be compromised for pregnant women. The major points include:

- Access to maternity aids
- Free delivery of newborns
- Mandatory distribution and collection of maternity kits
- Good care to pregnant women
- Good Health Equipment and supplies for pregnant women: Test equipment, incubators, Ultrasound imaging machine, infection detection machine, bed spaces for new mothers and their babies

Health Education and Public Awareness

- Healthcare professional staff training: Emphasis was laid on the training of doctors, nurses by participants. Certain participants indicated that the training should be intensified especially in the area of being compassionate health professionals.

5 The System Architecture

Based on the findings from the current system of maternity kit distribution and the research analysis conducted, Figure 5 shows the suggested system architecture for the proposed model. It is expected that there will be three categories of users in the system. Mobile devices designed with a friendly and easy-to-use graphical user interface (GUI) will be used to interact with the back-end. This system is also linked with cognitive service platforms for optimal performance.
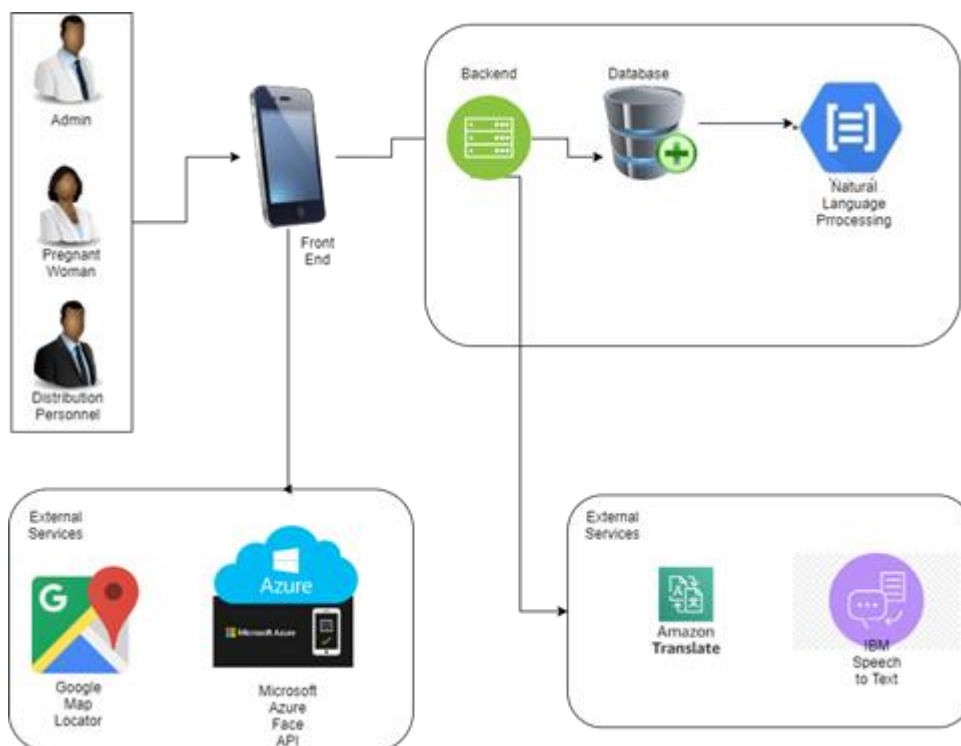

Figure 5. The System Architecture

5.1 Data Collection

The data to be collected from potential pregnant women for the design and development of the system includes:

- Name (voice recognition will be included if permitted)
- Location of collection (city or state) (Google Map API)

- Stage or month of pregnancy

- Phone number

- Homebirth or hospital birth

- Fingerprint

- Age

The system to be designed will entail:

- Text message (Twilio)

- Hosted with Heroku.

- Designed with Flask.

- Google Analytics

- ML (predicts expected date of delivery)

5.2   Use Case Scenario of the proposed system.

The use case helps to determine the functions that would be performed by users of the system. The proposed system has two actors that would be perform certain functions in the system.
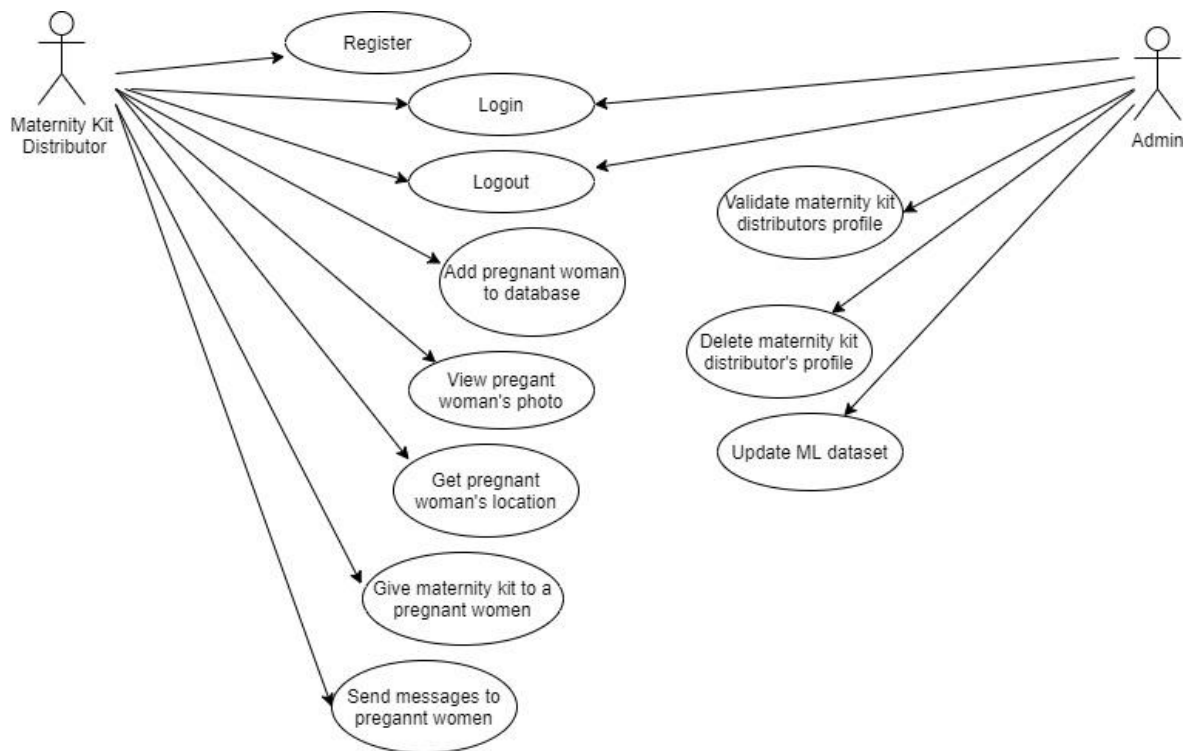
Figure 6. Proposed Maternity Kit Distribution Use Case design

5.3 Functionality requirements for the proposed system

Actor	Necessary Common Actions	Description
Admin **Maternity Kit Distributor**	Login	- Username - Password

Table 3 General Use Case Scenario

Actor	Action	Description and steps
Maternity Kit Distributor	Register	• User name • Email • Password
	Add pregnant woman to database	• Login • Enter woman's name • Insert Photo • Address/Location • Phone number • Email
	Get Pregnant woman's location	• Login • Click on direction page • Enter Location • Enter destination
	Give maternity kit to pregnant woman	• Login • Send message to pregnant woman. • Get pregnant woman's location. • Take picture of pregnant woman. • Validate with photo in the database

Table 4. Maternity Kit Distributor Use Case Scenario

Actor	Action	Description
Admin	Validate maternity kit distributors profile	• Login • Validate registered maternity kit distrbutor
	Delete maternity kit distributors profile	• Login • Delete maternity kit distributor profile from the users database
	Update ML	• Login • Update to ML dataset from codes

Table 5. Admin Use Case Scenario

5.4 Operations of the designed system.

To implement this system, two possible scenarios are proposed. The developed system is expected to be used with the following implementation styles.

The First Implementation Style:

In this process, the distributors of the maternity kits will be located at a given location in the city. When a pregnant woman is seen, permission to speak to her will be requested. If the consent of the pregnant woman is given, her details will be collected, and she will be registered into the system. If she is already in the system, the distributor will be notified, if a match with the same photo has been detected.

The Second Implementation Style

In this process, the distribution personnel will already have a list of pregnant women residing in a particular area or city. A text message will be sent to them to notify them that the NGO or government agency will be distributing maternity kits on a particular date and they should

be available. The participants (pregnant women can either send their exact location or address) to a specified number. The distribution team will then make use of Google Maps locator to track the participants and they will be verified using facial recognition to ascertain if they have already received the maternity kit or if they are registered in the system.

5.5 Comparison of the existing distribution system to the proposed model

Table 6 shows a comparison between the current system of maternity kit distribution and the proposed model. This helped to achieve the third objective of this research.

Theme	Current System	Proposed Model
Connectivity	In this current system, data is usually stored in files or registers. There is no connection to the internet or a digitalized database system.	The proposed model suggests an AI system that has enhance connectivity functions which is not a standalone machine. It proposes a machine-to-machine connectivity such as the AI application connecting to the Google Map API for address location..
Self -Learning	In this current system, there are no machines involved therefore there is no means for the system to self-learn	In the proposed system, the system is expected to learn for the datasets used in the prediction of the Expected delivery date of the pregnant women. Also, functionalities such as speech-to-text, and language translation will enable the system to

		lean based on the data inserted into the system. The AI system will act and adapt based on what it has learnt.
Identification	Women are identified mostly with a little membership card given to them at the health centres, hospitals, or collection centres or by using the photographs they submit at the point of registration.	Identification is to be done via facial recognition of stored photos of each pregnant woman by the AI system.
Authentication	Most times, no authentication is done to verify if the person receiving the kit, is the actual person.	The AI system proposes the use of fingerprints to further identify pregnant women
Records/Database	A paper-based healthcare delivery system is still operated in Nigeria. (Adebayo & Ofoegbu, 2014; Ibironke, 2017) Health records are still stored in books, files, or a register to tick that a particular pregnant woman has collected the pregnancy kit. It is also used during antenatal and post-natal visits. Sometimes there are incoherent record-keeping or missing data.	The proposed AI model will store data electronically using the SQLite database. Implementation of an E-health system will be introduced.

Usage of Technological Infrastructures	Most health centres have no computers, and most communities use no electronic means for health records.	The AI system proposes the use of portable electronic devices (PED) such as tablets, smart-phones, e-readers, and laptops by users of the system.
ICT Literacy	Most health workers are deficient in ICT literacy and compliant. Hence, the literacy level is and may be just adequate to execute their jobs	The proposed AI model would require users to have a sufficient level of ICT knowledge to be able to use the system
Technological Competency Training	Training sometimes is not done, because it may require some training cost.	Proper and effective training of individuals/users who will be involved in the distribution of the maternity kits should be implemented for this AI system to function effectively. Training on how to use the facial recognition system, navigate to locations, send bulk or individual messages, and verification using fingerprints will have to be made.
Stock of Kits	Most times, community health workers involved in the distribution rely on physically counting and the register. With this method, they know how many	The AI system proposes to be able to state the number of kits available and the number of kits delivered at every point in time.

	kits they have at any given time and how many have been distributed to the communities	

Table 6. Comparison between the existing distribution system and the proposed model.

5.6 The Minimum Viable Product (MVP) for the proposed AI model

In developing the proposed AI system, it is suggested that the MOSCOW list which indicates the 'Must have', 'Could have', Should have, and 'Wont have' features can be used. The 'Must have' features indicate the minimum viable product for this proposed AI design. This MVP has been suggested based on the fact that transitioning into an advanced technology in the health sector in Nigeria would require a huge budget to be allocated by the government. It is therefore recommended that certain features can be initially implemented before additional features and extensions can be added in the nearest future. These features include:

- A digital database for storing the data of pregnant women and the information for those who would be distributing the maternity kits. The current paper-based records would need to be transferred to an online database. For this proposed system, SQLite was used.
- The registration function to register maternity kit distributors.
- The login function for the kit distributors to be able to access the system which is meant for only authorized users.
- The logout function for the kit distributors to be able to logout of the system.
- Face recognition page to be used to recognise the pregnant women at the point of collecting the kit. The passport photographs of women which is usually collected at the point of registration, can be scanned into the system.
- A direction page embedded with Google Map API to be used to access the exact location of pregnant women.
- A page embedded with Twilio messaging API which will be used to send messages to pregnant women.
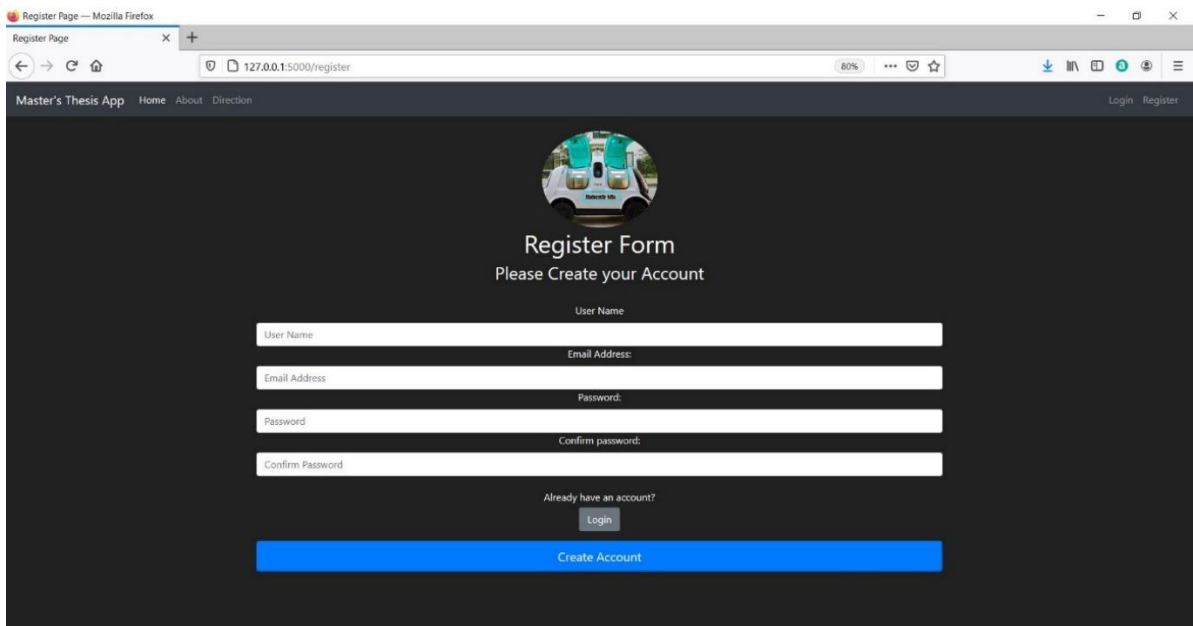
- The system can be hosted on the Heroku cloud platform because it is free and it is easy to manage.

6 AI Approaches

Pre-requisites:

Based on the system architecture and the design of the application, it is expected that before the application can be accessed by the application user who is the maternity kit distributor, the following procedures need to be performed:

- The application user should be registered into the database system. The user database provides a user authentication process that allows unique usernames and passwords are hashed in the database with the process called password hashing.

  Hence, a registration page containing a form is provided for the distributor to register and this is expected to be verified by the administrator of the system. Without registration, the system cannot be accessed.

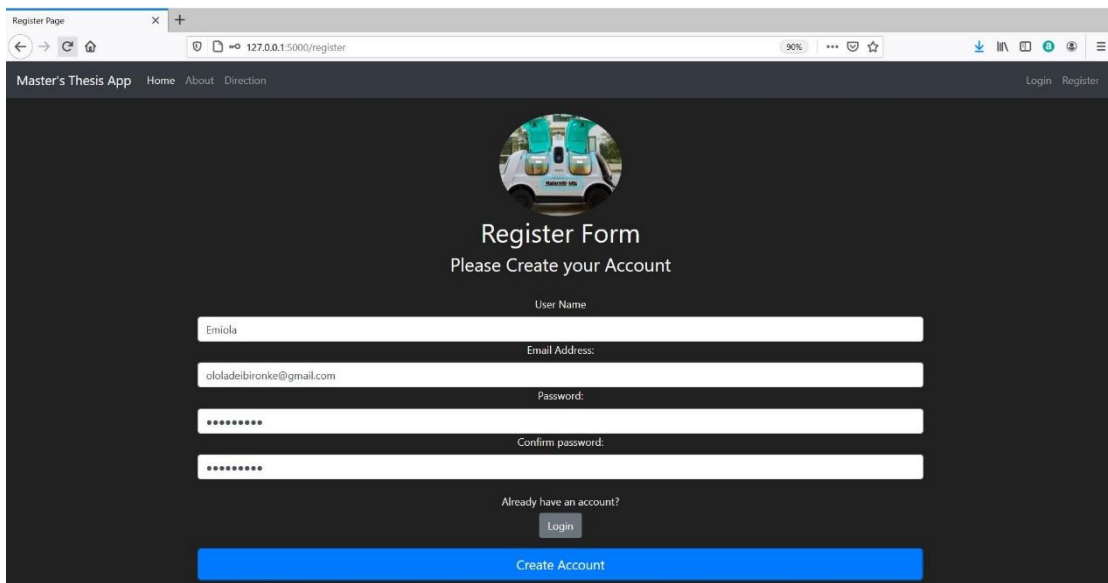Figure 7. The Registration page for the proposed AI system

Figure 8. A sample of the filled registration form

- The application user is expected to login with the details used during the registration process, that is *User Name* and *Password*
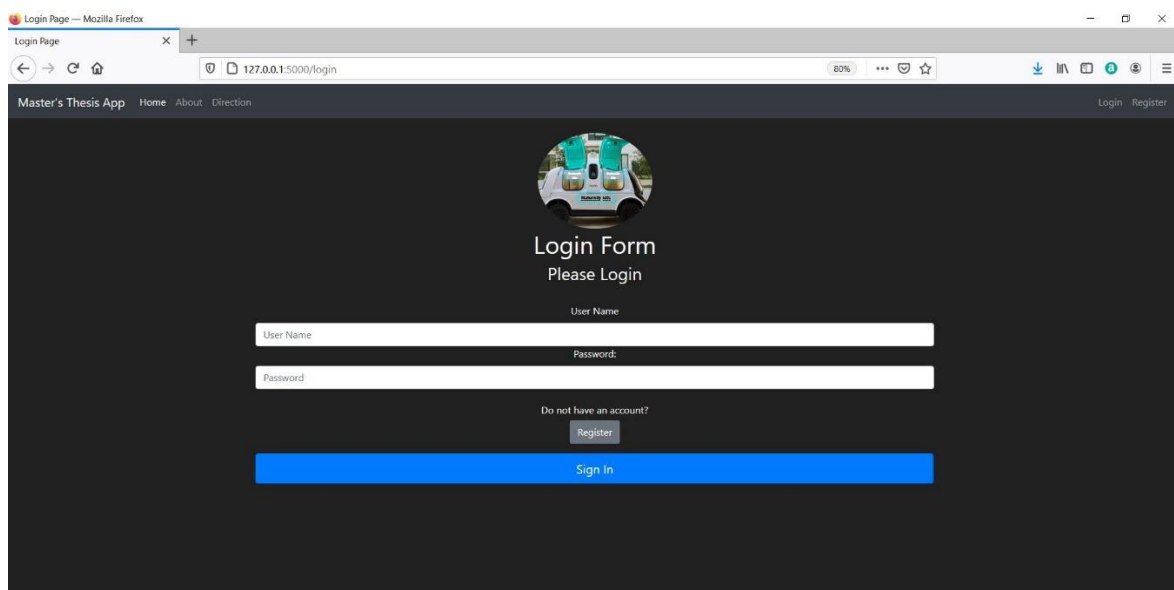

Figure 9. The Login Page for the proposed AI system

- After doing the steps mentioned above, the application user will be able to see the page with a list of all the pregnant women in the maternity kit database. The maternity kit database contains the lists of all the women that are expected to be given

maternity kits. These names can be collected from either the community head or from the hospital records. More names can be added in real-time as more pregnant women are identified.
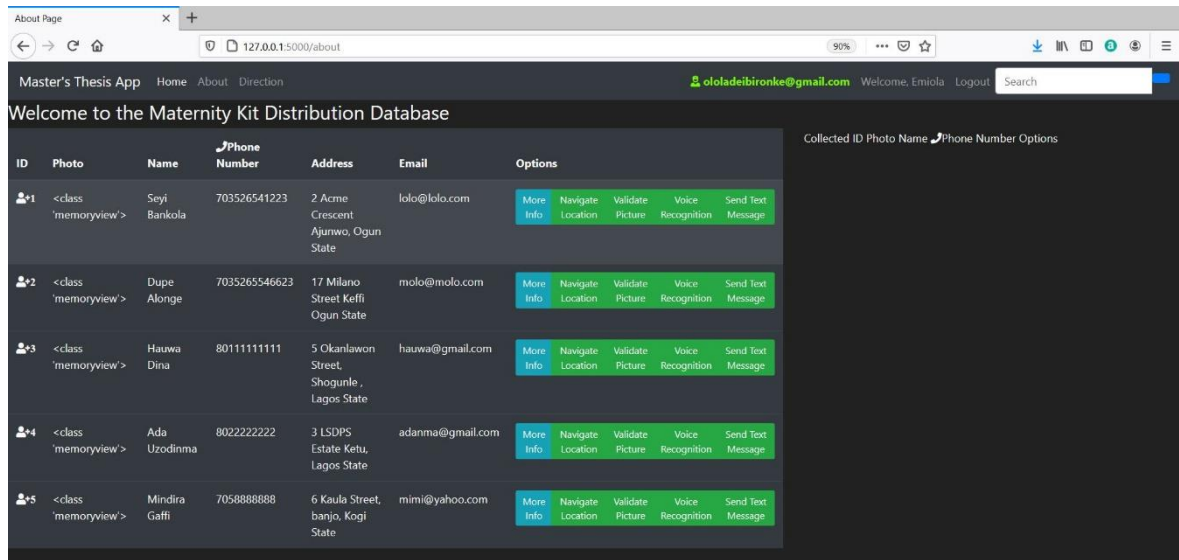

Figure 10. Page sample showing the list of pregnant women in the proposed AI system.

The following sub-topic discusses the AI functionalities that were suggested for the proposed AI system. The first four AI functionalities are currently implemented for the proposed AI system while the last three functionalities are for future recommendation of the expansion of the system.

6.1 AI approaches to Map Location

With the latest technology, routes between two locations can be mapped out, distances and miles can be calculated by the mode of transportation used or selected. For this study, Google Map API was implemented so that the exact or approximate location of the pregnant woman expected to receive the maternity kit can be seen. It will also be used to show the distribution personnel traffic on the routes.

On the Home page of the proposed model, Google Map API was used to indicate the location of the maternity kit distribution based on the country- Nigeria. This can be seen in figure 11 below.
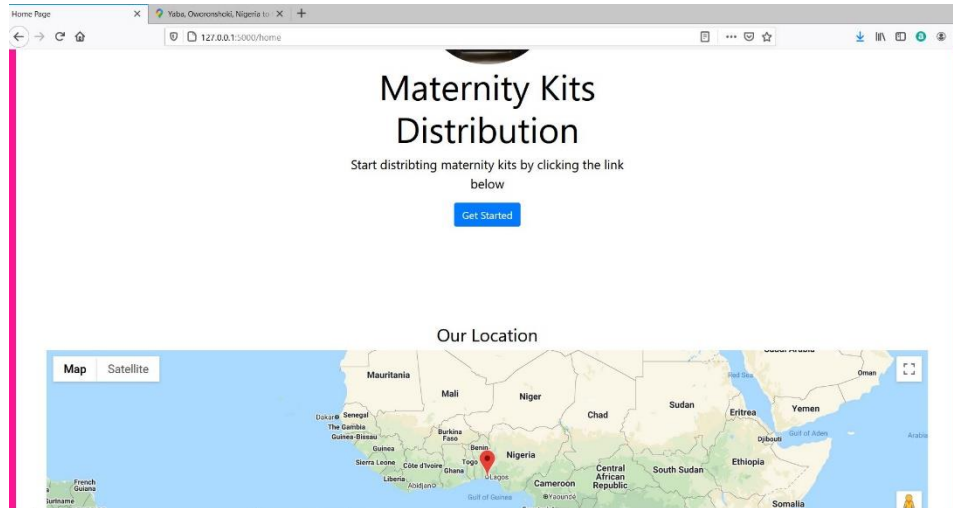
Figure 11: Home Page of the proposed model embedded with Google Map API.

In order to navigate to a particular pregnant woman's location, the direction page is clicked and the user is expected to fill out the text boxes as seen in the figure below. Figure 12 shows the direction page that would enable the user of the AI system to enter a source location to a destination. The user is then directed to the main google map showing the direction to the location they have entered.

Figure 12: Direction Page with inputs to be filled by the user.

Figure 13: Google Map is launched after the user's input has been filled
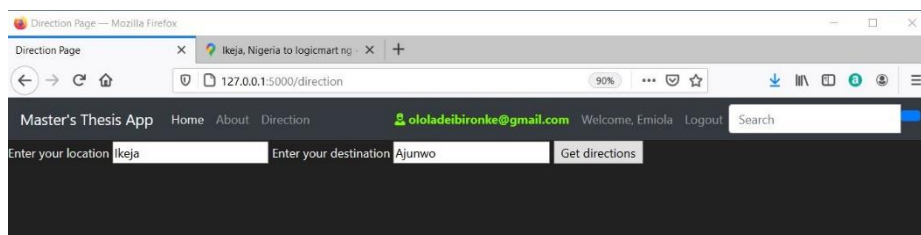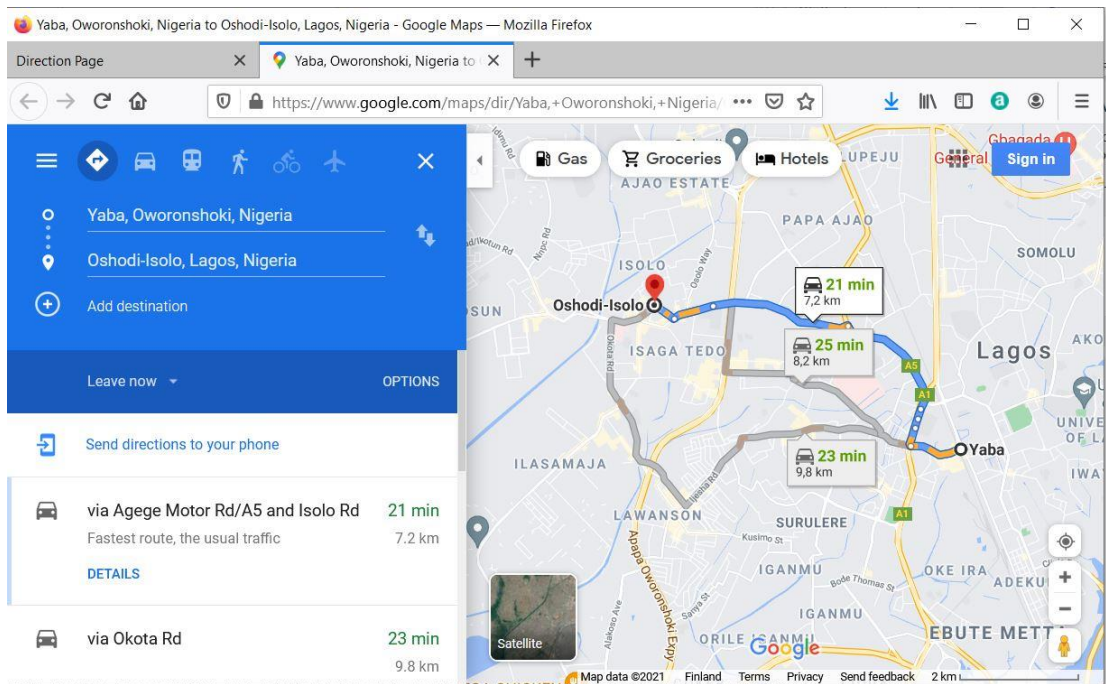and submitted.

6.2   AI approaches to Facial Recognition

According to Google (n.d.), face-related technology is useful to people and the society. Kaur et al. (2020), also agrees that the face is the most widely used and accepted biometric method which is a thoroughly researched area in computer vision for years. Facial recognition involves the process of identifying or verifying an individual's identity using their face. The analysis of the face is based on facial features. Facial recognition is being used by police, banks, airports, etc.

According to Thales (2021), the following processes are involved in facial recognition:

- **Face capture:** a face has to be captured.
- **Face detection:** a face is detected. Human faces and images are located in images.
- **Face match:** Facial identification as regards the contexts of this research involves matching a given face to one in an existing database containing different faces. A

face is matched to the database if it already exists. It involves a one-to-many mapping in the database.

This approach was suggested and implemented in this research because it does not involve the physical interaction of pregnant women with the application.

Based on the proposed model, sample pictures of photographs were tested using the facial recognition model (codes were written in python). The model accepts either .jpg or .png images. A file containing a list of images and their respective image names are stored in the image database. To use the model, a sample image of a pregnant woman is loaded into the face recognition model. The model detects a face in an image thereafter, a comparison from a list of images stored in the file is made to detect if there are any face match using the *face_recognition.compare_faces model*. A facial boundary box is drawn across a detected face in an image. If a face is detected and there is a match, the name of the person is displayed on the image as seen in Figures 15 and 16. The facial recognition package can detect multiples faces in an image but only one image file at a time. It is expected that if there is no match, the pregnant women should then be registered into the system. This AI approach will be used to ensure that the person receiving the kit is the same as the registered person. The figures 14, 15 and 16 are samples of some tested pictures:

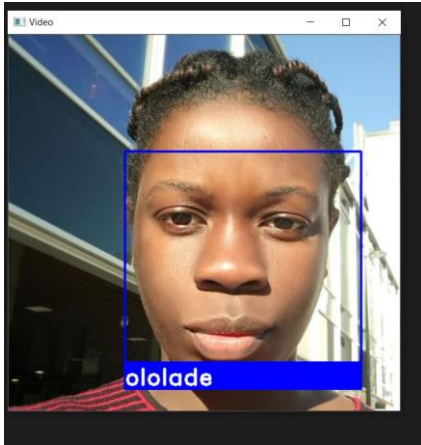Figure 14: Photo stored and labelled in the file as "*ololade*".

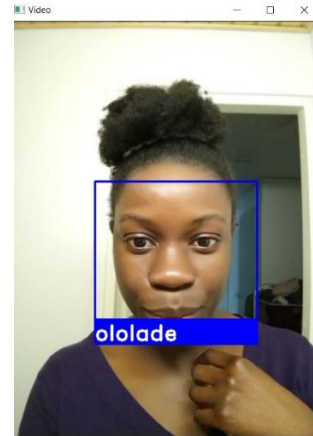Figure 15: Sample photo recognised from a file

Figure 16: Second sample photo recognised from file

In Figure 17 below, there was no facial match for the image below hence the text "unknown" is written on the image. In the process of carrying out this face match for this proposed model 17 picture sample were used on the model. The samples included photos with only one person to photos with two to three people. The sample also included photos of people from the same family and photos of people from different families. The photo also contained photos of the male and female gender. It matched photos based on facial features distances and it compares the features of the faces. It believed that the Constrained Local Model was embedded in the facial recognition model to find facial landmarks when comparing faces (Wu & Ji, 2019). Pictures with more than one face was also used to determine how effective the model was. It is important to note that this facial recognition model is not 100% efficient because it could not differentiate between a male and a female. It also was not able to detect different women from the same family. It recognised them as the same set of people in the image.
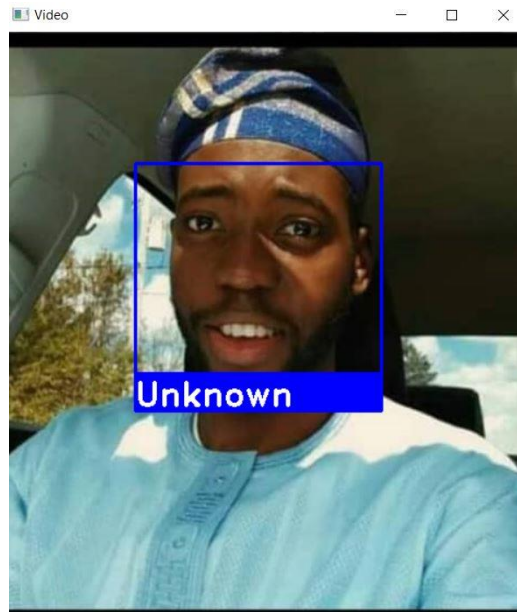
Figure 17: Unrecognised photo

In order to get a model that can predict different genders, it will be suggested that other cognitive tools with a high confidence capability to predict genders can be combined with this model. Platforms for facial recognition include Microsoft Azure Face API. This will also predict the facial features of faces in photos.

Advantages of the facial recognition approach:

- According to Google AI, one of the advantages of face recognition is to ensure that only the right person gets access to sensitive information meant for them.
- It helps to identify and track criminals.
- In the forensic sector, it can help to accelerate investigations.

6.3 Machine Learning (ML) for Delivery Date Prediction

Machine learning, a subdomain of AI, was embedded in the design of the proposed model. The decision tree classifier, a machine learning model was used in predicting the delivery date of a pregnant woman based on the first day of the last menstrual period. A dataset was

created using Microsoft Excel Spreadsheet, and some dates were omitted to check how the ML model could make precise predictions. The dataset contained the normal days (day of the month), months, and year for the year 2021. It also contained all the months in the year, days (Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, and Sunday), dates (numerical dates), and the year of the expected day of delivery (EDD) to be predicted. In figure 13 below, the decision tree classifier was used to predict the expected delivery date for a woman whose last menstrual cycle was on the 9th of December 2021. The prediction outcome for the expected delivery date is Friday, September 16th, 2022. ML models usually make use of a good amount of data. This expected date prediction did not make use of any calculation algorithm. Hence, it is expected that the dataset is updated, to avoid errors in the prediction outcome.

Figure 18: ML used for predicting expected delivery date.

6.4 Other technology Used- The Twilio Messaging API

The Twilio Messaging API is an online open-source API that is used in sending and receiving messages at scale. These messages can be customised according to the customers' needs.

It functions in over 180 countries and it is used by developers to deliver messages reliably. It also has real-time analytics for monitoring and troubleshooting message delivery and engagement (Twilio, 2021). Every registered user of Twilio is expected to create an account and a phone number is assigned to the user. In addition, an authentication token is created which is used in the programming process.

For the design of the proposed model, the Twilio API will be used to send messages to pregnant women. The message will contain the expected distribution date for the maternity kit, so that they are well informed. In addition, an added functionality is to allow the pregnant women to know that they have been effectively registered in the system. It will also be used to notify pregnant women about activities related to health. It is significant to note, that Twilio API has a usage range where charges are billed depending on the rate at which the services are used.
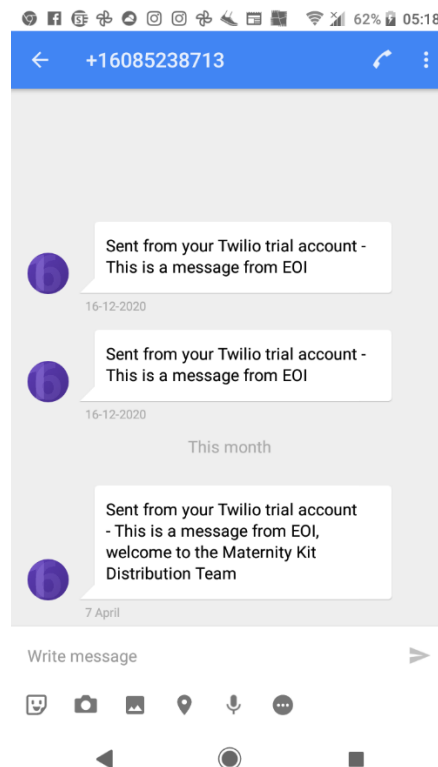
Figure 19: A sample of a Twilio Message sent to a phone number.

Note: The following AI approaches below have not been implemented as a result of the time required for the study. Notwithstanding, they are the suggested functionalities that can be added to the proposed model.

6.5 AI approaches to Speech-to-Text and Text-to-Speech

The Text-to-Speech and Speech-to-Text is a suggested AI approach that can be added to the functionality of the proposed system. This will be useful for distributors who have special needs as well as for women who have special needs too. This is to endeavour that there is no discrimination as regards the category of people involved in the distribution and collection of the kit. It will be used to ensure that there is provision for special needs people who are visually impaired or have difficulty hearing or speaking. Examples of cognitive platforms that can be used include IBM Watson Speech to Text (STT) and AWS Text-To-Speech

6.6 AI approaches to Language Translation

Previously, before technology could solve complex problems such as language translation, certified interpreters were needed when interviews or investigations were conducted between people who spoke different languages. In this 21st century, AI has been used to solve the problem of language translation. For example, the Australian Border Security officers make use of a translating and interpreting service to communicate with new immigrants that cross the Australian border (Australian Government Department of Home Affairs, n.d.). This AI approach can be used to ensure that certain languages are taken into consideration while the distribution is being carried out, because it may be expected that some NGOs may not speak the indigenous language of the community.

This approach will allow for effective understanding and communication. For example, as an international student here in Finland, I have been able to use the Google Translate app that is on my phone to read emails written in Finnish sent to me by some University staff. I have been able to use the app to convert them to English, so I can understand them. In addition, while in the supermarket, I have used Google Translate to get the Finnish word for certain goods that I need. This has made my shopping easier and faster rather than looking

for a shop attendant to describe my thoughts and needs. A translator on a mobile device can do much more translation than a human translator in that it has the ability to translate in many languages. Other examples of language translation platforms that can be used include: Amazon translate.

6.7 AI approaches to Voice Recognition

Voice recognition is another AI approach to recognizing and validating humans. Certain devices have embedded in them the ability to recognise the voice tones of the owners of the devices. For example, it is possible to navigate through a windows laptop using a voice recognition system. Initially, samples of your voice notes are stores and the system learns from them. It is based on this, that this approach was suggested for the pregnant women in the collection of maternity kits. During the registration of the pregnant woman on the proposed system, she will be required to provide a voice sample by saying her first and last names. This voice note is stored, which will be used to verify her at the point of collecting the maternity kit. This AI approach is expected to be used for further verification after the facial recognition has been used.

Note: All these individual AI approaches mentioned above will be inadequate if they are considered in isolation. This research aims to apply all these AI approaches in a variety of combinations to develop a powerful technology that can be used to help deliver maternity kits to pregnant women. In addition, Google Analytics can be used in accessing insights as to how the web application is been used by users.

7 The Top-down Approach and Bottom-Up Approach

In designing an AI system, it is important to choose the given approach in the system design. AI presents about three ways in which systems can be developed. This include: Top-Down, Bottom-Up Approach, and a self-managed or hybrid system. For this chapter, the Top-Down and Bottom-Up Approaches will be discussed, highlighting the differences.

In a nutshell, a Top-Down Approach to AI is a method of designing AI systems from solid human knowledge, while a Bottom-Up Approach is a method of designing AI systems that are self-learning systems. Table 7 below gives a clear difference between the Top-Down approach and the Bottom-Up Approach. For this research, the Bottom-Up approach was used.

Top-Down Approach	Bottom-Up Approach
It is also known as the symbolic approach	It is also known as connectionism
All knowledge used in the top-down approach is pre-programmed	The bottom-up approach is a knowledge base approach in which the program builds its own knowledge base.
It involves linking symbols, such as the semantic web where ontologies are created	The bottom-up approach functions like the way the human brain works. Explicit modeling is done, such as neural networks
It models high-level tasks.	It models lower-level human functions such as image recognition. Computer vision, speech recognition
Descriptions to be used are stored in the computer's memory such as a list.	The bottom-Up approach investigates how cognition can be recreated in artificial networks (Copeland, 2000)

Table 7. Comparison between Top-Down and Bottom-Up Approach

8 Self-Managed AI

A self-managed AI is an AI system that has gone through the process of self-learning. It involves the use of data mining, pattern recognition, and natural language processing to mimic the way human behaviour works. The data used by a self-managed system can be in the form of texts, speeches, images, videos, etc. The goal of a self-managed AI system is to solve complex problems that take a long time for humans to solve. It is also expected to make decisions (Terziyan, 2019).

In general terms, according to Ayala et al. (2012), a self-managed AI should be able to manage itself given a set of high-level goals without the intervention of human administrators. However, the system would require a lot of computational resources.

In describing a self-managed AI as regards maternity kit distribution, The AI is expected to perform the following, which is an attempt to answer the fifth objective of this research:

- Automatically detect or discover women on the system who are almost due for the delivery of their babies.
- Send messages to them automatically as regards the day the distribution of maternity kits will be made.
- Locate the address of a registered pregnant woman who is yet to receive a maternity kit.
- At the point of maternity kit collection, detect if the pregnant woman has been registered on the system through the facial recognition approach to AI.

9 Research Outcomes

The evidence presented in the research analysis suggested that pregnant women in Nigeria do not receive adequate health services as regards the delivery of their children. Based on the analysis performed, it can be seen that only 36% of the paper-based participants and 32.8% of the online participants had access to maternity kits. The research findings were discussed in terms of comparing the current system with the proposed system. A total comparison could not be done because an interview with a proposed NGO could not be scheduled. Also, health personnel and health workers involved in the distribution of maternity kits consisted of 9% of the entire participants. Nevertheless, secondary sources of information was used to ascertain and highlight the current system of maternity kit distribution.

Based on the data collected, it was discovered that participants were willing to give their phone numbers more than they were willing to give their names. The data collected will help in designing and further improving the functionalities of the system. Pregnant mothers and NGOs who distribute maternity kits and materials to pregnant women will benefit from the design of the proposed system. The system is expected to make maternity kit delivery effective. It is also expected to be secured and easy to use.

The findings in this study have several implications. First, more than half of the participants were willing to share their basic information. However, when asked to indicate which of the information they were willing to share, it was discovered that participants were not willing to share their photographs, voice samples, and fingerprints as much as they were willing to share their names, house addresses, email addresses, and phone numbers. This could limit the design of the implementation of the proposed system. In developing the proposed AI system for maternity kit distribution, it will be required that pregnant women would be willing to give certain of their details for the system to work effectively. Such details include photographs, fingerprints, voice notes, expected delivery date, address, and phone numbers.

Second, the qualitative work in this research indicated that most participants suggested that health workers need to be trained. Hence, in the implementation of this model, all health workers and future recruited workers who would be involved in using the AI system need to be trained without assuming whether they are technologically inclined or not. Otherwise, the

system will not be used effectively and there may be a delay in the distribution of the maternity kits, which is a problem that this research is meant to solve.

Third, in the design of the system using the facial recognition model, it was discovered that the model could not differentiate the pictures of different women from the same family because of the facial attributes common in families. This could mean that the system may not be able to efficiently identify woman A in family X from woman B in the same family X. Hence, the model would need to be developed further or another means of strong identification such as fingerprints will have to be used in such situations. This will be decided by the health worker involved in the distribution.

The foreseeable drawback in this project was the time it would take to complete the project to full implementation. Another drawback was the inability to get access to NGOs willingly to take part in an interview or answer the questionnaires. This limited access to first-hand information for this case study on the process of how maternity kits are distributed most especially in the rural areas. To get this information, secondary sources were used instead.

One of the characteristics observed in this case study research was that it was a time-consuming process for data analysis as a result of the qualitative and quantitative data that had to be analysed. Also, the process changed constantly (Creswell, 2012).

10 Conclusion

In summary, AI systems are designed so that they could learn, adapt and improve. They are designed so that they can do more than they have been programmed to do. In a nutshell, an AI system is expected to give you more than you have put into it. In the proposed design discussed in the previous chapters, it is expected that data is collected from pregnant women so that the system can be effective. AI systems make use of data to be able to give valuable results. The importance of the data can not be overemphasized. For example, data such as house addresses will enable the maternity kit distributors to have accurate direction steps using Google map API to locate the precise address of a pregnant woman. Several AI systems can be developed from the data collected based on this study.

In the design and development of an AI system for the tracking and distribution of maternity kits to pregnant women, focus must be on the perspective of the patient (pregnant women) and the users (health specialist or community health worker) to achievethe stated objectives. Data obtained as a result of achieving the major aim of distributing maternity kits will play a significant role in the development, planning, and maintenance of the healthcare system in Nigeria. In addition, based on the data obtained from pregnant women while ensuring they receive the maternity kits, certain researchers with permission granted, can research on other aspects that were not covered in this study.

Based on the findings of this research, the researcher believes that when those in the health sector consider using AI to improve healthcare services, the attention of the government and those in the decision-making positions will be drawn to increasing the current health expenditure (CHE) of the country. This is most important for those living in rural areas. This research also attempts to draw the attention of the government to the need to ensure that technology advancement reaches the rural parts of Nigeria.

The strength of this study is that the paper-based questionnaire and online questionnaire used was able to get the opinions of 75 participants (pregnant women, women who already had children, and health workers involved in maternity kit distribution) across the 36 states of the Federal Republic of Nigeria. This multidimensional approach was to take into consideration those who were not technology literates and those who are technologically educated,

thereby bridging the gap so that adequate information can be obtained from diverse categories of people. These participants also consisted of women and men who have had their children in Nigeria but who now live in other developed countries. They were able to state the issues they encountered relating to the distribution of maternity kits. These issues can be researched in the nearest further either by me or by other researchers to provide effective solutions. This solution can be implemented by the government and Non-Governmental Organisations.

10.1 Personal Motivation

As a researcher, I was motivated to carry out this research based on personal observations carried out during my visits to healthcare centres and government hospitals in Nigeria while in my early 20s. My motivation was further developed in the bid to acquire skills that would solve the healthcare problems of Nigeria, hence I applied for a master's program in Cognitive Computing and Collective Intelligence at the University of Jyväskylä in 2018.

10.2 Challenges and Dangers

The paper-based method of the survey provided interesting responses by participants. Although with the online-based questionnaire it was easy to edit and add more questions. Another challenge was that some of the questions were not answered by the participants and I did not consider that maternity kits could be purchased by the participants from other sources or by themselves.

11 Recommendation

According to (Afulani et al., 2019), further research needs to be conducted in the area of women's childbirth experiences most especially in facility-based childbirth. The findings of this study specifically identified the issues relating to the distribution of maternity kits in Nigeria. Most of the participants believed that more health care workers are needed. However, if we have more health workers and efficiency is still low and healthcare is not improved, would it benefit pregnant women? Hence, it is recommended to introduce advanced technology such as AI so that complex problems can be solved fast and more lives will be saved.

As regards the AI attributes for the expansion of this study, it is also recommended that other AI frameworks such as Neural Networks, Natural Language Processing, and Deep Learning can be used. In the long run, this project can be extended to using AI in packaging these maternity kits. Doing this will require computer vision. This will enable all the processes of packaging, distribution, and collection AI-focused.

This project can also be extended with an app usable by pregnant women where feedback can be received and used for further decision making or further feature advancement of the AI system from the primary end-users perspective. This feedback process can be done anonymously. The feedback can contain the outcomes of using the kits based on individual usage, the delivery system, and the attitude of the delivery personnel. Health workers who also use the kits can use this platform to suggest ideas and give their feedback as regards the effectiveness of the AI system or if improvement should be done. In addition, governments and NGOs can make use of this statistical data to improve health services and make decisions that would benefit the citizens of the country. Maybe, with this project, the Government can consider increasing their current health expenditure (CHE) on advanced technology that will save the lives of women and children and also in the nearest future remove Nigeria from the lists of countries with a high maternal mortality rate.

In terms of donation towards the development of the system, the application can also be extended to be usable by private individuals who want to contribute monetarily towards the

funding of maternity kits distribution. Potential donors can login and contribute using the app. It is also important to state that their data would be saved when they use the application.

In summary, the recommendations stated above have attempted to achieve the final objective of this research. However, certain recommendations are needed to be implemented before an AI system can be deployed. They include:

- Awareness creation and education of pregnant women as regards the AI system to be deployed, so that there is cooperation and trust can be gained on both sides to provide the right data to be used by the system.
- Provision of technological devices
- Effective, efficient, and planned training of both hospital health workers, community health workers, distributors, and IT personnel involved in the distribution and maintenance of the maternity kit AI system.

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Appendices

A   Online based Questionnaire Link

https://forms.gle/dBEgTa3w3Z353mWZ7

B   Paper-Based Questionnaire

QUESTIONNAIRE

Introduction

This survey is aimed at helping you contribute to the improvement of the services in the health sector of Nigeria. This questionnaire is basically for women, health workers or workers involved in the distribution of maternity kits. This survey will help in finding out the process involved in the distribution of maternity kits by health workers and the collection process and mode of collection of maternity kits by pregnant women (those who already have children and those who are currently pregnant). This survey will also help to investigate and identify issues relating to the current process of distribution and collection of maternity kits. A standard maternity kit contains essential items for the clean delivery of a baby, these items are used only once and then disposed. Examples include sterile surgical gloves, scalpel, a sterile clamp, sterile pair of scissors, adhesive pads, some tablets, etc. The survey is divided into four parts: Part A: Basic information, Part B: Mode of Collection, Part C: Mode of Distribution, and Part D: Recommendations. Your answers are very important and valuable to the success and outcomes of this research work. Thank you for your time in completing this questionnaire. At the end of the survey, you can choose to participate in a raffle draw which will be given to participants.

Section A:

Today's date: _____

Initials of your full name: _____

Which of the following category are you classified into?

☐ Personnel or Health Worker Involved in the distribution of maternity kits.

☐ You have one or more children.

☐ You are currently pregnant.

☐ Other _____

If you selected option 1 in section A, proceed to section C.

If you selected option 2 and/or option 3 or other in section A, proceed to section B.

Section B:

Did you have access to maternity kits?

☐ Yes ☐ No ☐ This is my first time of hearing of maternity kit

If yes, did the government hospital or government health centre give you a maternity kit?

☐ Yes ☐ No ☐ I do not know

If yes to the above question: how did you collect it from the government hospital or health centre?

☐ Delivered to my house ☐ Physical collection from hospital

If delivered to you in your house, what means of transportation did the government delivery person use?

_____

If you collected it yourself at the government hospital or healthcare centre, how comfortable was it for you? Kindly explain.

_____

_____

_____

Did a private individual or an NGO (Non-Governmental Organization) give a maternity kit to you?

☐   Yes   ☐   No   ☐   I do not know

If yes to the above question how did you collect it from the NGO?

☐   Delivered to my house

☐   Physical collection from a designated place

     ☐   Physical collection from hospital

If delivered to you in your house, what means of transportation did the delivery person use?

_____

If you collected it yourself at the NGO, how comfortable was it for you? Kindly explain.

_____

_____

_____

☐   Yes   ☐   No

Did you get the maternity kit from any other source?

Mention the source _____

What was the means of collection? _____

In all, was the maternity kit safe to use and intact at the point of delivery or collection?

☐   Yes   ☐   No

Section C: For Personnel or Health Worker Involved in the distribution of maternity kits.

What kinds of facilities are used in the distribution of maternity kits to pregnant women? Kindly Specify.

_____

_____

Do you feel that the maternity kits were well delivered by the appropriate means of trans-portation or collection method?

☐   Yes   ☐   No   ☐   Maybe

What mode of delivery would you prefer to use?

_____

How do you access the information of pregnant women when you need to deliver the maternity kits to them?

_____

_____

_____

Is it easy to access the information? Where 1 is not easy and 5 is very easy

☐   1   ☐   2   ☐   3   ☐

     4   ☐   5

How would you rate the delivery process?

☐   1   ☐   2   ☐   3   ☐

     4   ☐   5

What issues do you face while distributing these maternity kits?

_____

_____

_____

Section D:

Maternity kits are currently used in saving the lives of thousands of mothers and babies, especially those who have had their babies delivered at home and those living in rural areas. It encourages hygienic delivery of babies.

Examples of NGOs (Non-Governmental Organizations) and social enterprises involved in maternity kit distribution are: Marie Stopes International, Mothers Delivery Kit etc.

Would you prefer that maternity kits are delivered to you in your house by the government?

☐   Yes   ☐   No   ☐   Maybe

Would you prefer that maternity kits are delivered to you by an NGO?

☐   Yes   ☐   No   ☐   Maybe

If a maternity kit is to be delivered to you by a NGO, would you be comfortable sharing your basic information so that it can be delivered to your house directly?

☐   Yes   ☐   No   ☐   Maybe

What information are you willingly to give to be able to receive a maternity kit from an NGO?

☐   Name   ☐   Email   ☐   House Address

      ☐   Location

☐   Phone number   ☐   Age   ☐   Marital Status   ☐   Pregnancy stage

Any other information you are willing to disclose _____

If a maternity kit is to be delivered to you by the government healthcare, would you be comfortable sharing your basic information so that it can be delivered to your house directly?

☐　　　Yes　　　☐　　　No　　　☐　　　Maybe

What information are you willingly to give to be able to receive a maternity kit from the government?

☐　　　Name　　　☐　　　Email　　　☐　　　House Address

　　　☐　　　Location

☐　　　Phone number　　　☐　　　Age　　　☐　　　Marital Status　　☐　　　Pregnancy stage

Any other information you are willing to disclose _____

Would you be comfortable receiving a maternity package from a delivery person?

☐　　　Yes　　　☐　　　No　　　☐　　　Maybe

What kind of improvement would you like to be done to improve the maternity section of the health care in Nigeria?

_____

_____

_____

Raffle Draw:

Do you want to take part in a raffle draw?

☐   Yes   ☐   No

If yes, write your phone number? _____

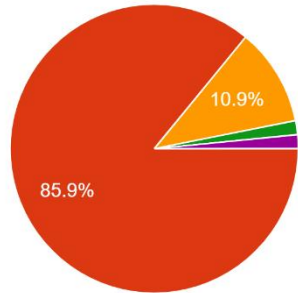If yes, write your email address? _____

....

Thank you for participating in the survey. Your response is confidential.

To contact me for additional information email stellagood03@gmail.com

C   Online Questionnaires Analysis charts

Which of the following category are you classified into?
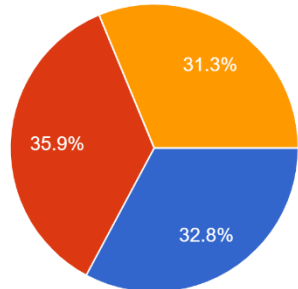
64 responses

- Personnel or Health Worker Involved in the distribution of maternity kits.
- You have one or more children.
- You are currently pregnant.
- A female
- No child

10.9%

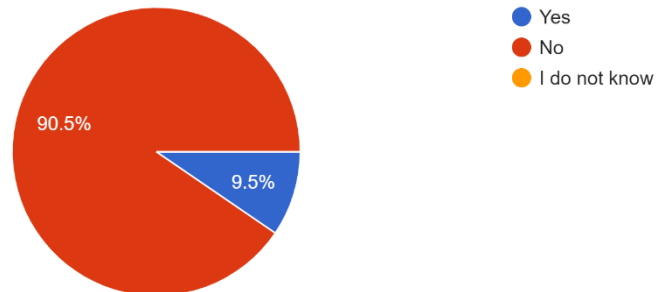85.9%

Did you have access to maternity kits?

64 responses

- Yes
- No
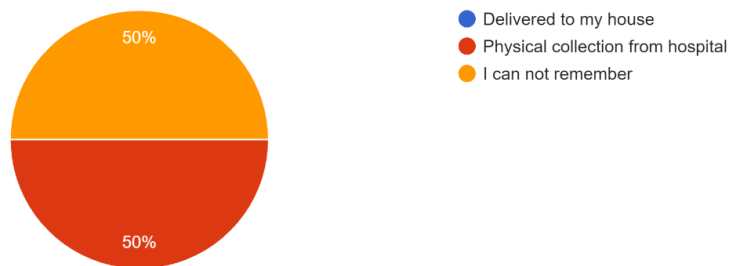- This is my first time of hearing of maternity kits

31.3%

35.9%

32.8%

If yes, did the government hospital or government health centre give you a maternity kit?
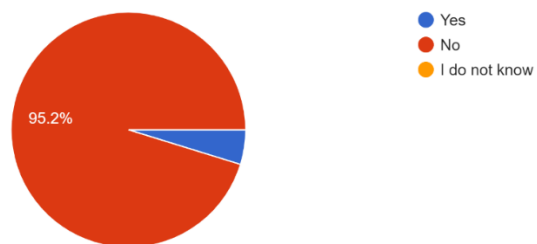
21 responses

- Yes
- No
- I do not know

90.5%

9.5%

If yes to the above question: how did you collect it from the government hospital?

2 responses

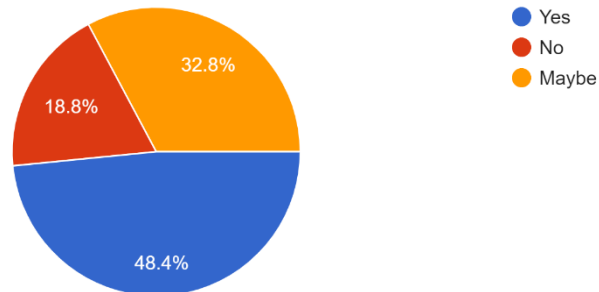- Delivered to my house
- Physical collection from hospital
- I can not remember

50%

50%

Did a private individual or an NGO (Non-Governmental Organization) give a maternity kit to you?

21 responses

- Yes
- No
- I do not know

95.2%

Would you prefer that maternity kits are delivered to you in your house by the government?

64 responses

- ● Yes
- ● No
- ● Maybe

32.8%

18.8%

48.4%

Would you prefer that maternity kits are delivered to you by an NGO?

64 responses

- ● Yes
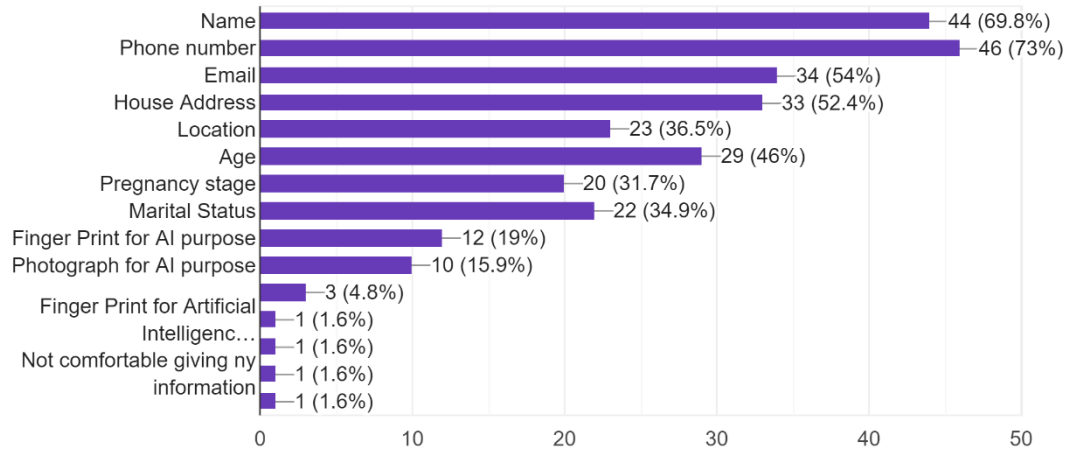- ● No
- ● Maybe

46.9%

17.2%

Yes
23 (35.9%)
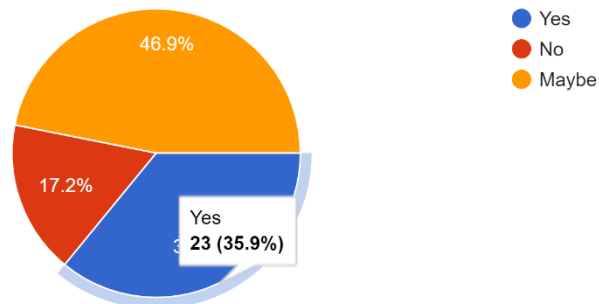
If a maternity kit is to be delivered to you by an NGO, would you be comfortable sharing your basic information so that it can be delivered to your house directly?
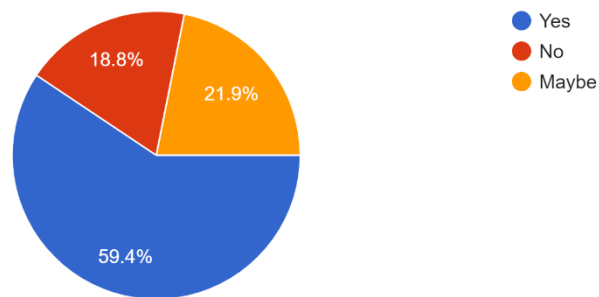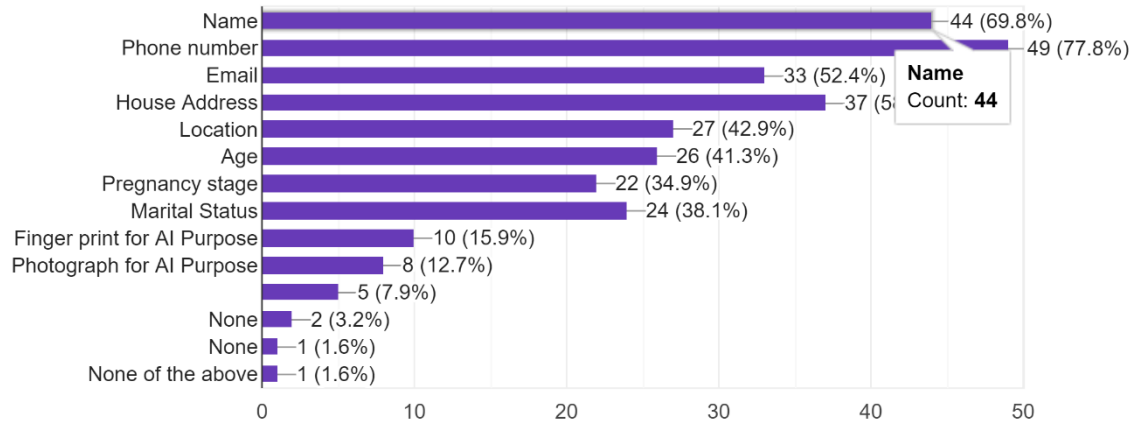
64 responses

- ● Yes
- ● No
- ● Maybe

12.5%

26.6%

60.9%
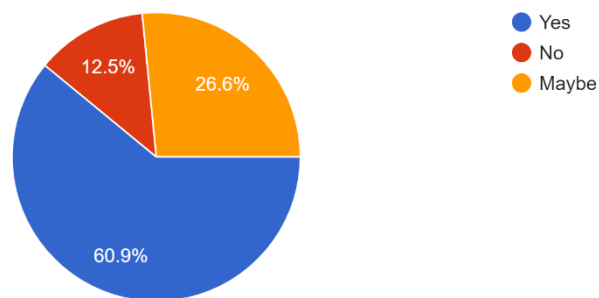
What information are you willingly to give to be able to receive a maternity kit from an NGO? The information you are willing to provided will be u...nce (AI) purpose (advanced technology) by the NGO

63 responses

Category	Value
Name	44 (69.8%)
Phone number	46 (73%)
Email	34 (54%)
House Address	33 (52.4%)
Location	23 (36.5%)
Age	29 (46%)
Pregnancy stage	20 (31.7%)
Marital Status	22 (34.9%)
Finger Print for AI purpose	12 (19%)
Photograph for AI purpose	10 (15.9%)
Finger Print for Artificial Intelligenc…	3 (4.8%)
	1 (1.6%)
Not comfortable giving ny information	1 (1.6%)
	1 (1.6%)
	1 (1.6%)

If a maternity kit is to be delivered to you by the government healthcare, would you be comfortable sharing your basic information so that it can be delivered to your house directly?

64 responses

- Yes — 59.4%
- No — 18.8%
- Maybe — 21.9%

What information are you willingly to give to be able to receive a maternity kit from the government? The information you are willing to ...purpose (advanced technology) by the government

63 responses

	Count
Name	44 (69.8%)
Phone number	49 (77.8%)
Email	33 (52.4%)
House Address	37 (5...)
Location	27 (42.9%)
Age	26 (41.3%)
Pregnancy stage	22 (34.9%)
Marital Status	24 (38.1%)
Finger print for AI Purpose	10 (15.9%)
Photograph for AI Purpose	8 (12.7%)
	5 (7.9%)
None	2 (3.2%)
None	1 (1.6%)
None of the above	1 (1.6%)

Name
Count: **44**

Would you be comfortable receiving a maternity package from a delivery person?

64 responses

- Yes — 73.4%
- No
- Maybe — 18.8%