# **ACRONYMS AND ABBREVIATIONS**

AIDS - Acquired Immune Deficiency Syndrome

APHRC - African Population Health Research Centre

CHV - Community Health Volunteer

DSS - Decision Support System

HIV - Human Immunodeficiency Virus

MDG - Millennium Development Goal

MMR - Maternal Mortality Ratio

NUHDSS - Nairobi Urban Health and Demographic Surveillance System

SDG - Sustainable Development Goal

UNICEF - United Nations International Children's Emergency Fund

UNFPA - United Nations Fund for Population Activities

WHO - World Health Organization

# **DECLARATION**

This proposal is my original work prepared with no other than the indicated sources and support and has not been presented elsewhere for a degree or any other academic award.

SIGNATURE ………………………………… DATE: …………………………………

Mwangi Peter Irungu

SCT321-C004-2079/2018

Jomo Kenyatta University of Agriculture and Technology

# **CERTIFICATION**

The undersigned certify that they have read and hereby recommend for acceptance of Jomo Kenyatta University of Agriculture and Technology a research proposal entitled “An Integrated Decision Support System to Reduce Maternal Morbidity and Mortality Rate in Kenya”.

Signature: ………………………………… Date: …………………………………

Dr. Waweru Kamaku

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**CHAPTER ONE**

**INTRODUCTION**

## **Overview**

This chapter provides the background information of this research proposal stating the problem statements, the set objectives and research questions of the study. The motivations behind the proposed research are outlined in the justification and significance of the study. The scope to be covered, limitations and assumptions of the proposed work is then covered and finally words considered to be crucial in the study are then defined.

## **1.2 Background Information**

Maternal health refers to the wellbeing of women during pregnancy, childbirth and postpartum period (Afica Progress Panel, 2010). It involves family planning, preconception, prenatal and postnatal care with an aim of giving a positive experience which in most cases would reduce the maternal morbidity and mortality. Whereas maternal morbidity refers to any physical or mental illness directly related to pregnancy and/or child birth, maternal mortality refers to the death of a woman while pregnant or within forty two days (42) days of delivery irrespective of site or pregnancy duration from any cause to pregnancy, or its management but not from accidental or incidental causes(WHO, 2018).The main cause of maternal deaths include severe bleeding, infections, unsafe abortion, high blood pressure and prolonged or obstructed labour.

Worldwide, it is estimated that 289,000 women died of pregnancy or childbirth related causes in 2013 which include but not limited to severe bleeding , obstructed labour, complications of unsafe abortions, infections, haemorrhage and high blood pressure, all of which have highly effective interventions (Khan, Wojdyla, Say, Gülmezoglu, & Van Look, 2006). This statistics is seen to be higher in Kenya.

Kenya continues to have a high maternal mortality ratio (MMR) despite the commitment from the government to address the issue. According to a survey report by (Survey, 2014) on the maternal mortality rate in Kenya as of 2010, it was estimated that 488 women out of 100,000 died as a result of pregnancy related issues. Consequently, Kenya is ranked as one of the most dangerous countries for a woman to give birth. The high rate of the maternal deaths was attributed to obstructed labour, complications of unsafe abortions, infections, haemorrhage high blood pressure and high number of unskilled personnel involved in delivery and cultural believes and practices.

In an effort to reduce the maternal mortality rate( MMR) in Kenya, the Kenyan government formulated a policy framework that would allow every person the right to access attainable standard of heath which would include the right to health care services including reproductive health care (Kenya Ministry of Health, 2014). In addition, it provided a devolved system of governance which gives the mandate of health care provision to county governments, hence providing an opportunity to address historical inequities in access to health care. Furthermore, in 2013, the Government of Kenya introduced free maternity services in all public health facilities (Bourbonnais, 2013).

Despite the political goodwill from the government to help reduce the MMR in Kenya, inadequate access to quality maternal services including ante-natal delivery and post-natal services continue to be a great challenge. Furthermore, access to skilled personnel during delivery continues to be a persistent challenge (Pyone, Smith, & van den Broek, 2017).Use of decision support systems (DSS) has so far been identified as an alternative of addressing these challenges.

A Decision Support System refers to a set of related computer programs that analyse data and presents it to end users for decision making activities (Jain, 2016). It facilitates data collection, storage and analysis of data so as to identify hidden patterns that can be useful in predicting probability of occurrence of a given outcome. The DSS system(s) have been tested and applied in the maternal health domain so as to assists the medical personnel while making decision. Due to its data storage capabilities, historical data of each patient can be retrieved hence no need of memorizing each patient’s details.

The African Population and Health Research Centre (APHRC) did a research of the role of DSS systems in enhancing community health Volunteers (CHV) effectiveness to improve maternal and newborns outcomes in Nairobi, Kenya. Use of the DSS significantly improved on the collected data completeness. Although there was a significant improvement in the data collection process, there existed gas in the data storage and analysis and information presentation functionalities.

The proposed work seeks to develop an integrated decision support system with an aim of reducing the maternal morbidity and mortality rate in Nairobi, Kenya. The approach would integrate data collection, storage, management, and analysis and information presentation functionalities. Consequently, the proposed work would help reduce on the maternal morbidity and mortality rate in Nairobi, Kenya.

## **Problem Statement**

Despite existence of decision support systems for maternal health care in Kenya, it was noted thatthere is scarce and unreliable maternal health data to be processed thus making it hard to carry out any analytical process to come up with remedies and prescriptive approaches for controlling maternal mortality in Kenya. This could be attributed to the fact that most, if not all, of the existing DSS systems concentrate more on data collection rather than the whole functionalities of DSS systems which are data collection, storage, management, and analysis and data reporting. The proposed work seeks to develop an improved DSS systems by integrating data collection, data storage, and analysis and information presentation functionalities.

## **1.4 Objectives**

### **1.4.1 General Objective**

The general objective of this research work is to develop an integrated information decision support system by incorporating data collection, storage, management, analysis and data reporting functionalities to reduce on the maternal morbidity and mortality rate in Kenya

### **1.4.2 Specific Objectives**

1. To identify gaps of existing techniques to reduce maternal morbidity and mortality in Nairobi Kenya
2. Describe maternal health indicators
3. Develop an integrated DSS for maternal health care
4. Design an android application for data collection by the CHVs
5. Implement an interactive and informative online web portal on maternal health

## **1.5 Research Questions**

1. What are the gaps of the existing techniques for maternal health care in Nairobi?
2. What are the maternal health indicators?
3. How can an integrated DSS for maternal health care develop and/or reduce maternal mortality and morbidity rate

## **1.6 Justification of the Study**

The developed integrated decision support system is expected to provide solutions to the challenges that have adversely affected women and newborns during the maternity. The system will provide a technologically based approach that would facilitate the process of data collection, data storage and management, data analysis and reporting. Using this system, medical practitioners would thus be in a position to handle more patients without the need of having to memorize each patient’s medical data thus minimize on the errors which may be as a result of human fatigue.

Additionally, this study will contribute knowledge to the maternal health care and decision support systems domain. Consequently, if adopted, it will greatly help to significantly reduce the maternal mortality rate (MMR) in Nairobi, Kenya, by supporting in making an informed decision.

## **1.7 Research Scope**

This study shall focus on maternal health care and application of decision support systems for maternal health care in Nairobi, Kenya. During the execution period, data collected within Nairobi and its environs only shall be used to test and validate the system.

## **1.8 Limitations of the Study**

During the period of this study a number of limitations are expected to be encountered. First, like any other research, time constraints will be faced given the task at hand of the research and the desirable delivery timelines. However, the research will make an effort to utilize the limited time by prioritizing key tasks of the study and executing them diligently. Second, financial constraint may affect progress of the study given the limited resources available to the researcher as a student. Despite the constraint, the researcher will strive to use the available resources without compromising on the quality of the work. Finally, the researcher is likely to be faced with the challenges of access patient’s medical data that would be key in testing and validating the proposed decision support system due to its confidential nature. However, the research strive to meet and follow the ethical considerations put in place to enable access patient’s medical records.

## **1.9 Assumption of the Study**

This study assumes that the data sample obtained to validate the system would include most of the factors that lead to high mortality rate in Nairobi, Kenya.

## **1.10 Definition of Terms**

**Maternal Health** refers to the health of women before and during pregnancy, childbirth and during postpartum period(WHO, 2010).

**Maternal Morbidity** refers to any physical or mental illness or disability directly related to pregnancy and/or childbirth (Koblinsky, Chowdhury, Moran, & Ronsmans, 2012).

**Maternal Mortalit*y*** is a

**Maternity** is the period of a woman during pregnancy and continues after childbirth (CITE)

**Decision Support System** is a

**Community Health Volunteer** is a

# **CHAPTER TWO**

# **LITERATURE REVIEW**

## **2.1 Overview**

This chapter provides a summary of the literature review done on maternal health care, maternal mortality, existing techniques that have been put in place to reduce maternal mortality rate, related studies and the conceptual framework of the proposed study.

## **2.2 Maternal Health in Kenya**

Reducing maternal mortality has been of great priority at the top of the global health agenda. To build upon the momentum generated by the 5th Millennium Development Goal(MDG 5), a transformative new agenda for maternal health has been laid out as part of the sustainable development goal ( SDG) to reduce the global MMR to less than 70 out of 100,0 live births by 2030 in which Kenya is a signatory.

The high rate of MMR in Kenya are attributed to factors which include but not limited to; lack of sufficient skilled labour during delivery time, lack of access to hospital facilities especially in the rural areas, high cases of HIV and AIDS infections, unsafe abortions among other causes. The calculations done by WHO, UNICEF, UNFPA and the World bank based on the available national data for Kenya, shows that MMR declined by twenty six (26) percent between 190 and 2015 from 687 per 100,000 births to 510 and the life time risk of maternal death is one (1) out of forty two(42)(CITE).

## **2.3 Maternal Health in Nairobi, Kenya**

In Nairobi, maternal mortality is higher and skilled attendance at delivery is lower especially in the slums of Nairobi. Lower number of public health facilities compared to its population, greater distance to the facilities and high costs of maternal health services could best explain the high rate of maternal mortality in Nairobi.

A number of studies have shown that the residents of the slum areas in Nairobi, which account to sixty (60) percent of its total population, register poorer health outcomes than other urban resident. (CITE). The MMR was as high as 706 maternal deaths out of 10000 births between 2003 and 2005 in two slums of Nairobi covered by the Nairobi Urban Health and Demographic Surveillance System (NUHDSS) (CITE).

## **2.4 Decision Support System Concepts**

Haettenschwiler’s and Gachet in (Gachet & Haettenschwiler, 2003) classified DSS systems according to the relationship with the users to:

1. *Passive DSS* is a system that aids the process of decision making but cannot bring out explicit decision suggestions or solutions
2. *Active DSS* helps to bring out decision suggestions or solutions
3. *Cooperative DSS* allows the decision maker to modify, complete or refine the decision suggestions provided by the stem before sending them back to e system for validation.

According to Daniel Power in (Power, Sharda, & Burstein, 2015), decision support systems can be classified to:

1. *Communication driven DSS* supports more than one person working on a shared task
2. *Data driven DSS* emphasizes access to and manipulation of a time series of internal company data and sometimes external data
3. *Document driven DSS* which manages, retrieves and manipulates unstructured information in a variety of electronic formats
4. *Knowledge driven DSS* that provides specialized problem solving expertise stored as facts, rules, procedures or in similar structure
5. *Model driven DSS* that emphasizes access to and manipulation of statistical, financial, optimization or simulation model. It utilizes data and parameters provided by users to assist decision makers in analysing a situation.

The defining characteristics that differentiate DSS system from other software is that they collect, store, analyse and present information. These functionalities are supported by its basic components which include the system inputs, user knowledge and expertise, outputs and decisions. The inputs include all factors and or/ characteristics that need to be analysed while the user knowledge and expertise constitutes the inputs that require manual analysis by the user.

The section 2.5 discusses the implemented DSS systems in Kenya for maternal health stating their contributions in the maternal health care domain and their limitations.

## **2.5 Related Studies**

This section discusses the existing DSS systems for maternal health care in care stating their significance and shortcomings.

Pauline , Eva , Milka, Ziraba and Catherine in (Bakibinga, Kamande, Omuya, Ziraba, & Kyobutungi, 2017) sought to address the identification and referral of ill mothers and newborns especially in the slums. They used the existing CHV work tools and mobile phone technology to show how an evidence based intervention can improve health outcomes a community level. The overall objective of their work was to develop and validate a decision support algorithm within a mHealth application in improving maternal and newborn outcomes in urban slums of Kamkunji in Nairobi, Kenya. Using the proposed system, it was anticipated that the CHVs would identify pregnant women who faced high risk hence refer them t the necessary health facilities. Despite these advances, heir project was faced with challenge of possible technology failure, loss of equipment (phones) and CHV turnover. In addition, the CHV workers are not medically trained hence are not allowed to treat rather than refer, even when the system suggests so with possible negative health consequences for the mothers and their newborns.

In the study by (Haskew et al., 2015), a cloud based electronic medical record(EMR) for maternal and child health was proposed. The EMR system, referred to as Uamuzi bora., was implemented in a maternal and child health outpatient setting in Western Kenya between April and June 2013.The impact of the system on improving completeness of data collected by clinical and health services was assessed in their work. Significant improvements in completeness of the antenatal record were recorded through implementation of the system. A difference of 42.9% in missing data was recorded. Despite the significant impact of the system on data completeness, overall screening rates in the antenatal care were low. **They recommended that data management and patient confidentiality must be considered when developing decision support systems for maternal health care.**

# **CHAPTER THREE**

# **METHODOLOGY**

## **3.1 Overview**

This chapter explains the research design that is proposed in the study. It further elaborates how the experiment will be setup, how data collection, data analysis and data presentation will be done. The scope of the study is then elaborated stating the sampling procedures and size that will be considered. The measures put across to ensure that quality control measures will be adhered to are then discussed under the reliability and validity section. The chapter ends by giving a brief summary of the methodology that will be used to conduct the research and also the ethical considerations that will be put in place.

## **3.2 Research Design**

This study is an experimental research based on the principles of data manipulation. It will be based on the principles of:

*Randomization* whereby the experiment condition to be measured will be assigned randomly to the experiment units so as to avoid biasness.

*Replication* that requires the experiment to be repeated on many experimental units in a bid to increase scope of inference.

*Local control* so as to minimize the experimental error by balancing, blocking and grouping the experimental units.

## **3.3 Population and Sample**

This study will consider sample data samples collected from health facilities in Nairobi County, Kenya. The data collected will include all the pregnancy related stages, that is, prenatal, antenatal and postnatal data. The prenatal data will consist of all details pertaining to health of the mother and child before birth, the antenatal will include all attributes related to the mother and child during pregnancy while the postnatal data will consist of all factors after birth.

## **3.4 Data collection**

A high quality data was required for realizing best results, it was important therefore that its acquisition be highly reliant on the quality of the data collection process. The study will rely on the utilization of maternal health data collected from health services in Nairobi. After attainment of research permit by the university, after approval of this research proposal, the researcher will approach the relevant bodies to request for the patient’s records, which are normally recorded in the facilities Electronic health records (EHR).

## **3.5 Experimental Setup**

## **3.6 Reliability and Validity**

The reliability and validity of this research are discussed in section 3.6.1 and 3.6.2 respectively.

### **3.6.1 Reliability**

Reliability is a measure of how consistent, stable and repeatable a research is and that the results obtained will be identical in the same situation but different circumstances(Twycross, Shields, & Rgn, 2005).The experiments will be run multiple times and results for each experiment recorded so as to evaluate if there exists any difference in the experiments.

### **3.6.2 Validity**

Validity can be defined as the degree to which a research measures what it was supposed to measure and it achieves content, construct and criterion-related validity. The content validity measures degree to which a randomly selected item represents a domain of property or trait being measured whereas the construct validity is concerned with the degree to which a research measures the construct it was designed to measure while the criterion-related validity detects presence or absence of one or more criteria considered to represent traits or the constructs of interest(Thatcher & Ph, 2010). Content and construct validity will be ensured by experts, peer reviews and supervisors

## **3.7 Data analysis**

## **3.8 Ethical consideration**

An approval from the Ethical Research Committee (ERC), Board of Postgraduate Students of Jomo Kenyatta University of Agriculture and Technology and a permit from NACOSTI will acquired before carrying out any of the research activities. The patient data that will be acquired will only be used for this research work and will not be published or shared without the consent and permission from the organization providing it.

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# **APENDIX A: WORK PLAN**

# **APPENDIX B: BUDGET**

|  |  |  |  |
| --- | --- | --- | --- |
| Activity | Quantity | Unit Cost(Kshs) | Total Cost(Kshs) |
| **Data Collection:**   1. Stationery:   -Pens  -Flash Disk  -Files   1. Printing 2. Literature Review 3. Internet Connection | 2 dozens  8 GB  4 Pieces  300 pages | 60\*12\*2  1,500  60  3 | 1,440  1500  240  900  30,000  10,000 |
| **Sub Total** |  |  | **44,080** |
| **DATA ANALYSIS**   1. Plagiarism Checker Pro 2. MathWork License Fee(Student version) |  |  | 14, 975  80, 000 |
| **Sub Total** |  |  | **94, 975** |
| **THESIS PROPOSAL PREPARATION**   1. Type setting and printing 2. Photocopying 3. Binding 4. Transport local 5. Subsistence | 200 Copies  950 Copies  8 hard bound copies | 30  3  370 | 6, 000  2,850  32, 560  40,000  60, 000 |
| **Sub Total** |  |  | **141, 410** |
| **Contegiencies** |  |  | **30, 000** |
| Grand Total |  |  | **310, 465** |