PHD DISSERTATION

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EXAMINATION OF MATERNAL MORTALITY IN SUB-SAHARAN AFRICA: RELATIONSHIPS AND EFFECTS MODEL ASSESSMENT

PHD Dissertation

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DECLARATION

Candidates Declaration

I, Frank Okwan, hereby declare that this dissertation is my own work produced under the guidance of my supervisors towards the PhD in Economic Science and all the sources and citations have been acknowledged in the form of complete reference. I wish to declare that no part of this dissertation has been published or submitted for the award of a degree in any academic institution or this university.

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Supervisor's Declaration

I hereby declare that this dissertation was prepared from the candidate's research work and supervised following guidelines on supervision of dissertation laid down by the University of Szeged, Hungary.

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DEDICATION

I dedicate this dissertation to the Almighty God for his faithfulness, mercies, and endless favor He bestowed on me during the trials and tribulation years of my stay and studies in Szeged, Hungary. I also dedicate, to my loved one Priscilla Boakye Dankwa, and my lovely children Isabella Yaa Ehuramah Okwan and Nana Yaw Boateng Okwan.

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LIST OF PUBLICATIONS

As at the time this thesis was submitted, two of the empirical studies and other studies related to this thesis have been published in highly ranked journals, other peer-reviewed journals, and conference proceedings. One of the empirical papers of this dissertation have been accepted for publication. This section presents the list of published articles.

Highly ranked journal publications

I. Okwan, F – Peter, Kovacs. (2021). Examining the Causal Effect of Social Development on Maternal Mortality in Sub-Saharan using Partial Least Squares(PLS) Structural Equation Modeling(SEM). *Universal Journal of Public Health, Accepted.*

II. Frank, O. – Cinema, T. T. (2021). Health Financing and Health Outcomes in Sub-Saharan Africa: A PLS-SEM Application. *Elementary Education Online* 20 (4), 1251-1264.

III. Amenah A. – Frank O. (2021). Estimating the effect of Health and Economic determinants on Infant Mortality in Iraq using Partial Least Square(PLS) Structural Equation Modeling(SEM), Turkish *Journal of Computer and Mathematics Education. Accepted*

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V. Okwan, F – Peter, Kovacs. (2019). Determinants of Maternal Mortality in Sub-Saharan Africa: A Cause-Effect Model Assessment. *Hungarian Statistical Review: Journal of the Hungarian Central Statistical Office*, 2(2), 15-31.

Other peer-reviewed journal publications

I. Okwan, F. (2019). Maternal Health Outcome and Economic Growth in Sub-Saharan Africa: A Dynamic Panel Analysis. *International Journal of Economics and Management Engineering* 14(9), 696-704.

II. Okwan, F – Peter, Kovacs. (2019). Testing the Existence of the Ricardian Equivalence in Ghana in this 21st Century. *International Journal of Applied Research in Management and Economics,* 2(2),16-27.

Conference proceedings publications

I. Okwan, F. (2020). Analysis of Global Competitive Pillars among Central and Eastern Europe Countries with Focus On Bulgaria and Romania. In *Proceedings of FEB Zagreb International Odyssey Conference on Economics and Business,* University of Zagreb, Faculty of Economics and Business, 2(1),222-238. Retrieved from https://search.proquest.com/docview/2458969986/fulltextPDF/FAE9A8BF930B4CF9PQ/1?accountid=17096

II. Okwan, F – Peter, Kovacs (2019). Path Analysis of Determinants of Maternal Mortality in Sub-Saharan Africa. *Academics World International Conference on Science, Social Science and Economics,* London, UK. (PP63). Retrieved from https://www.worldresearchlibrary.org/up_proc/pdf/3126-156992239163.pdf

Conference presentations

I. Okwan, F – Peter, Kovacs (2019). Path Analysis of Determinants of Maternal Mortality in Sub-Saharan Africa. *Academics World International Conference on Science, Social Science and Economics,* London, UK.

II. Okwan, F – Peter, Kovacs (2019). Testing the Existence of the Ricardian Equivalence in Ghana in this 21st Century. 2nd International Conference on Research in Management and Economics. Rome, Italy

III. Okwan, F. (2020). Analysis of Global Competitive Pillars among Central and Eastern Europe Countries with Focus On Bulgaria and Romania. *FEB Zagreb 11th International Odyssey Conference on Economics and Business, University of Zagreb***,** Faculty of Economics & Business, Croatia.

IV. Okwan, F. (2020). Maternal Health Outcome and Economic Growth in Sub-Saharan Africa: A Dynamic Panel Analysis. *ICEBR 2020: XIV. International Conference on Economics and Business Research,* Prague

ABSTRACT

Maternal mortality is considered one of the major challenges of population development worldwide. Even though, it has received extensive attention in the public health literature by both academicians and health professionals over the past two and half decades. Many studies have focused on identifying why the death of a mother during pregnancy and childbirth is still high in SSA (Sub-Saharan Africa) irrespective of the interventions that have been implemented by international bodies and governments in the region. The purpose of this study is to examine maternal mortality in SSA by embarking on empirical studies to investigate the effect of its determinants, its effect on social development, and its relationship with human development by using a dataset on 35 Sub-Saharan African countries. spanning between 1990 and 2015.

The first empirical study examines the determinants and their effect on maternal mortality by employing PLS-SEM (partial least squares structural equation modeling) techniques, a multidimensional approach, to integrate, socio-economic and socio-cultural determinants, and assess the causal relationships among them and their effects on maternal mortality in Sub-Saharan Africa. The results of the authors' analysis showed that the socio-cultural determinants have the greatest effect on the medical/health determinants. In the case of maternal mortality, medical/health determinants have the greatest impact, followed by socio-economic determinants. The socio-cultural determinants have both a direct and indirect effect on maternal mortality. The findings reveal that integrating the medical/health, socio-economic and social-cultural determinants in interventional policies meant to address the issue of maternal mortality, will reduce the high rate of maternal mortality in the Sub-Saharan region.

The second empirical study also investigated the effect of social development on maternal mortality in Sub-Saharan Africa by using Sen's development theory, as a theoretical underpinning of the study, and the Partial Least Square Structural Equation Modeling (PLS-SEM) as an estimation technique. The result of the empirical analysis showed that social development has both direct and indirect effects on the model. The direct effect is greater than the indirect effect. The direct effect is the effect of social development on reproductive capability, and the indirect effect is the effect of social development on maternal mortality through reproductive capability and freedom. The result also reveals a direct and positive effect of economic and political development on social development.

Social development has the greatest effect on maternal mortality, compared to all the other effects in the model. The result of the path analysis and the final model support all the hypotheses for the study.

The final empirical study examined the relationship between maternal mortality and human development measured by the HDI index. The study primarily used a panel dataset from 1990 to 2015 on 35 countries in SSA. The relationship is investigated using both fixed-effect and two-step system GMM. The result of the empirical analysis on 35 sampled Sub-Saharan African countries indicates a statistically significant relationship between maternal mortality and human development in Sub-Saharan Africa. Thus high maternal mortality levels will reduce human development, measured by the HDI index. This also implies that high maternal mortality will contribute to the poor standard of living, reduce education attainment and enrolment and also affect life expectancy at birth in Sub-Saharan Africa region.

The policy implications from this study call on governments to tackle the problem of maternal mortality by formating policies that will improve the economic conditions of inhabitants, especially women, increases capital investment in the health sector, and also improve social development which is also key in maternal health outcomes intervention.

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LIST OF ABBREVIATIONS

AVE - Average Variance Explained

CMACE - Centre for Maternal and Child Enquiries

CRVS - Civil registration and vital statistic

CPR - Contraceptive Prevalence Rate

DHS - Demographic Health Survey

DSS - Demographic Surveillance Site

EIU - Economist Intelligence Unit

FE - Fixed Effect

GMM - Generalized Moment Methods

GNI - Gross Nation Income

HDI - Human Development Index

IMR - Infant Mortality Rate

ICD - International Classification of Disease

ICPD - International Conference on Population and Development

LVs - Latent Variables

LICs - Low-income countries

LMICs - Low middle-income countries

MVs - Manifesting Variables

MMR - Maternal Mortality Ratio- MMR

MDGs - Millennium Development Goals

NIPALS - Non-Linear Iterative Partial Least Squares

OLS - Ordinary Least Square

PLS - Partial Least Square

RE - Random Effect

RASMOS - Reproductive- age mortality studies

SBA - Skilled Birth Attendant

SEM - Structural Equation Modelling

SSA - Sub-Saharan Africa

SDGs - Sustainable Development Goals

TFR - Total Fertility Rate

UNDP - United Nations Development Programme

UNICEF - United Nations International Children's Emergency Fund

UN - United Nations

LMICs - Upper middle-income countries

WB - World Bank

WDI - World Development Indicators

WHO - World Health Organisation

CHAPTER ONE

BACKGROUND OF THE STUDY

1. Introduction

The death of a woman during pregnancy and childbirth is still one of the major health, social and economic challenges in low and middle-income countries in this 21st century. To have a clear understanding of maternal mortality, as a public health and population development challenge. It is of utmost importance to look back into history. In the 19th Century, the main cause of maternal mortality was puerperal sepsis. Semmelweis (1 July 1818 – 13 August 1865), a Hungarian physician and scientist, now known as an early pioneer of antiseptic procedures described as the "savior of mothers", Semmelweis discovered that the incidence of puerperal fever (also known as "childbed fever") could be drastically cut by the use of hand disinfection in obstetrical clinics. Puerperal fever was common in mid-19th-century hospitals and often fatal. Semmelweis proposed the practice of washing hands with chlorinated lime solutions in 1847 while working in Vienna General Hospital's First Obstetrical Clinic, where doctors' wards had three times the mortality of midwives' wards. In 1959, he started writing his book, The Aetiology, Concept, and Prophylaxis of Childbed Fever, which was published in 1860 (Kadar, 2018; Hanninen et al.,1983).

Semmelweis was a Hungarian obstetrician who first showed that, in all but a few cases, puerperal fever—also known as childbed fever—was caused by an infection introduced into the birth canal from outside, which could be prevented by chlorinous disinfection of the hands of the obstetricians and midwives before they examined mothers in labor. Now, it could be said that *he was the father of preventive medicine and also the founder of Medical Statistics* and asepsis in obstetrics as well as surgery. Because the significance of bacteria was unknown at the time, Semmelweis called the causative agent of childbed fever “decomposing animal organic matter.” (Obenchain,2016)

While Semmelweis was working in Vienna, the maternal mortality rate was 18% in the First Department of Obstetrics in Vienna and when he was working in St. Rokus Hospital in Budapest, between 1851-1950, he reduced maternal mortality drastically to as low as 0.1 and 0.3%. This low incidence was attained only during the early years of the 1950s in European and North-American Hospitals. This is why Semmelweis is remembered internationally as “The Saviour of Mothers” and his statue is placed

alongside Hippocrates in the International Museum of Surgical in Chicago (*Note: This information is retrieved from the Semmelweis University, Hungary website and is cited in the reference list as Ref D*).

In the 20th Century, the leading cause of Maternal Mortality was shifting from puerperal sepsis to Postpartum Haemorrhage (Herczeg,2006) “At the beginning of this century during childbirth parturient mothers were fearful for saving their own lives. In the second half of the 20th-century obstetricians witnessed an unprecedented and rapid development of the management technology of human pregnancy and childbirth especially in the field of electronic surveillance and in the high dependency care of critically ill obstetric patients. In the last 25 years, fetal health was the primary focus in prenatal care and during delivery. Obstetrics in the 21st century will pose new challenges. Some women are prepared to undertake high medical risk to their own life by having a child close to or "beyond" at the extremes of their reproductive life.

The perinatal period is one of the most dangerous times of life. Family expectations are very high and the responsibilities of the obstetrician are diverging. It is very difficult to draw a line between good and substandard care, and practitioners of obstetrics are well aware of the fact, that modern reproductive research did not eliminate all the risks and hazards associated with childbirths.

Direct causes of maternal mortality in modern obstetrics include:

1. Post-partum hemorrhage
2. Infections during labor and delivery
3. Puerperal sepsis
4. Complications arising from the second stage of labor
5. Pregnancy-induced hypertension
6. Obstructed labor
7. Abortion related

Even nowadays one of the most frequent, but - with appropriate modern prevention and treatment - avoidable causes of maternal mortality is postpartum hemorrhage,frequently arising from postpartum uterine hypotonia/atonia. Maternal death rates arising from

infection and sepsis showed a steady decrease, while hemorrhage related maternal deaths declined more slowly, pointing to the fact, that they are more difficult to prevent

Postpartum hemorrhage is still a leading cause of maternal mortality in some areas of the world. The incidence of postpartum hemorrhage is 3-5% of all deliveries, its incidence is doubled after induced labor. It is the greatest single cause of maternal deaths in the majority of statistics and is directly responsible for 12-60% of maternal mortality in developing countries. Postpartum hemorrhage can be also indirectly responsible - as an associative factor - for a further percentage of maternal deaths, arising from other causes, such as infection and obstructed labor. About one-third of all maternal mortality can be attributed to obstetric hemorrhage. In sharp contrast to antepartum hemorrhages, which usually claim life after 10 hours if left untreated, postpartum hemorrhage kills swiftly in less than two hours if not properly treated.

The overwhelming majority of the cases of hemorrhage is occurring unexpectedly, exploding into a drama in the labor room, where blood is seen everywhere. The mother's face and lips are pale and her skin is covered with a cold sweat. Her calm suggests, that she thinks she is going to die. In such a severe clinical emergency scenario, successful management requires immediate access to specialist expertise and facilities, and the outcome is depending on the instant availability of blood replacement facilities, cool and swift expert decision on the steps necessary to bring the bleeding under control." (Herczeg,2006)

The need to investigate the causes of maternal mortality as observed by Semmelweis (1 July 1818 – 13 August 1865) and in addition the WHO has brought to light the main global causes of maternal mortality, which are hemorrhage (25%), sepsis (15%), pre-eclampsia/eclampsia (12%), abortion (13%) and obstructed labor (8%)(WHO,2017). These maternal causes of death contribute to about a quarter to half of all deaths among women in low-income countries. For over two decades, the maternal mortality ratio(MMR) has dropped by 44% from a global estimate of 385 maternal deaths per 100,000live birth in 1990 to 216 maternal deaths per 100,000 live birth in 2015 and subsequently declined to 38% in 2017 with a maternal mortality ratio(MMR) estimate of 211 per 100,00 live birth(WHO,2019). The global number of maternal deaths has also fallen by 43% from an estimate of 532,000 in 1990 to approximately 303,000 in 2015.

(WHO,2015) and also further reduced to 35% in 2017 with a maternal death of 295,000 (WHO,2019). The global lifetime risk of maternal death has also decreased from 1 in 73 to 1 in 180 for the past two and half decades. Even though maternal mortality has received increased attention in its reduction by governments and international agencies through the implementation of policies, programs, and strategies to improve maternal health, it remains the leading cause of death in developing countries especially SSA countries. Again, despite the commitments on the part of government and international organizations to reduce maternal mortality, it is still the 3rd cause of death among women in Africa and also one of the top five causes of death among the general population in Africa. It accounts for 14% of the general population deaths.

The World Health Organisation (WHO) report for 2019 on global maternal mortality estimates reported that in 2017, 295,000 women died during pregnancy and child birth with a maternal mortality ratio (MMR) ranging between 10 per 100,000 live birth for Europe and 542 per 100,000 live birth for Sub-Saharan Africa. Again comparing life time risk of maternal death of 1 in 7800 for Australia and New Zealand regions for the same year to that of the SSA region which is 1 in 37, showed that there are huge variations in terms of mortality ratio and lifetime risk. The differences in maternal mortality between the developed and developing region is very high (i.e. 40 times higher). There are also differences in the number of nursing and midwifery personnel per 10,000 populations for Europe and the SSA region. The number of nursing and midwifery personnel per 10,000 populations for Europe in 2018 is 83.23 whiles that of the SSA region for the same year is 9.94 per 10,000 populations according to the WHO report on Global Work Force statistic (WHO,2020). It has been estimated that about 88-98% of these maternal deaths in developing countries could be avoided if healthcare resources and services are more available (Graham, 2008). According to Shen and Williamson (1999), maternal mortality is a public health indicator that measures the variations between rich and poor countries than any other commonly used public health indicator. It is most often taken as the health indicator which primarily measures the comparative advantages between countries. The statistics from the World Health Organization report that developing regions such as SSA and South Asia account for 86%(254,00) of maternal deaths worldwide with Sub-Saharan accounting for more than half of the global estimate 66% (196,000) in 2017(WHO,2019 The situation of maternal mortality is still worrying. Sixteen out of the forty-eight countries in the region have very high maternal mortality

ranging between 500 to 999 maternal deaths per 100,000 live births in 2017 (WHO et al.2019).

The current estimates on maternal mortality show that the maternal mortality ratio, an indicator that measures the number of women dying from pregnancy and childbirth-related complications has decreased by 35%, that is from 451,000 maternal deaths in the year 2000 to 295,000 maternal deaths in 2017(WHO,2019). Though the global maternal deaths have decreased, the maternal mortality ratio for SSA is still high. According to the WHO report for 2019, SSA recorded maternal mortality of 542 maternal deaths per 100,000 live birth in 2017. Notwithstanding, the current outbreak of coronavirus pandemic will rather worsen the maternal mortality situation in low and middle countries of which Sub-Saharan African countries are not exceptional. According to Robertson, the covid-19 pandemic will increase maternal death by an additional 60% which is 567,000 (Robertson et al.2020).

The issue of the death of a mother during pregnancy and childbirth is seen as a misfortune, and over the years, it has become a burden for governments and other international organizations and a lot of interventions have been made towards addressing it since the late 1980s. It started with the Safe Motherhood Conference in Nairobi,1987 with different meetings that drew the attention of the world on the need to address the problem of maternal mortality by reducing it by half in one decade in developing countries. Thereafter, in 1994 and 1995, the International Conference on Population and Development (ICPD) in Cairo, Egypt, and the Fourth World Conference on Women, Beijing, re-echoed the need to address the issues of maternal mortality through reproductive health, right of a woman, women empowerment and gender equity which are the main foundations to the reduction maternal mortality which is a population development challenge (World Conference on Women and United Nations, 1996).

In 2000, the reducing of maternal mortality ratio was specifically made as a target for the United Nations Millennium Development Goals (MDGs) in 2000 (to reduce maternal mortality ratio(MMR) by 75% by the year 2015) and Sustainable Development Goals (SDGs) in 2015(to reduce maternal mortality ratio to less than 70 maternal deaths per 100,000 live birth for each year by 2030). Data show that despite the notable interventions, yet still, many women die from pregnancy, pregnancy-related complications, and child birth in the Sub-Saharan African region, and the reason for this is the lack of limited access to quality healthcare services, limited utilization of skilled care during pregnancy,

childbirth and postpartum condition that are associated with the low socio-economic status of women and bad cultural beliefs and practices in the SSA region.

1.1 Problem statement

A developing region such as Sub-Saharan African has a high level of maternal mortality of 542 deaths per 100,000 live birth compared to developed regions with 10 deaths per 100,000live birth and also due to the economic status of women in the region, women of reproductive age have a high life time risk of maternal death of 1 in 37 as compared to those in a developed region with low time risk of maternal death of 1 1n 7800 in 2017 (WHO et al. 2019). The high uncertainty of pregnancy outcome is not the only challenge to families but the inadequate healthcare delivery system and the prevailing low standard of living. This shows that reduction in maternal mortality and morbidity requires a multidimensional approach which includes the medical and social factors contributing to pregnancy and childbirth complications. Again, theoretical models developed by UNICEF (2008), Thaddeus and Maine (1994), and McCarthy and Maine (1992) to assist in research and implementation of interventions to address the problem of maternal mortality also showed that adequate health care service and delivery are not the only key factors necessary for safe pregnancy and child birth. Other social factors contribute to pregnancy and childbirth complications that need to be addressed when developing models and interventions to address the problem of maternal mortality. Ellen et al. (2001), have also argued that maternal mortality is influence by the social environment and these effects could be both direct and indirect, but recently, many researchers have focused on identifying the root cause of why maternal mortality keeps rising irrespective of the interventions made, and several antecedent factors have been identified both in the medical or health-related care services or socio-cultural and economic barriers (Adeusi et al., 2014).

According to Azuh et al. (2017), the health factors impede the smooth functioning of the health care service delivery and inevitably reduce the improvement of maternal mortality reduction while the sociocultural factors and economic barriers may limit women's health-seeking behavior, making pregnancy and childbirth precarious. For instance; authors such as Olaku (2016); Zolala et al. (2012), focused on analyzing the sociocultural factors and economic barriers where Sarpong (2013); Lule et al. (2005); Chukwu & Oladeji (2015) also focused on the medical factors that cause maternal mortality. However, all these studies focused on a single country or African countries in general, but SSA where the issue is most precarious is completely left unattended. The

implication is that groups of persons who needs improved maternal health care policy may remain hidden behind the larger populations of such studies and the policy recommendations may have little or no impact in reducing maternal mortality because of the lack of appreciation of the neighborhood conditions in where the maternal mortality is most perilous. A study that seeks to examine the issue in the SSA region is most recommended in deciding which policies will better help in addressing the issue in its proper context.

Secondly, most of the studies have either examined the medical explanatory variables alone or just made mention of the socio-cultural factors (Senah, 2003; Gumanga et al., 2011; Yego et al., 2013; Agan et al., 2010). But, the problem of maternal mortality may be due to the interplay of many antecedent factors such as sociocultural, socio-economic, health care services, and logistics which indicates that there is the need to examine not only the medical factors but other factors which are least studied to understand the factors affecting maternal health and mortality. There is still a gap in the research that focused on examining the direct and indirect interactions of both the medical, socioeconomic, and sociocultural factors with maternal mortality, the impact of this health outcome on population development, specifically human development in Sub-Saharan Africa.

Human development level has become one of the criteria used in measuring the performance of a country in terms of its social and economic development since the 1990s (UNDP,1990). Based on the development level, a country can be classified as a high medium and low development country. The average human development level for SSA has been low since the 1990s to date. This same region has also recorded a high average maternal mortality ratio for the same period. Studies conducted by Hasan, 2020, Lalthapersad-Pillay, 2014; Asefzadeh (2013); Tajik et al 2012; Lee et al 1997; have found a significant relationship between maternal mortality and human development. However, SSA region, where human development is low, coupled with higher maternal mortality, there is still a lack of studies examining the relationship between maternal mortality and human development this region. Again, according to Sen (2007&1999), social development is key in addressing reproductive health challenges such as maternal mortality through freedom and capabilities which is broader than basic needs, but there is no single study in the Sub-Saharan African region where maternal mortality is a serious issue has deemed it necessary to explore the effect of social development on maternal

health outcomes such as maternal mortality through reproductive capability by exploring Sen's theory on social development and its connection with reproductive health.
It is against this background; this study is conducted to examine maternal mortality in the SSA region. By examining this issue, this study hopes to throw more light on the major determining factors, their effect and recommend interventions that play an important role in overcoming the problem in the Sub-Saharan Africa region.

1.2 Objectives of the study

The main objective of this study is to examine the maternal mortality situation in Sub-Saharan Africa and the possible ways by which the region can effectively address it.

Specifically, the study seeks to:

I. To investigate the determinants of maternal mortality in Sub-Saharan Africa.

II. Investigate the effect of social development on maternal mortality in Sub-Saharan Africa.

III. To examine the relationship between human development and mortality in Sub-Saharan Africa.

IV. Determine some policy implications based on the outcome of the study to address the problem of maternal mortality in Sub-Saharan Africa.

1.3 Research questions

To achieve the stated objectives, this study formulates the following questions;

I. What are the determinants of maternal mortality in Sub-Saharan Africa?

II. What are the effects of these determinants on maternal mortality in Sub-Saharan?

III. To what extent can social development influence maternal mortality in Sub-Saharan Africa.

IV. Is there any significant relationship between human development and maternal mortality in the Sub-Saharan African region?

1.4 Hypotheses

The study formulated the following hypotheses based on the theoretical framework by McCarthy and Maine (1992) for analyzing maternal mortality determinants, the neighborhood theory by Ellen et al. (2001),(H_1, H_2, H_3) and the development theory by Amartya Sen's (1999) (H_4, H_5). In addition, the hypothesis on the relationship between maternal mortality and human development is drawn from the modernization and gender stratification theory(H_6).

1. H_1: Improvement in socio-economic determinants will reduce the level of maternal Mortality in SSA.

2. H_2: Improvement in health or medical determinants will reduce the level of maternal Mortality in SSA.

3. H_3 : Improvement in socio-cultural determinants will reduce the level of maternal mortality through the medical or health determinants in SSA.

4. H_4: Increasing the rate of social development, will improve the rate of. reproductive capability/freedom and reduce the level of maternal mortality in SSA.

5. H_5: Increasing the rate of reproductive capability/freedom, will decrease the rate of maternal mortality in SSA.

6. H_6: There is no significant relationship between human development and maternal mortality in SSA.

These hypotheses are tested using partial least square structural equation modeling, a multi-dimensional estimation technique, and panel regression estimation methods. This is done using SmartPLS software version 3, Stata 15, and Eviews version 10.

1.5 Significance of the study

The significance of this study is based on its relevance to contemporary economic, social, and health considerations.

I. The study will provide vital information that would be of help in formulating effective and efficient policies towards addressing the issues of maternal mortality in Sub-Saharan African countries.
II. The study will provide the basis for improving the scholar's general perspective on the behavior of maternal mortality determinant variables and provide alternative measures for maternal mortality challenges. The study will serve as a tool in revamping government policies towards maternal mortality reduction in Sub-Saharan Africa region.
III. The study will serve as an important guide to policy makers as to what form of policies to implement to assist in the planning of strategic interventions that will effectively reduce maternal mortality in SSA
IV. Finally, this empirical study would point to several areas requiring additional research efforts aimed at the further development of maternal mortality interventional models.

1.6 Outline of the dissertation

The dissertation is divided into seven chapters that are connected to the objectives of the study. It also comprises scientific literature from various research relating to the study. Chapter one covers the background to the study, the problem statement, the objectives of the study, the research questions, the hypothesis, the significance of the study, and a section on how the dissertation is structured.

Chapter two discusses the discusses the definition and measurement of maternal mortality relevant theories and conceptual framework adopted for the study. Chapter three presents a brief background on SSA and methodology used in the study. The methodology covers the data type, the research design and rational, estimation techniques, and procedure. Chapters four, five, and six discusses the empirical results of the study. Chapter seven presents the summary of the findings, conclusions and policy implications, further studies, and limitations of the study.

CHAPTER TWO

DEFINITIONS, MEASUREMENT, THEORIES AND CONCEPTUAL FRAMEWORK

Introduction

This chapter discusses the theoretical underpinning of the study. The chapter is divided into two sections. The first section discusses the definitions, concepts, and measurements of maternal mortality. The second section discusses the theories relating to maternal mortality and the conceptual framework for the study. The theories also help in identifying literature sources that will help in understanding the nature, scope, and analytical findings and conclusions of other studies and what they identified as important contributions to the topic under study. The conceptual framework assisted in making sense of the relationships among determinants that have been identified as important in addressing the maternal mortality problem.

2.1 Definitions of maternal mortality

Maternal mortality, in general, refers to the death of a woman due to pregnancy and childbirth (WHO, 1999). The World Health Organization (WHO) in 2005 also defines it as 'the death' of a woman whiles pregnant or within 42 days of pregnancy, termination or delivery from any cause irrespective of the duration and site of the pregnancy, its management but not from a complication that is accidental or incidental(WHO,2005).

2.1.1 Maternal mortality and complications related definitions

Maternal deaths

The death' of a woman whiles pregnant or within 42 days of pregnancy, from any cause irrespective of the duration and site of the pregnancy, its management but not from a complication that is accidental or incidental. (ICD 10, WHO,2012)

Pregnancy-related deaths

The death of a woman during pregnancy or within 42 days of termination of pregnancy, irrespective of the cause of death (WHO,2012).

Late maternal deaths

Death of a woman due to obstetric causes that are direct and indirect, occurring between 43days and less than one year after termination of pregnancy (WHO,2012)

Fortuitous (incidental) deaths

Deaths that occur during pregnancy or puerperium period but are not related to any cause (Say, L., Souza, J. P., & Pattinson, R. C.,2009)

Maternal near-miss (severe complications)

A woman who is at a high risk of dying from complications due to pregnancy, childbirth, or termination within 42 days of pregnancy but survived (Say, L., Souza, J. P., & Pattinson, R. C.,2009).

2.1.2 Concept of Maternal Mortality

According to Nicholas (2007), the definition of maternal mortality identifies maternal deaths based on their causes as either direct or indirect (Nicholas, 2007). Direct maternal deaths primarily result from obstetric complications from pregnancy, namely, maternal deaths during pregnancy, delivery, or postpartum including complications from intervention omissions, incorrect treatment, or a sequence of events resulting from any of the aforementioned complications (WHO, 2007). Examples of direct causes include conditions such as bleeding (hemorrhage), infections, hypertensive disorders, unsafe abortions, and obstructed labor with bleeding. Indirect causes result from previously existing diseases that develop before or during pregnancy but are not unique to direct pregnancy causes; they include anemia, malaria, tuberculosis, heart disease, and other conditions aggravated by the physiological effects of pregnancy.

CMACE (Centre for Maternal and Child Enquiries), in the United Kingdom, has also adopted the definition of maternal mortality from the WHO. However, unlike Nicholas (2007), it classifies the causes of maternal mortality into four main areas. These are based on time (i.e. during pregnancy and within 42 days after birth); direct causes, namely, obstetric conditions (hemorrhage, infections, hypertensive disorders, unsafe abortions, and obstructed labor with bleeding); indirect causes (i.e. cardiac illnesses, anemia, malaria, tuberculosis, heart disease and other conditions aggravated by pregnancy and coincidental (i.e. accidents) and late deaths (Cantwell et al. 2011). In the WHO, 2004 report, late maternal deaths are deaths occurring six weeks to one year after birth. The definition is recognized more frequently in countries with more advanced and well-structured health registration systems and technology for life-sustaining procedures,

where women can survive maternal complications beyond 42 days in the postpartum period. The WHO's (1999) definition that limits maternal deaths up to 42 days in the postpartum period is mainly for developing countries based on an under-development of healthcare technology (WHO, 2004).

2.2 Measurements of maternal mortality

The alternative classification of maternal mortality measures maternal mortality as a challenging health outcome for statistical measurement. Therefore, several measures have been developed both within the health sector and academia for measuring the magnitudes of maternal mortality. These measures include Maternal Mortality Ratio (MMR), Maternal Mortality Rate (rate), Life Risk Morality (TRL), and the Proportion of Maternal deaths among Reproductive Age Female deaths (PMDF).

Maternal Mortality Ratio (MMR)

MMR is the death of a mother during a given period per 100,000 live births during the same period. It is also regarded as a convenient measure of maternal mortality, and it measures the risk associated with each pregnancy (obstetric risk). Maternal Mortality Rate can be measured from different sources (Dawodu and Effiong, 1985). It is given as

$$\text{MMR} = \frac{Number \text{ of maternal deaths}}{Number \text{ of livebirths}} * 100{,}000$$

Maternal mortality rate (MM Rate)

This is the number of maternal deaths over a given period per 100,000 women of reproductive age (15-49) (Wilmoth, 2012). It measures both the obstetric risk and the frequency with which women are exposed to this risk (Cleland and van Ginneken, 1988). The MMRate can be calculated as follows

$$MM\ \ Rate = \frac{Number \text{ of maternal deaths}}{Number \text{ of woman aged 15-49}} * 100{,}000$$

Lifetime Risk (LTR) of Maternal Death

This measure accounts for both the probability of becoming pregnant and the probability of dying from pregnancy-related causes, and the risk is accumulated across a woman's

reproductive year. Consequently, LTR indicates the probability of maternal death throughout a woman's reproductive life. It takes into account the fertility probability and obstetric risk together, and the likelihood is expressed in odds, for example, one in 10 in a defined area (Dawodu and Effiong, 1985).

$$LTR\ Rate = 1(1 - MMrate)^{35}$$

The proportion of maternal deaths among female deaths (PMDR)

This measures maternal deaths as a proportion of all female deaths of reproductive age (usually 15-49 years) for a given period. In countries and areas with poor obstetric care, the proportion of maternal deaths among female reproductive deaths is expected to be high compared to settings where there is effective obstetric care: Note: the formula boxes are obtained from the works of (Ronsmans et al., 2006).

$$PMDR = \frac{Number \text{ of maternal deaths in a period}}{Number \text{ of deaths among women 15-49 in the same period}} * 100,000$$

2.2.1 Data sources and approaches of measuring maternal mortality

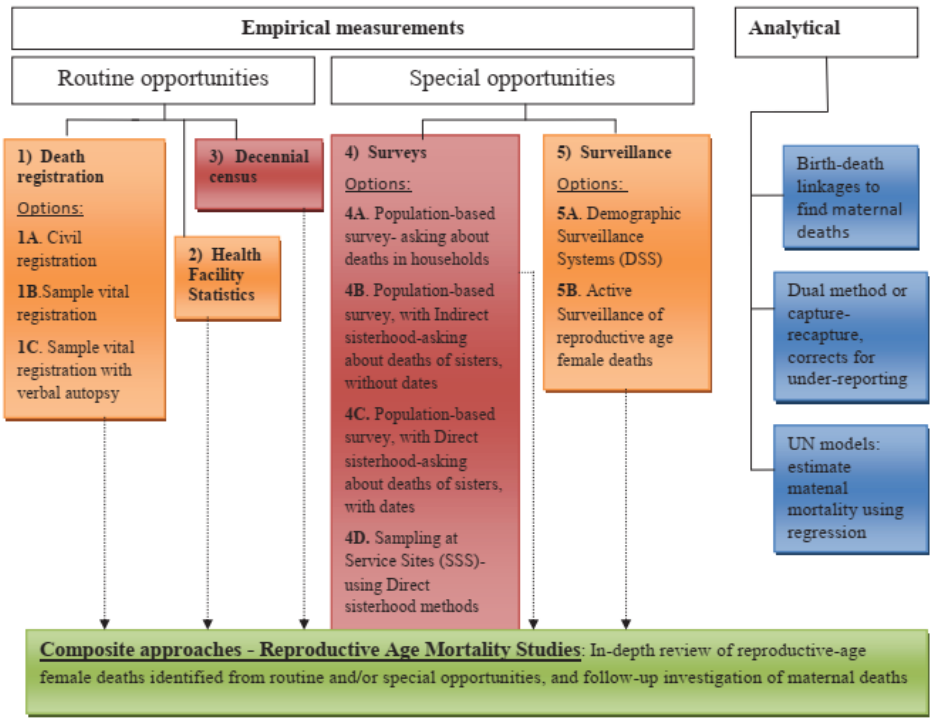
Due to the changes in identifying maternal death precisely, the problem of knowing the cause of death and the difficulty in certifying the cause of death medically in developing countries where maternal mortality is high is a challenge. The difficulty in the measurement of maternal death has called for several alternative data acquisition methods. Graham, Wendy J., et al. 2008 categorized these data measurements and approaches into two, empirical and analytical. The empirical approaches are direct means of researching for primary data. This approach relies on the collection of first-hand data and these data are collected on a routine basis. The following are routine sources of collecting maternal mortality data, they are; death registration (i.e. civil registration), vital registration, vital sample registration with the verbal autopsy, health facility statistics, and decennial census.

Apart from routine methods which depend on a primary source, special opportunities, such as surveys and surveillance are also used to collect maternal death data. Survey data are data that are collected at a single point in time. The methods used in collecting such data are direct and indirect sisterhood, household survey, and sampling at the health facility during antenatal service. Surveillance data are collect by visiting households repeatedly to observe any changes in their vital event. This is done through demographic surveillance sites (DSS) and active surveillance of reproductive age female deaths(RASMOS) (Graham, Wendy J., et al. 2008). The challenges of this approach of

collecting maternal death are incomplete and not available in developing countries where maternal death matters most. Again, the majority of the survey and surveillance methods categorized under the special opportunities require a large sample size, and this makes it more costly and bias in terms of sample size.

The analytical method comprises of the use of models to estimate maternal mortality ratio, capture and recapture approach, which is meant for the correction of under-reporting and birth-death connection to estimate maternal deaths. These approaches use statistical estimation techniques to estimate maternal mortality values from other proxy variables. The commonly used statistically modeled estimates are that of the UN and the Institute of Health Metrics, Washington University. The modeled estimates from these sources are the only national and global estimates that can be used to compare maternal mortality figures across countries. Maternal death estimates from these sources have influenced the planning, resources, and actions of international organizations and governments in developing countries where maternal mortality mater the most. Figure 4 is a summary of the data source and the methods used in the collection of maternal mortality data in low-income countries.

Figure 2.1 Data sources and approaches for measuring maternal mortality



Source: Graham, Wendy J., et al. 2008

2.2.2 Approaches of measuring maternal mortality

Maternal mortality estimates in low incomes countries are based on data from different sources. These sources are civil registration and vital statistic (CRVS) systems, households survey, census, verbal autopsy, and reproductive- age mortality studies (RASMOS).

Civil registration and vital statistic(CRVS) systems

This approach of measurement involves regular registration of all births and death that are identified through standard medical certification. It is one of the maternal deaths data sources that provides a permanent, mandatory, and general reporting of the incidence and characteristics of vital events which comprises all births and deaths, and causes of death. Reliable and accurate data on maternal deaths and maternal mortality are obtained through civil registration system with complete coverage and proper attribution of cause of death (AbouZahr 2011). One of the limitations of the civil registration and vital registration is misclassification and under-reporting of maternal deaths, which addressed through confidential inquiries (Deneux-Tharaux et al. 2005)

Household surveys

This approach uses direct sisterhood to obtain information by interviewing respondents about current deaths in their households and additional questions about the time of death with pregnancy and childbirth. Household surveys data approach of collecting maternal death data are generated using reference period of about 2-3 years proceedings the survey which is applicable for monitoring. The limitations of this approach are that it identifies only pregnancy-related deaths compared to maternal deaths and also generates estimates with varied confidence intervals. This reduces its ability for trend analysis.

Census

This approach has received endorsement from the United Nations Principles and Recommendations for Population and Housing Censuses since it could measure maternal mortality with the addition of a limited number of questions (WHO,2007). The approach reduces sampling errors because of the wide coverage and also provides detailed results for trend analysis, geographic sub-divisions, and social strata. Deaths identification at the household level is done within a short period of 1-2 years, but the census is conducted, every 10 years, which reduces the monitoring of maternal mortality. It can identify maternal death, only if combined with verbal autopsy. The training of personnel to conduct census is very critical, since it collects information on other information apart

from maternal death. Another limitation of census data is that estimates must be adjusted for other features as complete births and death statistics and population-related structure to obtain accurate estimates.

Verbal autopsy

This approach is mostly used in communities where medical certification of cause of death does not exist. The cause of death information is obtained by interviewing members of the family or the community. This is done periodically by research institutions that collect data on births and deaths between small populations. This approach is conducted as part of a demographic system and is mostly combined with household surveys and census. A verbal autopsy is an inexpensive approach for populations where there is no other alternative method for assessing the cause of death. This approach of measurement allows for misclassification of cause of deaths in women of reproductive age and cannot also capture a group of maternal death correctly, especially those that occurred during early pregnancy and causes due to prior health conditions of the mother (eg. malaria, hypertension, etc.)

Reproductive- age mortality studies (RASMOS)

This approach involves the use of systematic effort to identify and investigate the causes of death in a population by using a different source of data. The causes of death of all women of reproductive age are identified using multiple and varied sources. The classification of a death as either maternal or other death is done by interviewing household and health care providers and reviewing health facility records. This approach of measurement provides reliable and complete estimates for maternal mortality if conducted properly, but may lead to underestimation of maternal mortality levels if the identification is inadequate. This approach when used on a large scale, could be time-consuming, complicated, and expensive (Atrash et al 1995)

Health facility data

Health facility is the most common routine source of maternal mortality for developing countries. This source of maternal mortality is obtained from facility records, such as obstetric service delivery records, facility birth registers, special manual case tracing records, and reports. Apart from these sources, maternal death is also identified from the labor ward, antenatal clinic, and postnatal registers. Health facility data are mostly used in developing countries since they are generated locally and always available. However,

health facility data are not used by academics and agencies for gathering that for global maternal mortality estimates, since data from such sources have many errors and need to be interpreted with caution (Nelissen et al. 2013b). The sources where facility data are collected might be incomplete and the possibility of not recording death outside health facility might be high (Graham et al. 2008a; Hill et al. 2006)

2.3 Theories and conceptual framework

Several theoretical contributions have been made concerning the subject matter of maternal mortality. These theories are of relevance to this study as they serve as a building block to this research work, and they are the behavioral, psycho-social, life course theory, the material/neo-material, and the neighborhood theory. They are discussed extensively in the next section.

Behavioral Theory

This theory notes that health decisions and outcomes are determined by personal behavior and choices (Townsend et al., 1992). The role played by culture and genetics in the production of unhealthy behavioral outcomes is recognized by this theory. Behavioral scientists have noted that people who are less gifted with certain types of personal characteristics, such as intelligence have less control over their circumstances and are therefore more likely to have bad health behaviors. They also claim that culture, as a system of values and meanings, serves as a standard of behavior and defines the way of life where values, knowledge, and beliefs are shared (Blaxter, 1990; Helman, 2007). The use of modern health practices or perceptions of education according to behavioralists could be influenced by culture and people's beliefs like healthy life. These in many situations affect the health behaviors of persons and their actions or inactions may result in poor health.

Psycho-social theory

The psycho-social theory also states that the position of people or their social class in society affects their feelings and it brings direct stress effects on their health (Elstad, 1998; Theorell, 2000). Responsibilities that include life, such as financial constraints, lack of control at work, inadequate social support, and lack of intellect to succeed, most of the time bring about psychological stresses. Constant experience of stress may distract

individual health stability which results in a frequent activation of a 'fight-or-flight' response (Brunner, 1997), which may have a double health effect on a person's ability to survive in case of any serious environmental difficulties.

Life -Course theory

The life-course theory is basically on the effects of accumulated exposures of a long life span (Blane, 2006). This theory states that adult health status is due to a combination of complex physical, social and economic circumstance that takes place for over a duration of time, and is normally accumulated from early childhood (Bartley, 2004). Different approaches have been used to explain this theory. They are the critical period or latency approach, the risk Hertzman et al., 2001accumulation approach, and the chain of risk approach (Hertzman et al., 2001; Kuh and Ben-Shlomo, 2004). The critical period approach is of the view that if a hazard or adverse experience takes place at a certain age of the individual, it m affect the performance of its tissues, organs, and body structures that can not be reversed in any simple way or by a later experience. The accumulation of risk concept assumes that risks or advantages to health accumulate gradually over the life course (Kuh and Ben-Shlomo, 2004). For example, low family socio-economic status is associated with low birth weight, higher stresses, inadequate food, lower quality of education, poor living environment, and health-threatening behaviors, which together lead to later poor adult health.

The chain of risk concept argues on the effect of interactions between risk factors. It argues that, in some cases, exposure is only damaging to health in certain groups of people because of a sequence of previous exposures. The build-up of harm happens through a pathway – one bad experience or exposure leads to another and so on, which eventually damages health (Hertzman, et al., 2001). Early exposure in a chain of risks may have a trigger effect only for the next exposure and it may be that only the final exposure in the chain has a marked effect on health.

Materialist or neo-materialist Theory

The last theory is the materialist or neo-materialist theory which emphasis on deficiencies and inequalities (Lynch et al., 2000; Jarvis and Wardle, 2006). These specify disparities in people's working conditions, their living environment, and exposure to physical hazards, all of which influence their health. The materialist theory advocates that a person's wealth determines his or her social position in society and this tends to put more

psycho-social stress on individuals of lower social standing and consequently generate health-threatening behavioral responses (Jarvis and Wardle, 2006).

The neo-materialist theory makes emphasis that, living conditions such as provision of public service, social and economic policies are also determined by higher-level macro-structural factors (Lynch et al., 2000). These social structures shape social classes, determine the distribution of resources over social strata and consequently affect the quality of various social determinants of health.

Neighbourhood theory

This theory is based on how neighborhood influences health outcomes. Conceptually, this theory argues that the neighborhoods in which people live can have possible effects on their health. According to Ellen et al. (2001), these effects can come from four possible ways and they are neighborhood institutions and resources, stresses in the physical environment, stresses in the social environment, and the neighborhood-based network and norms. The trust of the neighborhood institutions and resources rests on different access to institutions and resources in the Neighbourhood. The argument here indicates that access to healthcare facilities and health personnel such as the number and quality of medical practitioners differs across neighborhoods, as does the nature of the medical technology and facilities. So, neighborhoods with poor institutions and resources tend to have a low level of health. These studies for instance found that residence in a poverty concentrated area has negative effects for a broad range of health-related outcomes including self-rated health (Luo and Wen, 2002), health behaviors (Yen and Kaplan, 1998), depression (Yen and Kaplan, 1999) and alcohol-related problems (Jones-Webb et al., 1997).

The physical stresses in the neighborhood environment influence health through contagious diseases like tuberculosis, malaria-infected areas, the proximity of polluting factories, and toxic waste sites, which may increase people's chances of contracting serious illnesses. These threats are common in lower-income and minority-occupied neighborhoods where people are exposed to higher concentrations of air-, water- and soil-borne pollutants (Macintyre et al., 2003; Ash and Fetter, 2004). In many epidemiological studies, air pollutants have been linked to lower life expectancy, increased mortality risk, frequent hospital visits, poorer birth outcomes, and asthma (Shah and Balkhair 2011; Almond et al., 2012). The social stresses in the neighborhood environment are based on the notion that people's health status can be directly affected by the social conditions in

the neighborhood in which they live. Implying that living in a society marked by strong economic and social conditions tends to have better health status than the less advantaged (Macintyre, 1994). For instance, exposure to crime and violence is a social condition seen to increase stress, as well as exposure to other social conditions such as noise. Individuals who live in such social conditions tend to have worse health outcomes as the stress may exacerbate hypertension and other stress-related disorders, and may also weaken the immune system and increase vulnerability to disease and disability. Recent empirical studies have shown that pregnant women living in low-income neighborhoods for example are significantly more likely than those living in high-income neighborhoods to have preterm births, and miscarriage/perinatal deaths (Agyemang et al., 2009). Kumari and Mengi (2010) also found a fairly large association between measures of adverse pregnancy outcomes and depressive tendencies in expectant mothers which they attribute to the effect of socioeconomic status in neighborhoods. They noted that the risk of miscarriage and stillbirths are mainly seen in lower-class females while females belonging to the upper class experienced mainly induced abortions (Kumari and Mengi, 2010). Atkinson and Kintrea (2000) further observed that neighborhood contextual factors have a stronger effect on women than men since women are more involved in the neighborhood than men. This implies that neighborhood contextual factors will have more effect on women's health far more than men, evidence which Seguin et al. (1995) earlier found that chronic stressors are embedded within and accrued from the environment that women live in.

The neighborhood-based social networks also contribute to women's health in that health can be influenced by the communal surroundings of neighborhoods, that is, by aspects of social relationships among the locals, including the scope of collective trust and feelings of connectedness among neighbors. Locals who are very close in a neighborhood may be more likely to work together to achieve common goals (e.g. cleaning the environment, healthy behaviors, and good schools), to share information (e.g., regarding childcare and other resources that affect health), and promote healthy behaviors (e.g. discouraging crime or other undesirable behaviors such as alcohol use among youths and pregnant women) (Sampson et al., 2002), all of which can directly or indirectly influence health. Social networks may also determine the behaviors to which one is exposed. If someone's friend drinks alcohol or has multiple sex partners, that person has a greater chance of behaving in the same manner (Berkman et al. 2000).

Fundamentally, the important aspect of all these theories is the distinctive but multidimensional recognition of the various risk factors that affect health. While the life-course theory, for instance, emphasizes the importance of historical experiences of an individual, the others recognize the temporal dimensions of risk that people are exposed to. These theories also recognize the underlining impact of the social structural environment on health status. A combination of these theories into an integrative framework will therefore reflect the hypothesis that health outcomes are both personal responsibilities and or social responsibilities of the neighborhoods within which one lives. Due to the intractability of maternal health outcomes and data requirement issues associated with the life course theory, its inclusion in the cross-sectional analysis is often problematic. This model requires that the research has accumulated information about a respondent's early life-course to be able to link that with current birth outcomes (Dannefer, 2003; Blane, 2006). This study proposes to integrate three theoretical frameworks namely behavioral, psychosocial, and materialist theories. This is because our approach recognizes health outcomes as both due to individual behavioral choices, and social status, and at the same time emphasizes the role of community in shaping health outcomes.

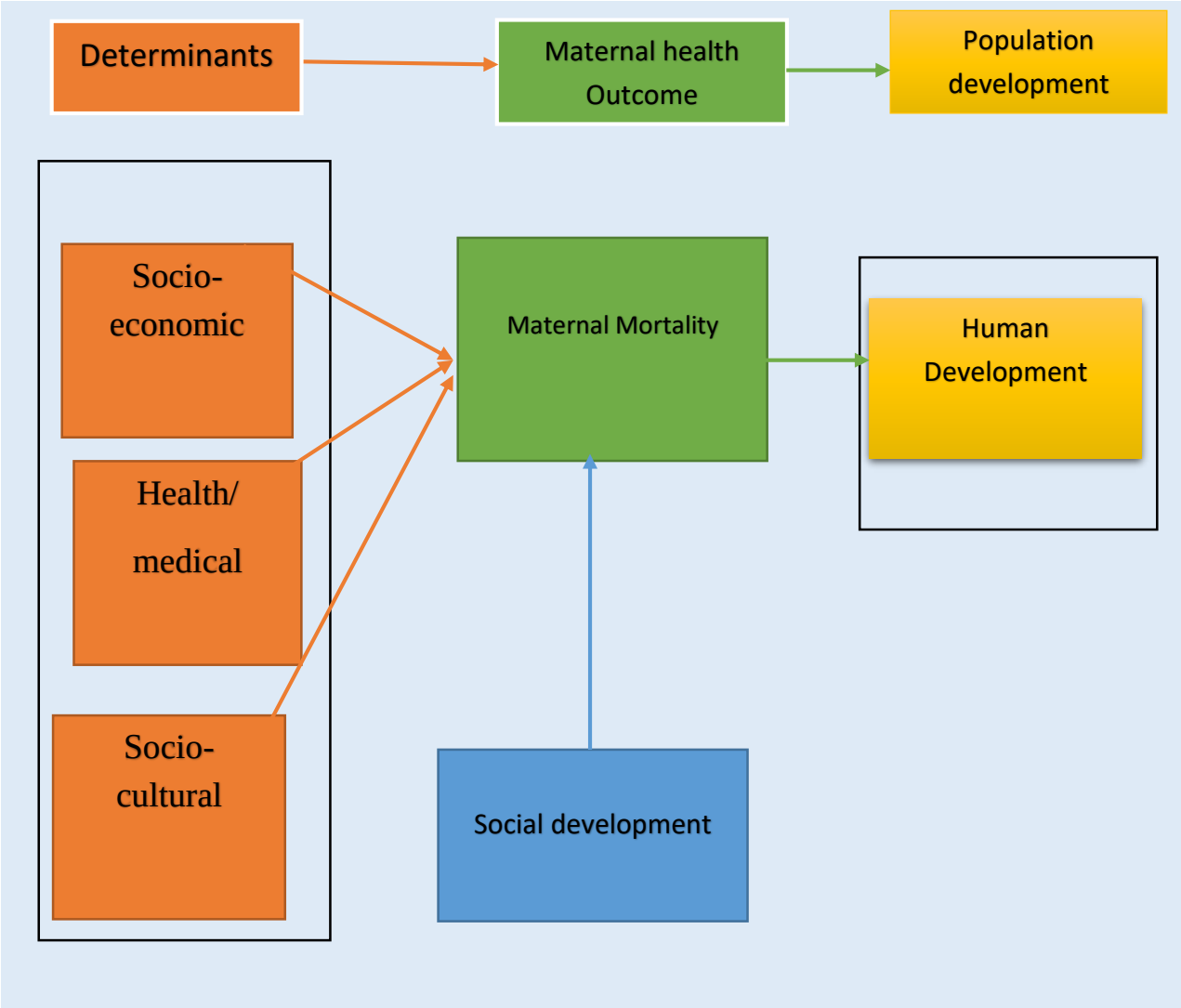
2.4 Conceptual framework

McCarthy and Maine (1992) proposed a framework for rational analysis of the maternal mortality problem. According to them, the maternal mortality problem is not contributed by only the intermediate determinants but also the distant determinants being the social factors. The neighborhood theory by and Ellen et al., 2001, have also argued that maternal mortality is influence by the social environment and these effects could be both direct and indirect. Based on the conceptual framework by McCarthy and Maine (1992), the neighborhood theory by Ellen et al., 2001 and other development theories such as Sen's theory of development, modernization, and the gender stratification theory. This study is conceptualized into three blocks.

The first block analyses the determinants of maternal mortality based on the conceptual framework by McCarthy and Maine 1992 and the neighborhood theory by Ellen et al., 2001. The second block addresses the effect of social development on maternal mortality by drawing ideas from Sen's theory of development. The third block is conceptualized based on the modernization theory and the gender stratification theory to examine the relationship between human development and maternal mortality. This

conceptual framework is represented in Figure 2.1. These theories and their linkage to the topi are discussed in detail in the remaining sections of this dissertation.

Figure 2. 2 Thesis conceptual framework



Source: Authors own construction based on the neighborhood theory

This section discusses the conceptual framework with the latent variables and selected variables of interest. It further discusses the theoretical and empirical relationship between the selected variables reflecting the latent variables and maternal mortality. It also indicates the basis for the use of some of the variables in the empirical analysis.

The first block as presented in Figure 2.1 focuses the determinants and their effect on maternal mortality. These determints are soci-economic, socio-culture and

health/Medical. They are measured as latent variable in this study. The section beow discuss the indicators reflecting these latent variables.

Socio-economic latent variable

The socio-economic determinants indicators selected for study are based on the conceptual framework for analyzing maternal mortality and morbidity by McCarthy and Maine (1992). According to them the education level, the occupation, and the wealth or income education of the woman and that of their community influences maternal mortality. The study selected female education, female unemployment rate, education index, and GNI per capita measure for income level as an indicator or manifesting variables for the socio-economic latent variables. These variables are selected as socio-economic determinants of maternal mortality by drawing theoretical under pining from the neighborhood theory and psycho-social theory. These two theories best explain the relationship between socioeconomic determinants and health, in our case maternal mortality. I addition, author(s) such as Osemwengie (2020 Tlou B. (2018); Girum and Wasie (2017); Chirwa- Banda, P (2016); Maleku & Wei, F (2013); Alvarez et al. (2009) used indicators as socio-economic determinants to examine their effect and relationship with maternal mortality.

Socio-cultural latent variable

Socio-cultural determinants are also selected with the framework by classified as distant determinants by McCarthy and Maine (1992). They also classified it as distant factors. According to them, both the social and legal autonomy of women which allows them an equal opportunity as men in access to health care and education also influence the level of maternal mortality. The socio-cultural indicators used in measuring the socio-cultural latent variable are Female literacy, gender index, and secondary education since women are denied access to higher education on a cultural basis. The use of these variables as indicators for social-cultural determinants and how they influence maternal mortality are drawn from the behavioral theory. The socio-culture indicators used in the study to examine the relationship and effect of socio-cultural determinant maternal mortality are also drawn from studies conducted by Marabele (2020); Choe (2017); Meh C. (2017) Adjiwanou (2014); Maleku & Wei, F (2013).

Medical or health latent variable

The relationship between the health or medical indicator used as a measure for medical or health determinants is also drawn from the conceptual framework by McCarthy and Maine

(1992). They termed it as intermediate determinants which measure heath care used and access. According to them these intermediate determinants which in the case are health or medical determinants measured by indicators such as antenatal care coverage, skilled birth attendant, access to an improved water source, contraceptive prevalence rate, total fertility rate influence the distant factors, which in our case, are the socio-economic and socio-cultural determinants to influence maternal mortality. The use of these indicators as a measure for the health or medical determinants and their effect and relationship with maternal mortality is underpinned by the Materialist or neo-materialist Theory and neighborhood theory. Authors such as Masturoh et al. 2017; Girum and Wasie 2017; Alvarez et al. (2009) Eghieye (2014); Aseweh et al. (2011); Buor and Bream (2004investigated the relationship and effect of medical or health determinants on maternal mortality by using these indicators as a measure for medical or health determinants.

Note: The empirical studies justifying the selection of indicators measuring scio-economic, socio-cultural, health/medical latent variables are discussed in detail in impirical study one (chapter 4). This also cptures the author's name, year of publication, variables considered and major findings of their studies.

Maternal mortality is captured as an endogenous latent variable in the first block as reprented in Figure 2.1

Maternal Mortality

Maternal mortality an endogenous variable in this study is defined as the death of a woman that occurs due to direct obstetric complications or indirect pregnancy complication that is associated with the pre-medical condition of the woman, but not from outcomes that is due causes from incident or accident (Kassebaum et al., 2016). This is measured by maternal mortality ratio (MMR), which is the annual number of death of women due to pregnancy and child birth complications per 100,000 live birth. According to Sen, improved maternal heath outcome will mean wellbeing. It has also been hypothesized countries with poor maternal health outcomes have high inequality, poor social and economic development. Authors Osemwengie (2020); Meh. C (2019); Palimbo (2019); Gruim &Wasie (2017), Azuh (2017); Dersarkissian (2013); Alverez et al. (2009); Buor & Bream (2004) have used it as a dependent variable in their studies.

The second block as presented in Figure 2.1 focuses on social development and its effect on maternal. The social development theory by Sen,1999, indicates that social

development is influence by indicators refecting both economic and political development. Again, social development also influence indicators reflecting reproductive capability/freedom to influence maternal mortality. This section discusses the social development, economic development, political development and reproductive capability/freedom latent variables and indicators reflecting these latent variables.

Social Development

Social development is improving the well-being of all inhabitants of society with the sole aim of achieving full potential, in this context, we conceptualized the indicators from the view of Sen,1999, Mohan, 2007a. and relationship of these indicators with maternal mortality based on previous studies. According to Sen, Social development is measured by indicators that reflect social policies, such as the building of educational facilities to increase literacy, the building of health care infrastructure to improve health outcomes, and activities that will improve the social relationship with society and different people across the globe. In addition, Mohan also sees it as a process that widens the direction of freedom from the individual's perspective. In this regard, we measured social development using indicators such as Public health expenditure Adult literacy rate Mobile phone subscribers, Internet users, access to improved water sources and sanitation, Human development index measures of overall wellbeing. These variables have been used as social development indicators that have a relationship with maternal mortality in studies conducted by Dawodi (2020); Tlou B. (2018); Girum& Wasie (2017) and Gonzalez (2017) Cheng (2012).

Economic Development

We conceptualized exogenous economic development as economic growth. This is measured by GNI instead of GDP. The GNI captures the total economic activity of a country. The GNI calculated the economy's total income irrespective of whether the income is generated by the nationals with the country or generated from investments in foreign business. The GNI per capita, which is a measure of the total dollar value of all goods and services produced by a country and income received from its residents divided by mid- year population has been used as a proxy for economic growth in studies conducted by auth Batist (2019); Gruim &Wasie (2017); Alverez et al. (2009); Almasi (2015); Neal & Falkingham (2014). They examined the relationship between maternal

mortality and economic growth using the GNI per capita as a proxy for economic growth. The use of GNI as a proxy for economic development is drawn from these studies.

Reproductive capability/freedom

Reproductive capability/Freedom latent variable which is a measure of how people have a sex life that is safe and satisfying, and in addition capable of having the freedom to decide on how to do it and when it's appropriate to do so (UN,1994). Sen and Annand (1994) also conceptualized it, as a reproductive health element that can be obtained through widening of the various choices people have. Sen is of the view that choice could be achieved through two means, one is the individual's arrangements that bring him/her freedom. These arrangements are mostly achieved through institutions. The second option is that the individual can improve on his/her freedom and capabilities through the freedom to partake in social choice and make informed decisions that could contribute to the development of these opportunities. Based on these arguments and definitions, the study selected skilled birth attendant contraceptive prevalence rate, antenatal care early marriage to measure reproductive capability/Freedom. The use of early marriage as a measure of reproductive freedom is based on the fact that girls who marry early, lack the power to take decisions relating to their health, which restricts their capability and freedom. The indicator was not selected as just a measure for reproductive capability/freedom but have been used as determining variables that influence maternal mortality by studies conducted by Marchie (2019); Rana (2018); Girum and Wasie 2017 Bayati (2016); Eghieye (2014); Buor and Bream (2004).

Political Development

Political development in this context will be measured based on how democratic a country is, and this is about how Sen(199a) and Srinivasan (2007) define democracy. According to them, seen through political and a public discussion that is based on reasoning. The political development used in this study is operationalized as a political body that gives people the opportunity, either to discuss or draw the attention of opinion leaders or peers to their personal or the needs of the society in which they leave and demand the requisite attention from these opinion leaders or peers. The Democracy Index (Demindex) of the Economists Intelligence Unit is used for political development in this context as is one of the properly validated indexes for the measurement of political development in developing economies. The Demindex is measured based on five democratic areas:

electoral process and pluralism; civil liberties; the functioning of government political participation and political culture. This indicator has been used in the study conducted to examine the relationship between health and democracy (Walker & Szafron, 2015; Hammer, 2010; Shiffman, 2007).

The linkage of political development, economic development, social development and reproductive capability/freedom to maternality is drawn fron Sen's social development theory.This dicussed in the next section.

2.4.1Amartya Sen's theory on the development

The theories on social and human development proposed by economics scholar Amartya Sen have been on the development agenda for developing countries since the late '80s. Notwithstanding, the productive changes, the United Nations Development Program (UNDP), has implemented the human development theory by Sen in their developmental programs since the 1990s (Fukuda-Parr, 2005). Even though Sen's human development theory has been in the economic and the development literature since the late '80s, there is still a lack of scientific studies that explores the applicability of Sen's paradigm on social and human development to the reproductive health of women in underdeveloped countries, such as Sub-Saharan Africa.

The social and development theory by Amartya Sen can be seen as a detailed theoretical framework that outlines the causal relationships of an individual's well-being from micro to a macro system with robust application to women's reproductive studies like maternal mortality. Sen explains in detail the application of his development paradigm to reproductive health, that is, in his case maternal mortality. Sen argues that human beings should have the ability ''to achieve actual livings that one can have reason to value'' (Sen,1999a, p. 73). He further stated that people should be given options to choose from or what he termed as ''capability sets'' to attain what they strive to achieve (Sen,1999a). He named it ''capability'' or ''freedom'' (Sen 1999a). Sen also termed the wellbeing of people as real achievements to achieve what they strive to attain. He defines achievement as ''how well is one's being'' or ''different things one may value doing or being'' (Sen,1999, p.3). Sen further explains that people's well-being could be put together to show their real achievements or the ''amount and the level of functions enjoyed by the individual'' (Sen,1999, p.75). He also defined capability or freedom as available options to choose from various existences or achievements. He refers to these variations, as being

equal to someone not eating (termed in his case as well-being) or just because he/she lacks food (inadequate capability or freedom) or food is available, but he/she chooses not to eat (decided to select other achievements from a preferred capability set) (Sen,1999a).

He further explains based on his development paradigm, that every development aims to achieve wellbeing, and this can be done through the enhancement of freedom and capability. This can be done at the same time by enhancing wellbeing directly. He also stated that the aims of development are multidimensional and its set of components depends on each other, however, the rate of each component is influenced by the amount it contributes to human development; and the question is, does the increase in indicators reflecting social development lead to human freedom and capability (Sen,1992)? Sen further argued that the development strengths that influence the creation of human opportunities directly are key than any other development strengths. He also stressed social development components as compared to other development components like economic growth or political development, which are very important but more or less lead to human development or capability which will result in well-being.

According to Sen social development is a reflection of ‘‘social policies which comprises putting up of educational structures, social insurance, health care social work and the building up of social relationship among various individuals in societies and the world’’ as a whole. He justified his argument by giving evidence to show that investment in social development strengths in poor societies brings about a better quality of life for the inhabitant (Sen,1993). He used the low maternal mortality situation in Kerala, India, and the high maternal mortality in China to conclude his argument by saying that variations in the maternal mortality rate for these countries are due to the difference in the social development efforts in these two countries (Sen, 2007). If we are to apply Sen’s development model to reproductive health, which in our case is maternal mortality, then we can also argue that that reduction in maternal mortality is the preferred state of well-being we aim to achieve and freedom or capability in terms of reproductive health can reduce the rate of maternal mortality

The the third block of conceptual framework also shows the link between human development and maternal mortality as presented in Figure 2.1. This section discusses the empirical basis for the selected variables used in examining this relationship between human development and maternal mortality.

Human Development Index

The HDI is used as a measure for human development as it captures both the social and economic development of the inhabitants of a country. Again, it measures both the monetary and non-monetary aspects of wellbeing. The human development index is a statistical measure used to assess the level of well-being and the quality of the inhabitants of a country. The index consists of three components; namely health, education, and income. The health aspect of the index is measured by life expectancy at birth, which aggregates the long and healthy life of the population. The education component also captures how knowledgeable the inhabitants are, is measured by adult literacy and their level of education. The income component which also captures the standard of living of the population is measured by per capita gross domestic product (GDP). The HDI has been employed as a measure for human development in studies conducted by Hasan (2020) Batist (2019); Asefzadeh (2013).

Maternal mortality ratio

Maternal mortality, which is the main variable of interest in this study is defined as the death of a woman that occurs due to direct obstetric complications or indirect pregnancy complication that is associated with the pre-medical condition of the woman, but not from outcomes that is due causes from incident or accident (Kassebaum et al., 2016). This is measured by maternal mortality ratio (MMR), which is the annual number of death of women due to pregnancy and child birth complications per 100,000 live birth. According to Sen, improved maternal heath outcome will mean wellbeing. It has also been hypothesized countries with poor maternal health outcomes have high inequality, poor social and economic development. This indicator is a measure of the quality of the health care system of a country. Several authors such as Manyika (2019); Sede & Irekpitan, 2014; Amiri & Gerdtham, 2013; Alverez et al 2009 and Kirigia et al. 2006 have used maternal mortality ratio as a measure for maternal mortality in their studies. It has been used by Hasan (2021) and Asefzadeh (2013 in their studies examining the relationship between human development measured by HDI and maternal mortality.

Gross Domestic Products(GDP) per Capita

GDP per capita measures the annual percentage growth rate of gross domestic product divided by mid-year population which is based on constant 2010 U.S Dollars. It is often used as a measure of economic growth. It is expected that an increase in GDP per capita should improve the outcomes of the inhabitant of a nation. The reason is that an increase

in the per capita income of a country will lead to an improvement in health care access and use by the household through the provision of health care infrastructure by firms and governments. This indicator has been employed as a measure for income in studies conducted by Bayati (2016); Hassan and Kalim, (2012) Chen (2010); Ensor et al., (2010). Islam (1995) and Furuoka 2009 used it as an explanatory variable to examine the relationship between HDI and GDP per capita

Infant mortality rate

Infant Mortality Rate (IMR) refers to the probability of dying before age one, per 1000 live births. It is measured as the number of infant deaths per 1000 live births per year. In other words, Infant mortality is the death of a child less than one year of age. It is measured as the number of deaths of children under one year of age per 1000 live births Akinkugbe and Afeikhena (2006) Anyanwu and Erhijakpor (2007) Yaqub, Ojapinwa and Yussuff (2012). In addition, Nuhu et al. (2018) and Lee et al.1997 also employed their studies to examine the relationship between HDI and IMR.

Total fertility rate

It has been proven in both the theoretical and empirical literature that total fertility is directly linked to maternal mortality (McCarthy & Maine, 1992; Williamson,1999). Thus low fertility will lead to a reduction in maternal mortality. The level of fertility which is key in maternal mortality reduction is defined as the average number of children a hypothetical cohort of women would have at the end of their reproductive period if they were subject during their whole lives to the fertility rates of a given period and if they were not subject to mortality. It has been used as a control variable in studies conducted by Gonzalez & Ren (2017); Germ and Wasie (2017); Buor and Bream (2004). Myrskylä et al. (2009) and Harttgen (2014); Furuoka 2009 have also used it in their examination of the relationship between HDI and fertility.

Life expectancy at birth

According to Engineer et al (2010), life expectancy is an indicator that statistical measures the mean years one is expected to live. It is the only health component used in the computing of the human development index. It is mostly measured by life expectancy at birth(LEB), which is a statistical measure of the number of years a newborn would live if

prevailing patterns of mortality at the time of his/her birth were to stay the same throughout its life. Authors such as Ogungbenle, Olawumi, and Obasuyi (2013); Olakojo and Novignon (2012) Anyanwu and Erhijakpor (2007) used this measure as an explanatory variable in their studies. It is often used as a proxy for health outcomes Furuoka 2009 also employed this variable to examined the relationship between life expectancy and HDI.

Note: The empirical studies supporting the use of the above listed variables (HDI, Maternal mortality ratio, GDP per capita, Toal fertility rate, Life expectancy at birth, and Infant mortality rate) in our analysis is discussed in detail in empirical study three(chapter 6). This also cptures the author's name, year of publication, variables considered and major findings of their studies.

CHAPTER THREE

BRIEF BACKGROUND ON SSA, DATA AND ESTIMATION METHODS

Introduction

This chapter contains the brief geographical background on SSA, data type and sources, research design used for the study. The chapter also presents the data analysis methods used in the study. In the data analysis section, the estimation technique and procedure are also discussed in detail.

Brief background and maternal mortality in Sub-Saharan Africa

To understand why maternal mortality is important for discussion in this region. This section presents a brief background and the maternal mortality situation and trends in this region

3.1 Brief background on SSA

Sub-Saharan Africa(SSA), geographically refers to 47 of the 54 independent African countries. It lies south of the Sahara Desert and is politically classified by the United Nations as an area of the African continent that is located south of the Sahara. South Sahara Africa (SSA) region comprises twenty-five (25) coastal countries, sixteen (16) landlocked countries, and six (6) island countries. The Sahara Desert geographically shares a boundary with north Africa which is dominated by Arabs. SSA covers a large geographical area in Africa, and it is the habitat for ecological regions such as the Sahel, Savanna belt, tropical rainforest, and the Horn of Africa. The Sahel covers countries such as Chad, Mauritania, Niger, Sudan, and Mali. The Savanna belt which shares boundaries with the Sahel at the south is also made up of large wooded grassland ecosystems and countries such as Ethiopia and South Sudan. The tropical rainforest is also made up of the Great African Lakes which are concentrated at the west of the tropical rainforest, Congo region, and Southern coastal area of West Africa. Horn Africa is concentrated by hot, semi-arid climate and desert. The region occupies a large size of land surface of about twenty-three (23) million square kilometers. The land surface size occupied by SSA is larger than 28 European Union countries put together and it is the second-largest region after Asia in terms of land area. The region has a population of over one billion and a density of 46.34 per kilometer square. The population for the region spread over 3000 distinct ethnic groups with over 1000 different languages, diverse cultures and also shares a common and unique tradition.

The region has a growth rate of 2.3% and the highest fertility rate in the world. SSA has more than 40% of its younger population under 15years old who are women having an average of four (4) children during their lifetime. The world development indicators report of the World Bank shows that the gross domestic product(GDP) per capita for SSA increased from USD 605.50 in 1990 to USD 1596.98 in 2015, and the gross national income(GNI) per capita also increased from USD 1448.57 to USD 3603.11 for the same period. The adult literacy rate for the region also increased from 52.23% in 1990 to 63.62% in 2015.

In terms of natural resources, SSA has a large deposit of natural resources such as oil, gold, diamond, bauxite, manganese, iron ore, copper uranium, chromium, vanadium, antimony, and coltan. South Africa is the major producer of platinum and a major exporter of manganese and chromium. Sub-Saharan African countries such as Nigeria, Congo Cameroon, Angola, Gabon, and Equatorial Guinea are the major exporter of oil in the world. The region also has a large deposit of gold and diamond which are among the best in the world, from countries such as Ghana, Botswana, Namibia, and Mali. SSA is the largest producer of high-grade natural deposits such as bauxite, uranium, iron ore, and copper. These resources can be found in Sub-Saharan African countries such Congo DR, Niger, Zambia, Leone, Niger, and Guinea Liberia (Suma,2007).

Figure 3. 1 Map of Africa showing Sub-Saharan Africa

Source: https://www.librarything.com/topic/183039)

Concerning health, the region has made some improvement, after the Bamako initiative in 1987, which aimed at reshaping health policies in the Sub-region. However, the high level of infant and maternal mortality for SSA shows that progress in terms of the quality of the health care system is still below expectation. The region has the highest child mortality, thus one out of every child dying before their fifth birthday (World Bank,2016) and high maternal mortality of 547 per 100,000 live birth (WHO,2015). SSA is also challenged with a high risk of malaria and HIV/AID. The number of deaths associated with malaria accounts for 90% of the global estimates(WHO,2016). The number of people leaving with HIV/AIDS in Sb-Sub-Saharan Africa accounts for 69% of the global estimates. The health care delivery system is persistently challenged with how to meet the basic health delivery standards. This shortcoming has contributed to the ability of the health facilities to reduce most of the death associated with diseases or a combination of diseases occurring from preventable or manageable causes. Primary health care in the sub-region is very poor since most of the people reside in rural communities where access to transportation and health care system is limited. The region is also

challenged with adequate skilled health personnel. There is a constant shortage of medical supply in SSA due to poor procurement practices and distribution. Sub-Saharan Africa has a high doctor-to-patient ratio of less than one doctor to 1000 people. Aside from the poor health care system, Sub-Saharan African has increased its life expectancy from 40yrs in 1960 to 61yrs in 2017(World Bank,2019).

3.2 Maternal mortality in Sub-Saharan Africa

Sub-Saharan African is one of the regions in the world with the highest maternal morbidity and mortality irrespective of interventions by government and international organizations. It is also one of the regions with high maternal mortality at the country level. Nigeria is the country in Sub-Saharan Africa that is estimated to account for more than one-third of maternal deaths globally in 2015, with approximately 58,000 maternal deaths, representing 19% of the global maternal deaths estimate. Sierra Leone is also the only country in Sub-Saharan Africa that recorded the highest maternal mortality ratio of 1360 per 100,000 live births. Globally, the two countries with the highest lifetime risk of maternal death are in Sub-Saharan Africa. They are Sierra Leone and Chad, with a maternal lifetime risk of 1 in 18 and 1 in 17 respectively.

In 2015, 2% of the estimated maternal death in the region were related to AIDS as compared to the global estimate of 1.6. This relates to a maternal mortality ratio (MMR) of 11 per 100,000 live birth. Five countries in the region recorded more than 10% AIDS-related maternal mortality. They are South Africa (32%), Swaziland (19%), Botswana (18%), Lesotho (13%), and Mozambique (11%). Even though some countries in the region have improved their income status according to the world bank classification, maternal mortality is very high in the region. Table 3.1 shows the average maternal mortality ratio(MMR) for lower-middle-income countries in the region over the period for the study. Table 3 throws more light on the effect of the poor maternal health system in the |region, especially countries in the region with Low Middle Income (LMIC) status. The analysis in Table 3.1 indicates that Nigeria has the worst maternal mortality ratio among low middle income countries in Sub-Saharan Africa. This estimate for Nigeria shows on average 1,115 women die per every 100,000 life birth for the period 1990-2015. Se Tome and Principle is the low-income country in the region with the lowest average maternal mortality for the study period.

Table 3. 1 Maternal mortality for Low middle-income countries(LMICs) in Sub-Saharan Africa

Countries	Average MMR
Angola	848.68
Cape Verde	99
Cameroon	711
Congo Rep	583.5
Cote d'Ivoire	710
Djibouti	368
Ghana	435
Kenya	676
Mauritania	803
Nigeria	1058
Sao Tome and Principe	215
Sudan	502
Swaziland	528
Zambia	437
Lesotho	614

Source: Authors own construction from WDI

Poor maternal health care continues to be a challenge in upper-middle-income countries (UMICs) in Sub-Saharan Africa. The analysis in Table 3.2 also shows that upper-middle-income countries in the region are also confronted with the problem of poor maternal health care. The analysis further indicates that the high maternal mortality ratio among the Upper Middle-Income countries must be addressed. The results of the analysis in Table 2.2 indicates that Equatorial Guinea has the high maternal mortality estimate of 695 per 100,000 live birth, which means on the average 695 women die per 100,000live birth over

the period 1990 to 2015 in Upper Middle-Income countries in the sub-region. The lowest maternal mortality ratio for Upper Middle-Income countries is 53 per 100,000 live birth and is recorded in Mauritius.

Table 3. 2 Maternal mortality for Upper middle-income countries(UMICs) in Sub-Saharan

Countries	**Average MMR**
Botswana	245
Equatorial Guinea	695
Gabon	371
Namibia	760
South Africa	107
Mauritius	53

*Source***:** Authors own construction from WDI

The Low-Income countries in the region, are the ones most affected by high maternal mortality, due to low socio-economic status and poor maternal health systems. The result in Table 3.3 indicates that the low-income countries have the highest maternal mortality ratio in the region. The maternal mortality ratio for low-income countries in Sub-Saharan Africa ranges between 446 and 2233 maternal deaths per 100,000 live birth. The high maternal mortality estimate is recorded in Sierra Leone (i.e. on average 2233 women die per every 100,000 live birth) and the lowest is 446, which is recorded in Senegal (i.e. on average 446 women die per every 100,000 life birth). The lowest maternal mortality estimates for low-income countries in the region are higher than the lowest estimates for the upper middles income countries and lower-middle-income countries in the region**.**

Table 3. 3 Maternal mortality for low-income countries(LICs) in Sub-Saharan Africa

Countries	Average MMR
Benin	511
Burkina Faso	524
Burundi	965
Central African Republic	1116
Chad	1227
Comoros	635
Congo Democratic Republic	832
Eritrea	820
Ethiopia	811
Gambia The	862
Guinea	870
Guinea-Bissau	717
Liberia	1211
Madagascar	539
Malawi	786
Mali	779
Mozambique	877
Niger	742
Rwanda	812
Senegal	446
Sierra-Leone	2233
Somalia	1003
South Sudan	1213
Tanzania	729
Togo	470
Uganda	550
Zimbabwe	502

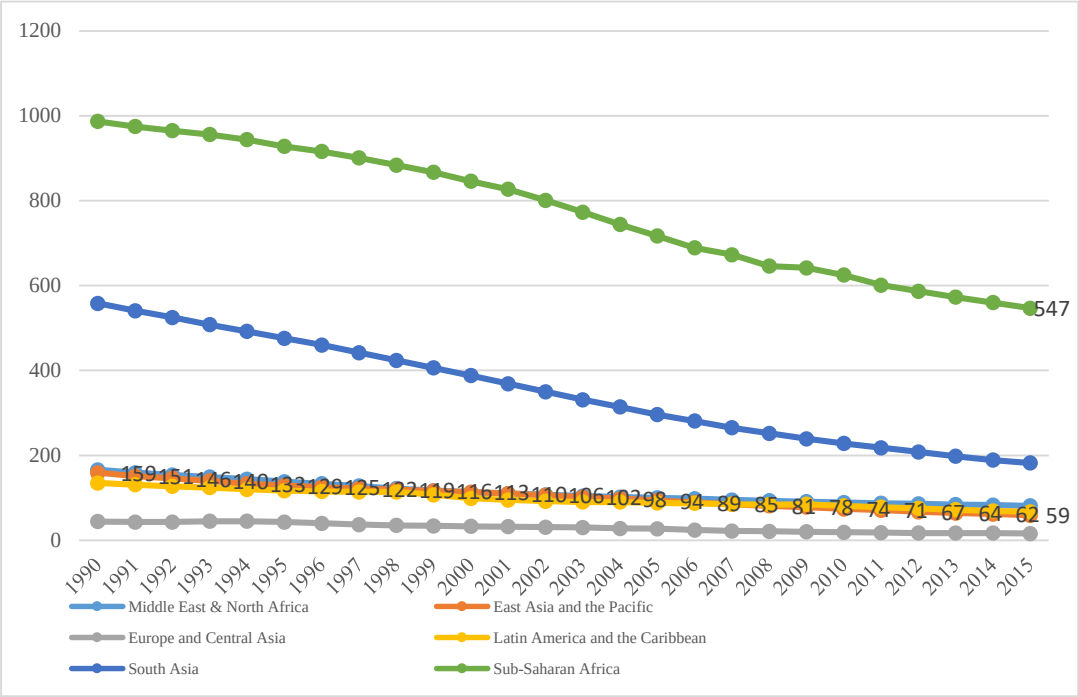
Source: Author's Computation from WDI

The performance of Sub-Saharan Africa in the reduction of maternal mortality a key population

development as a target in both the Millennium Development Goals and the Sustainable Development Goal has not been impressive. The sustainable development report of the WHO for 2017 estimated maternal mortality of 542 maternal deaths per 100,000 live for the region, compared to the global rate of 211 maternal deaths per 100,000 live birth for the same year (WHO 2017, 32). As observed in Figure 2.4, the maternal mortality ratio

estimated for SSA from 1990 to 2015 has been consistently very high as compared to other sub-regions in the world. The figure depicts a decreasing trend in maternal mortality for the regions of the world, including Sub-Saharan Africa, but the worrying situation is that the maternal mortality ratio for the sub-region is still very high. As shown in Figure 3.2, in 2015 the Sub-Saharan African region recorded a maternal mortality ratio of 547 maternal deaths per 100,000 live births compared to the Middle East and North Africa (81maternal deaths per 100,000 live birth), in East Asia and Pacific (59 maternal deaths per 100,000 live birth), Europe and Central Asia (16 maternal deaths per 100,000 live birth), Latin America and the Caribbean(67 maternal deaths per 100,000 live birth) and South Asia(182 maternal deaths per 100,000 live birth). A critical observation of WHO report 2015 on the Millennium Development Goals 5 reveals that maternal mortality estimates for the SSA region are thirty-four times higher than that of the estimate of Europe and Central Asia (16 maternal deaths per 100,000 live birth), nine times higher than East Asia and Pacific (59 maternal deaths per 100,000 live birth), eight times higher than Latin America and the Caribbean(67 maternal deaths per 100,000 live birth) and seven times higher than the estimate for the Middle East and North Africa (81maternal deaths per 100,000 live birth). Though South Asia(182 maternal deaths per 100,000 live birth) is the second-highest in the world, the estimates for SSA is three times higher than that of South Asia

Figure 3. 2Trend of maternal mortality ratio in Sub-Saharan compared to other regions



in the world (1990-2015)

Source: Authors own construction from WHO online database 2018

3.3 Data and sources

The study used both cross-sectional and panel datasets for the empirical analysis to achieve the objectives of the study. The cross-sectional data spans between 2008 and 2015; and the panel dataset also covers the period 1990 to 2015. The cross-sectional data is sourced from the demographic health survey which collects accurate and representative data on population, health, HIV/AIDS, and nutrition. These datasets are collected five years preceding the survey and it is conducted in over 90 countries in the world. The survey data for the selected countries are based on the current year of the survey and the availability of data on selected variables of interest. The data for the study are primarily secondary data sourced from international online databases such as the World Health Organisation (WHO), Nations Development Programme (UNDP), Demographic Health Survey (DHS), World Development Indicators (WDI) of the World Bank and Economists Intelligence Unit's report. The data for the study covers 35 countries in the Sub-Saharan African region. The 35 Sub-Saharan African countries sampled for the study are Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central Africa Republic, Chad, Comoros, Congo, Cote d'Ivoire, Democratic Republic of Congo, Gabon, Gambia, Ghana, Guinea, Guinea Bissau, Kenya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, South Africa, Sudan, Tanzania,

Togo, Uganda, and Zimbabwe. The focus of this study is all 47 countries in SSA, but due to lack of data, we used 35 countries for our analysis.

The description and sources of the variables used in the analysis for the study are presented in Tables 3.4,3.5 and 3.6. These variables and their definitions are categorized base on empirical studies.

This section presents the description and sources of variables used to estimate the effect of determinants (socio-economic, socio-cultural, and health or medical) on maternal mortality (Table 3.4).

Table 3. 4 Description and sources variables used to examine the effect of determinants on maternal mortality

Variable	Description	Source
Maternal mortality ratio	The number of women who die from pregnancy-related causes while pregnant or within 42 days of pregnancy termination per 100,000 live births.	WHO(World Health Organization
Socio-economic		
GNI per capita (Atlas method)	Gross national income (in US dollars) divided by midyear population	WDI World Bank
Female occupation	Percentage of women occupying middle and senior positions	DHS
Female Unemployment	Percentage Share of the female labor force that is without work but available for and seeking employment.	WDI
Education index	The average mean years of schooling of adults and expected years of schooling for children, the two expressed as an index obtained by scaling with the corresponding maximum.	UNDP
Socio-cultural		

Female literacy	Percentage of the female populations aged 15 and above who can read and write and understand a short simple statement about their everyday life.	DHS
Female secondary education	Percentage of the female population aged 15–49 with secondary education and above	DHS
Gender deviation index	The ratio of female to male human development value.	UNDP
Medical/health		
Antenatal care coverage	Percentage of women aged 15–49 that were attended at least once during pregnancy by skilled health personnel (doctor, nurse, or midwife).	DHS
Skilled birth attendant	Percentage of births that received care from qualified medical personnel.	DHS
Access to an improved water source	The percentage of the population using an improved drinking water source.	UNDP
Contraceptive prevalence rate	The percentage of women aged 15–49 years, married or in-union, who are currently using, or whose sexual partner is using, at least one method of contraception.	DHS
Life expectancy at birth	The number of years a newborn would live if prevailing patterns of mortality at the time of his/her birth were to stay the same throughout its life.	WDI
Total fertility rate	The average number of children a hypothetical cohort of women would have at the end of their reproductive period if they were subject during their whole lives to the fertility rates of a given period and if they were not subject to mortality.	WDI

Source: Author(s) own construction

Note: WDI: World Development Indicators of World Bank; DHS: Demographic Health Survey; UNDP: United Nations Development Programme; WHO: World Health Organization

Note: The theoretical and empirical justification for the use of these variables in examining the effect of determinants (i.e. socio-economic, socio-cultural, health, or medical) on maternal mortality is discussed in detail in chapter two, one of the theoretical chapters of this dissertation.

The description and measurement of variables used in examining the effect of social development on maternal mortality.

This section also presents the description and sources of the variables used in examining the effect of social development on maternal mortality. Table 3.5 presents the definition and sources of variables employed in the empirical analysis.

Table 3. 5 Description and sources of variables used to examine the effect of social development on maternal mortality

Variable	Description	Sources
Maternal Mortality Ratio (MMR)	The number of women who die from pregnancy-related causes while pregnant or within 42 days of pregnancy termination per 100,000 live births.	WHO
Economic Development		
GNI per capita(Atlas method)	The total value of goods and services produced in a country (in US dollars) is divided by midyear. Population	WDI
Social Development		
Human development index	A composite index that measures overall well-being	UND
Public health expenditure	Public expenditure on health from domestic sources as a percentage of total public expenditure.	WDI

Adult literacy rate	Percentage of people above 15years who can read and write with understanding	WDI
Internet users	Percentage of people who have used the Internet from any location.	WDI
Mobile phone subscribers	The number of people per 1000 population that subscriptions to a public mobile telephone service that provide access to cellular technology	WDI
Access to an improved water source	The proportion of inhabitants using improved drinking water sources.	UNDP
Political Development		
Demindex	A measure based on five democratic areas: electoral process and pluralism; civil liberties; the functioning of government political participation and political culture	EIU
Reproductive Capability/Freedom		
Antenatal care coverage	Percentage of women aged 15–49 years that were attended at least once during pregnancy by skilled health personnel (doctor, nurse, or midwife).	DHS
Births attended by skilled health personnel	Percentage of births that received care from qualified medical personnel.	DHS
Access to an improved water source (%)	The percentage of the population using an improved drinking water source.	UNDP

Contraceptive prevalence rate **(%)**	The proportion of women currently using(or whose sexual partner) a particular method of contraceptive method at a point in time.	DHS
Early marriage(%)	Percentage of girls marriage before age 18	DHS
Immunization	Percentage of pregnant women who received all vaccinations	DHS

Source: Author(s) own construction

Note: WDI: World Development Indicators of World Bank; DHS: Demographic Health Survey; UNDP: United Nations Development Programme; EIU: Economist Intelligence Unit

Note: The theoretical and empirical justification for the use of these variables in examining the effect of social development on maternal mortality is discussed in detail in chapter two, one of the theoretical chapters of this dissertation.

This section presents a detail definition and measurement of variables used in examining the relationship between human development and maternal mortality.

Dependent variable

The HDI is used as a measure for human development as it captures both the social and economic development of the inhabitants of a country. Again, it measures both the monetary and non-monetary aspects of wellbeing. The human development index is a statistical measure used to assess the level of well-being and the quality of the inhabitants of a country. The index consists of three components; namely health, education, and income. The health aspect of the index is measured by life expectancy at birth, which aggregates the long and healthy life of the population. The education component also captures how knowledgeable the inhabitants are, is measured by adult literacy and their level of education. The income component which also captures the standard of living of the population is measured by per capita gross domestic product (GDP).

Independent variables

The independent variables used in the study are based on both the theoretical and empirical literature on the relationship between human development measured by the HDI and maternal mortality measured by the maternal mortality ratio. We used total fertility rate(TFR), life expectancy at birth(LEXP), and GDP per capita(GDPPP) as control

variables apart from the main variables of interest (maternal mortality ratio (MMR and infant mortality rate(IMR)

Maternal mortality ratio

Maternal mortality, which is the main variable of interest in this study is defined as the death of a woman that occurs due to direct obstetric complications or indirect pregnancy complication that is associated with the pre-medical condition of the woman, but not from outcomes that is due causes from incident or accident (Kassebaum et al., 2016). This is measured by maternal mortality ratio (MMR), which is the annual number of death of women due to pregnancy and childbirth complications per 100,000 live birth. According to Sen, improved maternal health outcomes will mean well-being. It has also been hypothesized countries with poor maternal health outcomes have high inequality, poor social and economic development. This indicator is a measure of the quality of the health care system of a country.

Gross Domestic Products(GDP) per Capita

GDP per capita measures the annual percentage growth rate of gross domestic product divided by midyear population which is based on constant 2010 U.S Dollars. It is often used as a measure of economic growth. It is expected that an increase in GDP per capita should improve the outcomes of the inhabitant of a nation. The reason is that an increase in the per capita income of a country will lead to an improvement in health care access and use by the household through the provision of health care infrastructure by firms and governments.

Infant mortality rate

Infant Mortality Rate (IMR) refers to the probability of a child dying before age one, per 1000 live births. It is measured as the number of infant deaths per 1000 live births per year. In other words, Infant mortality is the death of a child less than one year of age. It is measured as the number of deaths of children under one year of age per 1000 live births.

Total fertility rate

It has been proven in both the theoretical and empirical literature that total fertility is directly linked to maternal mortality (McCarthy & Maine, 1992; Williamson,1999). Thus low fertility will lead to a reduction in maternal mortality. The level of fertility which is key in maternal mortality reduction is defined as the average number of children a hypothetical cohort of women would have at the end of their reproductive period if they

were subject during their whole lives to the fertility rates of a given period and if they were not subject to mortality.

Life expectancy at birth

According to Engineer et al (2010), life expectancy is an indicator that statistical measures the mean years one is expected to live. It is the only health component used in the computing of the human development index. It is mostly measured by life expectancy at birth(LEB), which is a statistical measure of the number of years a newborn would live if prevailing patterns of mortality at the time of his/her birth were to stay the same throughout its life.

Table 3.6 presents the description and sources of variables considered in empirical analysis on the relationship between human development and maternal mortality in SSA.

Table 3. 6 Description and sources of variables used to examine the relationship between human development and maternal mortality

Variable	Description	Sources
Human Development Index(HDI)	The measure of the overall wellbeing of the population	UNDP
Maternal Mortality Ratio (LMMR)	Natural logarithm of maternal mortality	World Bank and WHO
Infant mortality rate (LMMR)	Natural logarithm of infant mortality rate	WDI
Total Fertility Rate (TFR)	A measure of the average number of children that would be born to a woman over her lifetime	WDI

Life Expectancy at birth (LLEXP)	Natural logarithm of life expectancy	WDI
GDP per capita (GDPPP)	GDP per capita measures the annual percentage growth rate of gross domestic product divided by midyear population which is based on constant 2010 U.S Dollars	WDI

Source: Author(s) own construction

Note: WDI: World Development Indicators of World Bank; DHS: Demographic Health Survey; UNDP: United Nations Development Programme

Note: The empirical justification for the use of these variables in examining the relationship between human development and maternal mortality is discussed in detail in chapter two, one of the theoretical chapters of this dissertation

3.3.1 Design and rationale of the study

This study employed a quantitative design approach to investigate the effects and relationships of socio-economic, health/medical, and socio-cultural determinant and maternal mortality, social development on maternal mortality, human development, and maternal mortality. According to Creswell, quantitative research allows the researcher to objectively examine the interactions between the research variables and also present hypothetical results based on specific research questions (Creswell,2013).

Quantitative analysis also enables the researcher to operationalized definitions of variables of interest which can be used to derive causal relationships (Bryman,1984). The use of quantitative research also gives room for social research to be repeated in different situations which also improves reliability and validity, a major problem in social research (Matveev, 2002; Creswell, 2013). This study used quantitative measures to examine the effects and relationships between maternal mortality, its determinants, social development, and human development in Sub-Saharan Africa.

3.4 Methods of Data analysis

The study used the Partial Least Square(PLS) Structural Equation Modelling(SEM) technique to analyze the cross-section data to understand both the direct and indirect interactions between the variables of interest for the study. A panel data analysis approach is adopted to examine the relationship between the variables of interest**.** The PLS-SEM

estimation is done with the SmartPLS software version 3. Eviews version 10 and STATA 15 version are also used for the panel data analysis.

Estimation method for empirical chapters four and five

The partial least square(PLS) structural equation modeling (SEM) is employed in empirical studies 4 and 5 to investigate the effects of determinants (i.e. socio-economic, socio-cultural, and health or medical) on maternal mortality; and the effect of social development on maternal mortality in SSA.

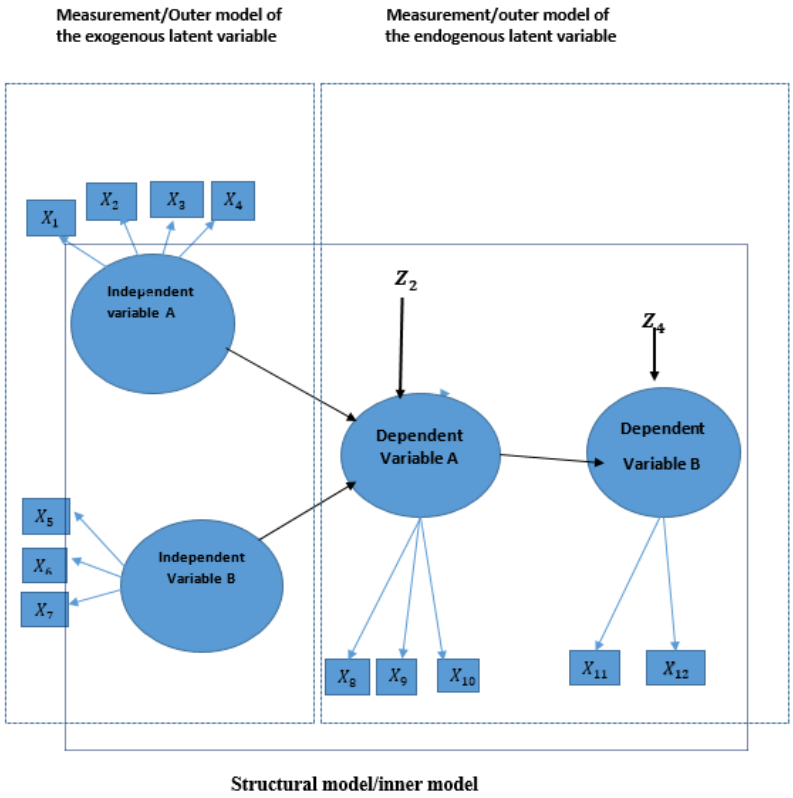
3.5 Partial least square structural equation modeling (SEM) estimation method

Partial Least Square(PLS)-SEM developed by a Swedish econometrician Wold (1975) under the name NIPALS (non-linear iterative partial least squares) is a statistical technique that combines both factor analysis with ordinary least square regression. It is a multivariate statistical technique that allows simultaneous multiple investigations among dependent and independent latent variables. This estimation technique is also referred to as variance-based as it focuses on maximizing the total variance of the endogenous latent variable explained by the exogenous latent construct and also estimate the model parameter using the total variance.

PLS-SEM consists of three components namely; the measurement or outer model, the structural model or inner model, and the weighting scheme. The measurement model or inner model measures the relationship between the latent variables and the observed or indicator variables (Hair Jr. *et al.*, 2014). The structural or inner model reflects the path relationship between the latent variables. The weighting which is specific to Partial Least Square - SEM is used specifically for the estimation of the inner weight. The PLS-SEM can be used to estimate both reflective and formative indicators. The reflective indicators estimation is for explanatory studies and that of the formative is for confirmatory studies. The reflective indicators have error terms, but the formative indicators do not have error terms. The PLS-SEM uses the Ordinary Least Square techniques to calculate the path coefficient and also uses the bootstrapping approach to estimate the standard error and to test the significance of the path coefficients. The name Partial Least Square emanated from the fact that the parameters are estimated using a series of least-squares equations and also the iterative estimation of the parameter per latent variable is derived partially.

The PLS-SEM uses a non-parametric statistical technique and does not impose distributional assumptions (Dijkstra, T. 1983) as compared to the ordinary least squares (OLS) regression. It gives meaningful results even if the sample size is very small. (Chin, W. W., & Newsted, P. R. (1999). Apart from its distributional advantage, the PLS-SEM algorithm for computing the measurement or outer model and structural or inner model is done separately instead of simultaneously. PLS-SEM is more flexible and precise, can analyze multiple relationships simultaneously, test models with many equations, obtain global adjustment measures, and also model the mediating and moderating variables as well as the model errors. It uses different indicators as a measure for the latent variable as well as a single indicator, which does not apply in the case of other regression models. PLS-SEM estimates can be obtained using the following software; SmartPLS, ADANCO, XLSTAT, WarpPLS, VisualPLS, PLS graph (Soft Model Inc. 1992-2002), etc. Figure 3.1 presents the structure of the PLS-SEM model

Figure 3. 3 Path Model



Source: Author(s) own construction

3.5.1 Partial Least Square SEM estimation procedure

The PLS-SEM model consists of two sub-models, they are; the measurement or outer model which measures the relationship between the indicators or observed variables and their associated latent variables or constructs (The arrows pointing to the boxes measures the correlation between latent variables (LVs) and manifesting variables (MVs) or indicators as shown in Figure 3.1) and the structural or inner model also measures the path relationship between the latent variables or constructs (The arrows pointing to the circles, measures the causal relationship between independent or exogenous and the dependent or endogenous latent variables or construct, refer to Figure 3.1) The fitness of the measurement model which in this case is a reflective model as indicated in Figure 3.1 is evaluated by the internal consistency of the model which is measured by the Cronbach's alpha, indicator reliability, average variance extracted and composite reliability. The convergence validity of the specified model is assessed by using the indicator reliability and average variance explained and finally the discriminant validity.

The composite reliability which is more appropriate for PLS-SEM, according to Hair Jr. et al (2014) is between 0.60 and 0.70 for explanatory studies and 0.7 and 0.9 for other types of research. The average variance explained should be greater than 0.5 by the Fornell & Larcker, 1981 criteria. The individual reliability should be a minimum of 0.4 for explanatory studies and 0.7 for confirmatory studies (Hulland, 1999). The discriminant validity of the measurement model is assessed using the discriminant validity of the PLS-SEM model, which could be assessed using the Fornell and Lacker criteria (1981) and Heterotrait-Monotrait Ratio (HTMT) by Henseler, Ringle, and Sarstedt (2015). The Fornell and Lacker criteria assess the discriminant validity of the final model by comparing the square root of the average variance explained (AVE) for each construct with the correlation between the latent constructs (Fornenell and Lacker,1981).

According to Henseler, Ringle, and Sarstedt (2015), discriminant validity estimated using the Heterotrait-Monotrait Ratio (HTMT) of the PLS algorithm should be below 0.9. This indicates that discriminant validity has been established between a given pair of reflective latent variables or constructs.

The Cronbach's alpha, composite reliability, and the average variance explained are estimated using equations (3.1) to (3.3).)

$$\textbf{Cronbach's } \alpha = \frac{\mathbf{K}.\bar{r}}{[\mathbf{1}+(\mathbf{k}-\mathbf{1})\bar{r}]} \quad (3.1)$$

Where **K** is the number of indicators for the constructs and **r** is the mean correlation matrix for the upper or lower triangular

$$\textbf{composite reliability} = \frac{\left(\sum_{k-1}^{k} \boldsymbol{l_k}\right)^2}{\left(\sum_{k-1}^{k} \boldsymbol{l_k}\right)^2 + \sum_{k-1}^{k} Var(\boldsymbol{e_k})} \quad (3..2)$$

Where the variable l_k in the equation represent the standard outer loading of a specific construct K which is measured by an indicator variable k. e_k is the measurement error associated with the indicator variable k and Var (e_k) is the variance attributed to the measurement error, is estimated as 1 - l_k^2.

$$\textbf{Average Variance Explained} = \frac{\left(\sum_{k-1}^{k} \boldsymbol{l_k}\right)^2}{K} \quad \textbf{(}3.3)$$

Where K in the above equation **represents** the number of indicators for the constructs and the variable l_k represent the standard outer loading of a specific construct K which is measure by an indictor variable k.

The structural model is assessed using the coefficient of determination (R^2), predictive validity(Q^2) and effective size (f^2). The predictive validity(Q^2) measures the effect sizes and also how well the path model can predict the beginning observed values (Hair et al. 2017, p. 106). The predictive validity(Q^2) is obtained by using the blindfolding algorithm of the smartPLS software. According to Hair, the Q^2 the value should be greater than zero(0), this indicates that the model is relevant to predicting the factor (Hair,2014). The coefficient of determination (R^2) measures the percentage of the given construct that can be explained by the other constructs and the independent variables affecting it. Höck & Ringle (2006) proposed that an R^2 value of 0.67 is substantial, 0.33 and 0.19, moderate and weak respectively. The coefficient of determination is estimated using equation 3.4

$$\textbf{Coefficient of Determination } (\mathbf{R^2}) = \frac{\sum_{i=1}^{n}(y_i-\bar{y})^2 - \sum_{i=1}^{n}(y_i-\hat{y})^2}{\sum_{i=1}^{n}(y_i-\bar{y})^2} \quad \textbf{(}3.4)$$

$$\textbf{Coefficient of Determination } (\mathbf{R^2}) = \textbf{(TSS – RSS) / TSS =MSS / TSS (}3.5)$$

where **TSS** -Total Sum of Squares = $\sum_{i=1}^{n}(y_i-\bar{y})^2$

where **MSS** -Model Sum of Squares = $\sum_{i=1}^{n}(\boldsymbol{y_i}-\bar{\boldsymbol{y}})^2 - \sum_{i=1}^{n}(\boldsymbol{y_i}-\hat{\boldsymbol{y}})^2 = \sum_{i=1}^{n}(\hat{\boldsymbol{y}}-\bar{\boldsymbol{y}})^2$

where **RSS**-Residual Sum Squares = $\sum_{i=1}^{n}(\boldsymbol{y_i}-\hat{\boldsymbol{y}})^2$

The effect and size of the structural model is assessed using f^2 and q^2. The f^2 measures the size and the significance of the path coefficient. The f^2 also, measure how large the percentage of unexplained variance accounted for by the coefficient of determination(f^2). It is also estimated using the blindfolding algorithm of the smartPLS software. According to Cohen(1988) an f^2 of 0.02 represent a small effect, 0.15 and 0.35 represent medium and large respectively. The f^2 and q^2 are estimated using equations 3.6 and 3.7

$$\mathbf{f^2} = \frac{\mathbf{R^2included - R^2excluded}}{\mathbf{1 - R^2included}} \quad (3.6)$$

where the $R^2included$ and $R^2included$ are the coefficient of determination (R^2) value for endogenous latent variable when a specific predictor concept is added or removed from the model. The $R^2included$ in the model is estimated with all the endogenous latent variables in the model and $R^2excluded$ value is also estimated by removing specific endogenous latent variables in the model.

$$\mathbf{q^2} = \frac{\mathbf{Q^2included - Q^2excluded}}{\mathbf{1 - Q^2included}} \quad (3.7)$$

3.5.2 The PLS Software Estimation Procedure

According to Chin& Newested (1996), the Partial Least Square algorithm comprises an iterative process of Ordinary Least Square(OLS) regression and begins with an initialization point where the latent variables or constructs are approximated by a linear combination of indicators or manifesting variables. The weight that is obtained from the linear combination is determined using a method that is similar to the principal component analysis for reflective and regression analysis for formatives indicators.

The second and third stage is the inner approximation which follows immediately after the outer approximation. The outer approximation is the stage where the best linear approximations are identified to express the individual latent variable or constructs employing its indicator or manifesting variable, and its coefficients are termed as outer weights. The fourth stage comprises the calculation of the factor scores for each stage and scaling of the latent variables or constructs to have a mean zero and variance one. These stages are estimated mathematically as follows

The first stage(initialization) is estimated as follows:

Let the indicator or manifesting variable(MVs), represented by $\boldsymbol{X_1}$,....., $\boldsymbol{X_p}$ have mean, E(X_i) = 0 and variance, Var(X_i) = 1. All the weight of the latent variables is set to 1 and the latent variable(LVs) are scaled to have unit variance. This is expressed by equations 4.1 and 4.2 as follows

$$\widehat{\boldsymbol{Y}} = \boldsymbol{XB} \tag{4.1}$$

$$\widehat{\boldsymbol{Y}} = \frac{\hat{y}_g}{\sqrt{\mathbf{VAR}(\hat{y}_g)}}, \quad \boldsymbol{g} = \mathbf{1}, \ldots\ldots\ldots, \boldsymbol{G} \tag{4.2}$$

Where **B** is the adjacent matrix and the latent variables (LVs) are initialized as $\hat{Y} = (\widehat{\boldsymbol{y}}_1, \ldots\ldots, \widehat{\boldsymbol{y}}_G)$

The second stage is the inner approximation. This stage consists of the estimation of each of the latent variables (LV) as a weighted sum of its neighboring latent variables(LVs). The weighting technique at this point depends on the type of weighting scheme applied. Here the recomputed latent variables(LVs) are scaled to have unit variance. This is expressed by equations 5.1 and 5.2

$$\widetilde{\boldsymbol{Y}} = \widehat{\boldsymbol{Y}}\boldsymbol{E} \tag{5.1}$$

$$\widehat{\boldsymbol{y}}_{\boldsymbol{g}} = \frac{\hat{y}_g}{\sqrt{\mathbf{VAR}(\hat{y}_g)}}, \quad \boldsymbol{g} = \mathbf{1}, \ldots\ldots\ldots, \boldsymbol{G} \tag{5.2}$$

The inner estimation for the inner approximation is obtained by $\bar{Y} = (\overline{\boldsymbol{y}}_1, \ldots\ldots, \overline{\boldsymbol{y}}_G)$

The third stage is the outer approximation. Here, for the initialization, all the weights are set to one and the weights are recalculated again based on the weighting scheme. The weight at this stage is determined based on the mode of the measurement, that is either mode A for reflective measurement or mode B for formative measurement. The block of the manifesting variables (MVs) mode A is the response variable and that of the latent variable(LV) is the regressors. This is also estimated by Eqn. 6.1

$$\widetilde{\boldsymbol{W}}_{\boldsymbol{g}}^{\boldsymbol{T}} = (\widetilde{\boldsymbol{y}}_{\boldsymbol{g}}^{\boldsymbol{T}}\widetilde{\boldsymbol{y}}_{\boldsymbol{g}})^{-\mathbf{1}}\widetilde{y}_g^{\,T}\boldsymbol{X_g} = \boldsymbol{COR}(\widetilde{\boldsymbol{y}}_{\boldsymbol{g}}, \boldsymbol{X_g}) \tag{6.1}$$

Mode B multiple regression coefficients are written with the latent variable(LV) as response and accompanying the blocks as an indicator or manifesting variable(MV). This is expressed by Eqn. (6.2)

$$\widetilde{w}_g = (X_g{}^T X_g)^{-1} X_g{}^t \tilde{y}_g \qquad (6.2)$$
$$= VAR(\boldsymbol{X}_g)^{-1} COR(\boldsymbol{X}_g, \widetilde{\boldsymbol{y}}_g)$$

A reflective indicator (Mode A) is used in this study.

In stage 4, the factor scores are estimated and the outer weights vectors $w_{1,\ldots\ldots,}w_G$ are arranged in an outer matrix **W**. The result of the outer estimates of the latent variable $\hat{Y} = (\widehat{\boldsymbol{y}}_1,\ldots,\widehat{\boldsymbol{y}}_G)$
is obtained by Eqn. 7.1 and 7.2

$$\widehat{\boldsymbol{Y}} = \boldsymbol{XW} \qquad (7.1)$$

$$\widehat{\boldsymbol{Y}}_{\boldsymbol{g}} = \frac{\widehat{Y}_g}{\sqrt{\mathrm{VAR}(\widehat{\boldsymbol{Y}}_{\boldsymbol{g}})}}, \quad g = 1,\ldots\ldots\ldots,G \qquad (7.2)$$

Here in stage 5, the factor scores estimate in step 4 becomes the final estimate if relative changes of all the outer weight from one iteration to the next are smaller than a predefined tolerance as expressed in equation 8.1

$$\left|\frac{\widehat{w}_{kg}{}^{old} - \widehat{w}_{kg}{}^{new}}{\widehat{w}_{kg}{}^{new}}\right| < tolrence \qquad (8.1)$$
$$\forall\, \kappa = 1,\ldots\ldots\ldots \mathrm{K} \quad \Lambda \quad g = 1,\ldots\ldots,\mathrm{G}$$

The PLS algorithm's inner weight is estimated using a weighting scheme. According to the centroid weighting scheme, the matrix of inner weight is express in the form as specified in Eqn. 8.2

$$e_{ij} = \begin{cases} sign(r_{ij}) & ,for\ c_{ij=1} \\ 0 & ,else \end{cases} \quad i,j = 1,\ldots\ldots\ldots,G \qquad (8.2)$$

This stage is the estimation of the path coefficient, total effects, and loading. After estimating factor scores using the PLS algorithm, the path coefficient is obtained by ordinary least squares(OLS), based on the structural model. The latent variable(LV), $\widehat{\boldsymbol{y}}_{\boldsymbol{g}}$, $g = 1,\ldots\ldots,G$, the path coefficient for each regression coefficient is the regression coefficient on its predecessor set $\widehat{\boldsymbol{y}}_{\boldsymbol{g}}{}^{\boldsymbol{pred}}$ is estimated using equation 8.3

$$\widehat{\boldsymbol{\beta}}_{\boldsymbol{g}} = (\widehat{\boldsymbol{y}}_{\boldsymbol{g}}{}^{predT}\widehat{\boldsymbol{y}}_{\boldsymbol{g}}{}^{pred})^{-1}\widehat{\boldsymbol{y}}_{\boldsymbol{g}}{}^{predT}\widehat{\boldsymbol{y}}_{\boldsymbol{g}}$$

$$= \mathbf{COR}\,(\widehat{\boldsymbol{y}}_{\boldsymbol{g}}{}^{predT}, \widehat{\boldsymbol{y}}_{\boldsymbol{g}}{}^{pred})^{-1}\,\boldsymbol{COR}(\widehat{\boldsymbol{y}}_{\boldsymbol{g}}{}^{pred}, \widehat{\boldsymbol{y}}_{\boldsymbol{g}} \qquad (8.3)$$

The elements $\widehat{b}_{ij}\ i,j = 1, \ldots\ldots, G$ matrix of the path coefficient $\widehat{\boldsymbol{B}}$ is estimated using Eqn. 3.5.9

$$\widehat{\boldsymbol{\beta}}_{\boldsymbol{ij}} = \begin{cases} \widehat{\boldsymbol{\beta}}_{\boldsymbol{gi}} & ,for\ j \in y_i{}^{pred}, \\ 0 & ,else \end{cases} \qquad (8.4)$$

The transition matrix for the structural model is known as matrix B. The total effects, $\widehat{\boldsymbol{T}}$ is the sum of the step transition matrices 1 to G. This is obtained by Eqn. 8.5

, $$\widehat{\boldsymbol{T}} = \sum_{\boldsymbol{g=1}}^{\boldsymbol{G}} \widehat{\boldsymbol{B}}_{\boldsymbol{g}} \qquad \textbf{(}8.5)$$

The path algorithm estimates the cross and outer loading as follows

$$\widehat{\Lambda}^{\boldsymbol{cross}} = \boldsymbol{COR}(\boldsymbol{X}, \widehat{\boldsymbol{Y}}) \qquad (8.6)$$

$$\widehat{\boldsymbol{\lambda}}_{\boldsymbol{kg}}{}^{cross} = \begin{cases} \widehat{\boldsymbol{\lambda}}_{\boldsymbol{kg}}{}^{cross} & ,if\ m_{kg=1} \\ 0 & ,else \end{cases} \qquad (8.7)$$

Estimation method for empirical chapter six

3.6 Panel regression estimation method

Panel or longitudinal data analysis is a statistical estimation method used to analyze cross-sectional and time-series data. These types of data are collected on an individual over the same time. According to Gujarati, 2003, the combination of the time series or cross-sectional data improves the quality and the number of the dataset in a manner that would be impossible when using only either the time-series data or the cross-sectional data. In panel or longitudinal data analysis, the problem of heterogeneity is addressed by controlling for the heterogeneity. In this case, the unit of analysis being, individuals, companies, or nations is seen as heterogeneous. Panel or longitudinal data analysis methods allows for more complicated behavior to be tested than in cross-sectional or time series analysis. Panel or longitudinal data analysis estimation is appropriate for this study since it allows for the identification and measurement of effects that are not easily detected in purely cross-sectional or time series analysis.

The general panel regression is specified as follo

$$y_{it} = a_i + \mu_1 x_{1it} + \mu_2 x_{2it} + \ldots\ldots\ldots\ldots + e_{it} \qquad (9.1)$$

Where y_{it} represent the response variable for country i in the time period t, a_i is variable that represents the equation for a country i. x_{it} is a vector representing the

predictor variables for country i in the time t, μ represent the vector of unknown parameters that are common among countries and e_{it} is the disturbance term for country i in the time period t.

There are different types of panel regression models, but for this study, the fixed effect (FE), Random Effect(RE), and System generalized method of moments (GMM**)** panel regression estimation methods are discussed, since they are the ones employed in the empirical analysis for the study.

Fixed effect model

The fixed effect model is a panel regression model in which the group means is a fixed sample from a population. Panel data used in fixed-effect model estimation are grouped according to different observed factors. The grouped means for such data are modeled as fixed. In fixed effect panel data estimation, each group means is determined as a group-specific-fixed quantity. When heterogeneity in the panel data is constant, a fixed effect panel regression model is appropriated since it can control for the biasedness in the omitted variables as a result of the unobserved heterogeneity in panel data. One of the assumptions for using the fixed-effect model is that error terms could be correlated with the individual fixed effect. The fixed effect model is specified as follows

$$y_{it} = X_{it}\beta + \propto_i + \mu_{it} \; for \; t = 1, \ldots\ldots, T \; and \; i = 1, \ldots, N \qquad (9.2)$$

Where y_{it} represent the response variable for country i in the time period t, X_{it} represent $1 \times P$ time-variant explanatory variables, β is a $P \times 1$ matrix, $\propto_i$ represents the individual unobserved time-variant effect and μ_{it} is the disturbance term for country i in the time period t.

Random effect model (RE)

According to Greene, 2003, a random effect regression estimation model, is a regression model with a random constant term. The random effect regression model is a regression model in which the group means are random and can be modeled as random for each grouping. The redundant error in a random effect model is addressed by assuming that the intercept is a random outcome variable. The assumption for estimating panel data using a random-effect model is that the individual-specific effects are uncorrelated with the explanatory variables.

The Random-effects model is specified as follows

$$y_{it} = \beta_{\circ i} + \beta_1 x_{it}\, \beta_2 x_{it} + \varepsilon_{it}$$

$$\text{Where } \beta_{\circ i} = \beta_i + V_i \qquad (9.3)$$

$$\therefore y_{1t} = \beta_i + \beta_1 x_{it} + \beta_2 x_{it} + \varepsilon_{it} + V_i$$

Where y_{it} represent the response variable for country i in the time period t, x_{it} is a vector representing the predictor variables for country i the time period t, β represent the vector of unknown parameters that are common among countries, V_i is the random error for the specific heterogeneity for individual country i and is constant over a time period, e_{it} is the white noise specific to a particular observation for country i in the time period t.

Hausman Test

The Hausman test, which is mostly conducted in panel data analysis to determine if the fixed or random effect model is appropriate is also known as a test for model misspecification. The Hausman test assumes a null hypothesis that the chosen model has a random effect and an alternative hypothesis, that the chosen model has a fixed effect, meaning that the individual heterogeneity terms and the regressors in the model are correlated. However, if one fails to reject the null hypothesis, then the random effect model is appropriate, meaning that the unique error term and the regressors in the model are uncorrelated.

3.6.1 System generalized method of moments (GMM)

The System generalized method of moments popularly known as System GMM is a dynamic panel estimation method proposed by Arellano and Bond (1995) and finally developed by Blundell and Bond (1998). The name system GMM emanated from the method of derivation. This dynamic panel estimation method combines moment conditions based on both difference and level equations. The System GMM estimation is more efficient since it uses the level of the lags as instrumental variables for the differential equations and the differences in the lags as instrumental variables for the levels equation. The System GMM method is more efficient than the difference GMM as it has more instrument variables compared to the difference GMM. The system GMM estimation method is appropriate when the individual observation in panel data is large and with a small time period. This method is useful in addressing the endogeneity problem in panel models. According to Roodman, System GMM is used in addressing the heteroskedasticity and autocorrelation problems associated with time series and cross-sectional data (Roodman, 2009).

The System GMM estimation method developed proposed by Arellano and Bond (1995) and finally developed by Blundell and Bond (1998) is appropriate for addressing the biasedness and inconsistencies in panel data, since the Ordinary Least Squares (OLS), estimation could provide estimates that are bias and inconsistent (Wooldridge, 2013). Also according to Anderson and Hsiao (1982), the individual time-invariant effect is removed by applying the first difference and at this point, the estimation of the instrumental variable can be done. The second and third difference or lag of the explanatory variables, specified as $y_{i,t-2}$ $y_{i,t-2}$ $y_{i,t-3}$ or $\Delta y_{i,t-2}$ and $\Delta y_{i,t-2}$ can be used to formulate the instrumental variable for the lagged explanatory variable. According to Roodman, 2009, the instrumental variables built from this process are highly correlated with the lagged explanatory variable but are uncorrelated with the error term. However, according to Arellano and Bond (1991), the model developed by Anderson and Hsiao (1982) is consistent but cannot explain the potential orthogonality in panel data. To address the shortcomings of the dynamic panel model developed by Anderson and Hsiao (1982), Arellano and Bond (1991) developed a dynamic panel model known as the difference generalized method of moments **(GMM)** which is based on transforming of the differencing and generalized moment methods (GMM) to address the dynamic panel data problem. This method of estimation by Arellano and Bond (1991), is consistent but biased for a limited sample, due to poor instrument for the lagged level of first differenced variables. The proposed model by Arellano and Bond (1995) and Blundell and Bond (1998) is formulated as a system of equations that uses the lagged estimates of the dependent as the independent variables to introduce more instrumental variables as compared to the model proposed by Arellano and Bond (1991), hence making this system GMM model more appropriate for addressing the panel data problem. The underlying assumption for the use of this model is that the first differences of the instrument variables are not correlated with the individual fixed effects.

For the estimates of the System generalized method of moments (GMM) model to be consistent, the serial correlation in differenced errors must be tested. The serial correlation is tested using the Arellano-Bond test for autocorrelation, which is specified as (E($\Delta\mu_{i,t}$, t$\Delta y_{i,t-2}$) = 0). This is tested under the null hypothesis that there is no serial correlation. For the non-existence of serial correlation, the null hypothesis must be rejected for the AR (1) in the first difference residual and fail to reject the null hypothesis for the AR (2) in the first difference residual. The validity of the instrument is also tested using the Hansen J test

statistic of over-identifying restriction. This is also tested using the hypothesis that the instruments used are valid, meaning that the instruments and residuals are uncorrelated.

The general system GMM model is specified as follows;

$$y_{it} = \varphi y_{i,t-1} + \lambda X_{it} + \omega_{it}$$

$$\omega_{it} = \pi_{it} + \Omega_{it} \quad (10.1)$$

Where X_{it} represent the vector of the dependent variables, ω_{it} represent the constant error term., the subscripts i in the model represent a particular country, and t representing the time period. The parameters π_{it} and Ω_{it} stands for the fixed effect and the individual shocks respectively.

Stationarity test (Unit Root Test)

The stationarity of time series data for panel analysis is important since most econometric models use the current time that is based on time series stationary theory. The stability of data used for panel analysis is necessary since panel data is a combination of both time-series and cross-sectional data. Again time series data are always not stable, hence data used for panel analysis if non-stationary could result in what is termed as spurious regression. This situation occurs when the t-ratio of the slope coefficient reveals not to be significantly different from zero and the expected coefficient of variation (R^2) value is small. According to Brooks (2014), time-series data is stationary if it has a constant mean, variance, and autocovariance for every given lag. The stationarity of time series could be obtained by the method of differencing. A time series that becomes stationary after the first difference, is termed as I (1), which is integrated at order one, and if stationary is obtained after the second difference it is also term as I (2), which is also integrated at order two, etc. An I (1) series can be termed to contain a unit root and I (2) termed as containing two unit-roots. This section discusses three important unit root tests that are used to check for stationarity in Panel analysis. They are unit tests developed by Breitung (1994) and Quah (1994) and finally completed by (Levin, Lin, and Chu (1992,2002) and Im, Pesaran, and Shin (1997, 2003). (i.e. Levin, Lin and Chu tests and Im, Pesaran, and Shin test)

Levin, Lin, and Chu test

The unit root test proposed by Levin, Lin, and Chu (2002) for panel data assumed a null hypothesis that the series consists of a unit root against an alternative hypothesis that the series is stationary. The null and alternative hypotheses can be expressed as follows

$$H_O: \rho_i = 0 \, , for \; all \; i$$

$$H_1: \rho_1 < 0$$

Levin, Lin, and chin proposed three different models that can be used in determining stationarity in panel analysis. The models are specified as follows, a model with no individual effect, the second model is one with the individual-specific effect but without time trend, and the third model comprises a series with no individual-specific effect, linear and time trend.

Im, Pesaran and Shin(IPS) test

The unit root test proposed by Im, Pesaran, and Shin (2003) suggests the use of the mean of the individual unit root statistic to test for a unit root in heterogeneous panels. This is done by finding the averages of the individual unit root test statistics. This test also suggests the averaging of the Augmented Dickey Fuller (ADF) in situations where the disturbance term correlates with the various correlation properties across the cross-sectional units as proposed by Baltagi,2005. This test assumes a null hypothesis that each series in the panel contains a unit root and an alternative hypothesis of some but not all the individual series contains a unit root. The null and alternative hypotheses are specified as follows

$$H_O: \rho_i = 0 \, , for \; all \; i$$

$$H_1: \rho_1 < 0 \;\; for \; i = 1,2, \dots , N_1$$

And

$$H_1: \rho_1 = 0 \;\; for \; i = N_{1+1}, \dots , N$$

Cross-section dependence

Checking for cross-sectional dependence has become one of the basic requirements for panel data analysis. This has become necessary because occurrences such as oil price shocks, recessions, global financial and economic crises are possible events that affect almost all countries. This situation could induce significant cross-sectional

interdependency across cross-sectional units (entities such as individuals or countries), the model regressors, and disturbance terms (Eberhardt—Teal, 2011; Pesaran, 2006). However, panel data estimation techniques such as), Pool Mean Group(PMG) Fixed Effect (FE), Random Effect (RE), and Generalized Method of Moments (GMM) estimators mistakenly disregards the possibility of the existence of inter- dependence among entities such as countries or individuals (cross-sectional units). Misleading inferences could arise when cross-sectional dependence among regressors and cross-sectional units (countries or individuals) is mistakenly ignored, even when present in panel data. The cross-sectional dependency for the pane data used in this study is checked using Breusch-Pagan LM (1980, Pesaran CD (2004), and Pesaran LM (2008) test. In a situation where cross-sectional dependence exists in the panel dataset, first-generation unit root test such as augmented Dickey–Fuller test (ADF) tests, Phillips–Perron(PP) test Levin, Lin and Chu test Im, Pesaran and Shin(IPS) test, etc. cannot be used to test for stationarity. This problem of cross-sectional dependence is addressed by using the 'CIPS' unit root test by Pesaran (2007) since it accommodates the cross-sectional dependence in the dataset.

CHAPTER FOUR
DETERMINANTS OF MATERNAL MORTALITY IN SUB-SAHARAN AFRICA: A CAUSE-EFFECT MODEL ASSESSMENT

Introduction

For the past two and half decades, maternal mortality continues to be high in Sub-Saharan Africa, compared to other regions in the world. This abysmal high mortality in SSA is associated with inadequate health care, low economic and social status of most people in this region, specifically women, and harmful cultural and religious practices with health care access and use. Employing Partial Least Squares(PLS) Structural Equation Modelling (SEM), a multi-dimensional statistical estimation technique, as well as a cross-sectional dataset on 35 Sampled SSA countries spanning between 2008 and 2015. This chapter investigates the effect of determinants (socio-economic, medical or health, and socio-cultural) on maternal mortality. This is achieved by answering the following research questions; What are the determinants of maternal mortality in Sub-Saharan Africa? What are the effects of these determinants on maternal mortality in Sub-Saharan? The study further tests the following hypotheses; H_1: Improvement in socio-economic determinants will reduce the level of maternal Mortality in SSA, H_2: Improvement in health or medical determinants will reduce the level of maternal Mortality in SSA and H_3 : Improvement in socio-cultural determinants will reduce the level of maternal mortality through the medical or health determinants in SSA. The chapter starts with a background on the topic in section 4.1. Section 4.2 and 4.3 present a detail discussion on conceptual model for analysing the determinatins of maternal mortality and empirical literature on maternal mortality determinants. The estimation method, empirical model, and issues related to the data and their sources are discussed in section 4.4 and its sub-sections. Section 4.5 presents and discusses the empirical results. The final section of this chapter, which is section 4.6 presents the conclusion of the study.

4.1 Background of the study

According to the WHO sustainable development goals(SDGs) report, 295,00 women die each year worldwide from pregnancy-related complications; about 90 percent are in developing countries, with the worst rate being in Sub-Saharan Africa (WHO,2019). The statistics from the UNDP (United Nations Development Programme), 2018 report that Africa has the highest maternal mortality rate, with SSA mainly responsible for the abysmal maternal death rate in the region, accounting for 53 percent of the global maternal

deaths in 2017. The death of a mother during pregnancy is seen as a misfortune, and, over the years, it has become a burden for governments in SSA where international organizations have attempted to help address it through many interventions. In 1987, the international SMI (Safe Motherhood Initiative) was launched in Nairobi, Kenya. Its sole aim was to reduce the problem of maternal death and ill health in developing countries such as SSA. Most countries in the region took a keen interest in the initiative and worked out several policy programs to help achieve a reduction in maternal deaths. However, developing countries, including the SSA region, could not achieve the set target of reducing maternal death by 50 percent (Starrs,1987).

Recently, many studies have focused on identifying the reasons why maternal mortality keeps rising irrespective of the interventions initiated. Several antecedent factors, such as inadequate medical/health-related care services and socio-cultural and economic barriers, have been identified (Adeusei et al.2014). Most extant studies look at the medical explanatory variables alone or only mention the socio-cultural factors (Senah 2003; Agan et al. 2010, Gumanga et al. 2011, Yego et al. 2013). However, the problem of maternal mortality may be due to a combination of several (socio-cultural, socio-economic, health care services, etc.) factors. According to McCarthy and Maine (1992), death due to pregnancy and childbirth complications are not caused by only inadequate health care, but the low economic and social status of the woman and the community in which she lives. Again Shen &Williamson (1999) also emphasized that socio-economic factors such as education, economic background, and discrimination against sex are important determinants that influence maternal mortality. As such, there is a need to study not only medical/health factors but also others. There is still a gap in the research on medical/health, socio-economic and socio-cultural determinants of maternal mortality in SSA.

Against this backdrop, our study empirically examines the maternal mortality problem by applying a structural model that incorporates social, cultural, economic, and medical/health-related determinants. Further, it identifies the causal relationships among these determinants and their effects on maternal mortality in SSA. We used PLS-SEM estimation techniques that do not impose distribution on variables, and multidimensional measurement to determine the causal relationships among these constructs.

4.2 Conceptual framework for analyzing the determinants of maternal mortality

The study analyzed the determinants of maternal mortality by modifying the framework for analyzing the determinants of maternal mortality proposed by McCarthy and Maine (1992). This section discusses the modified framework and how the determinants interact with each other, to influence maternal mortality directly and indirectly as argued by the neighborhood theory. Figure 2 presents the modified framework.

According to McCarthy and Maine (1992), the survival of a woman during pregnancy depends on different and complex factors other than health care delivery services. It begins with her prior health conditions to the environment where she was natured. This condition includes her nutrition status (weight, height, and anemic), diseases (infectious and chronic), education, culture, and mental satisfaction. They further stated that the state of the pregnancy also affects the outcome. However, Shen &Williamson (1999) also emphasized that socio-economic factors such as education, economic background, and discrimination against sex are important determinants that influence maternal mortality. This study analyses the effect of maternal mortality and its determinants based on the conceptual and theoretical framework for analyzing the determinants of maternal mortality by McCarthy and Maine (1992).

The conceptual and theoretical framework for the study, which is a modification of McCarthy and Maine's conceptual and theoretical framework for analyzing maternal mortality have structured the factors that determine maternal death and its risk into two namely intermediate (medical or health) factors and distant factors, which are categorized as socio-cultural and socio-economic. These factors base on the framework contribute to the overall outcome of maternal death and the risk associated with it. The basic principle of this framework is that pregnancy is an essential requirement for a woman to develop a complication that may lead to maternal death or its associated risk. In addition to the framework by McCarthy and Maine, the study also adopted the neighborhood theory by Ellen et al., 2001 which states that socio-economic and socio-cultural are indirect determinants of health outcomes that are contributed by the effect of the direct determinant known as intermediate variables (Ellen et al., 2001).

According to the framework proposed by McCarthy and Maine for analyzing the determinants of maternal mortality (McCarthy & Maine, 1992), maternal death is influenced by five intermediate determinants namely: the health status of the woman; her

reproductive status; her access to health supplies; her healthcare behavior (including use of health services); and a set of unknown factors. The intermediate factors are also influenced by distant factors such as socio-economic and socio-cultural determinants. Maternal death or risk is influenced by these determinants.

Health status

The health status factors are disease-related conditions such as anemia, malaria, and Tuberculosis, nutritional status, and prior obstetric history of a woman. The health status of a woman before and during her pregnancy affects her chances of developing and surviving a complication. According to McCarthy and Maine (1992,), a woman with anemia is more likely to die from an obstetric condition such as a hemorrhage.

Reproductive status

The reproductive status will be age, marital status, and parity of the woman. These are factors that can influence a woman's probability of getting pregnant or developing a complication that can end up in death. In their framework, they also observed that conditions such as prolonged labor, developed obstetric fistula, or death from obstructed labor is common with younger women.

Health care access

An increase in the risk of poor health outcomes is normally due to poor access to health care services and delivery. Services that can be delivered to women who want to avoid pregnancy are family planning and abortion. According to McCarthy and Maine, 1992 women who want to have safe and complication-free birth should be offered services such as antenatal care services, delivery care services postnatal care services, and primary health care services.

Health care use and behavior

The availability and use of health care services such as antenatal, family planning, postnatal, and skilled delivery are probable of reducing the poor health outcome. The risk of maternal mortality and disability is affected by the availability of health care services and use. This is based on the woman's health-seeking behavior as well as the health care services available to her.

Distant determinants (socio-economic and socio-cultural)

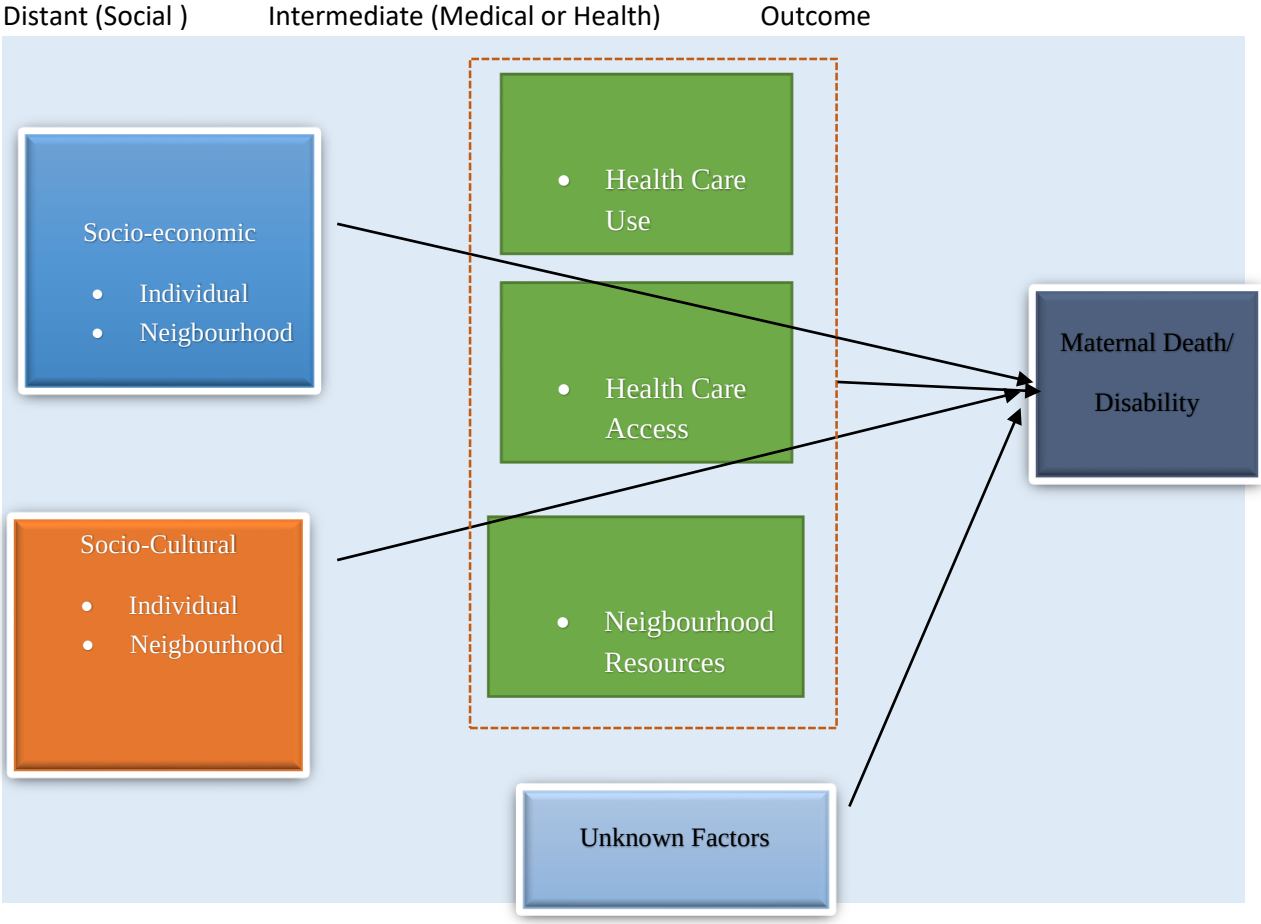
The distant factors in the framework are socio-economic and socio-cultural factors that can contribute to poor maternal outcomes. They are the woman’s status in the community

and her family. These factors are related to her education, occupation, level of income or status, and that of the family or the community she resides.

Unknown or Unpredicted Factors

An important fact that can be acknowledged is that pregnancy complications can result from factors other than maternal health care services use and access, conditions of a woman before or during her pregnancy, and other reproductive factors. Women from good backgrounds and have access to maternal health care services and are in good health before getting pregnant also have a complication that is unknown and cannot be predicted. Figure 2.2 below is the proposed conceptual model based on McCarthy and Maine (1992) model for analyzing the relationship between maternal mortality and its determinants.

Figure 4. 1 Proposed conceptual model based on McCarthy and Maine (1992) model



Modification of McCarthy and Maine, 1992 model framework

Source: Author own construction

4.3 Empirical literature review on determinants of maternal mortality

Studies that analyze the determinants of maternal mortality have adopted some of the determinants of the framework of McCarthy and Maine (1992) as noted above. They either focus on the distant determinants (socio-economic and social-cultural) or the intermediate determinants (medical/health). An observational and case-control study by Masturoh, Respatih, and Murti (2017) adopted the McCarthy and Maine (1992) framework to analyze the determinants of maternal mortality. That study focused on intermediate (medical/health) determinants and socio-economic determinants. The results, using path analysis, indicated that antenatal coverage and obstetrical complications influenced the risk of maternal mortality in the Brebes district, Indonesia *(*Masturoh, Respatih, and Murti (2017). They also observed that antenatal coverage was influenced by a higher level of education as well as the mother's job. Another study conducted by Meh (2017) on the determinants of maternal mortality in Cameroon used DHS (demographic and health surveys**)** data for 1991, 2004, and 2011. The author used a modification of the McCarthy and Maine (1992) framework to analyze maternal mortality. The study focused on socio-economic, socio-cultural, and intermediate (medical/health) determinants. Using logistic regression, Meh showed that there were relationships among age, parity, education, and maternal mortality. The author's analysis also showed that there was a significant relationship between maternal mortality and distance to the medical/health facility in the northern part of Cameroon and that maternal mortality was significantly associated with domestic violence and ethnicity.

Another ecological study conducted by Girum and Wasie (2017) on the determinants of maternal mortality using a sample of 82 developing countries with data from international databases focused on socio-cultural, socio-economic, and intermediate (medical/health) determinants between 2008 and 2016. Their study showed that the maternal mortality ratio significantly correlated with antenatal coverage, skilled birth attendance, access to improved water and sanitation, adult literacy, and GNI (gross national income) per capita inversely. Their analysis further showed that there was a significant relationship between the maternal mortality ratio and socio-economic indicators, health care, and morbidity.

Using data from 2001 to 2008 in different provinces, Zolala et al. (2012) studied the determinants of maternal mortality in Iran. The results of the multiple regression analysis showed that male literacy and unemployment were significantly and inversely related to maternal mortality. The analysis further showed that there was a slightly

significant association between maternal mortality and the proportion of midwives. The studied variables included socio-economic, socio-cultural, and intermediate (medical/health) determinants.

Alvarez et al. (2009) conducted a multi-ecological study on 45 SSA countries using data from international databases such as the World Bank, WHO, UNDP, and UNICEF (United Nations Children's Emergency Fund) between 1997 and 2006. Their study focused on intermediate (medical/health), socio-cultural and socio-economic determinants. The result from their regression analysis established a relationship among the socio-economic and socio-cultural determinants and the maternal mortality ratio.

Buor and Bream (2004) examined the determinants of maternal mortality in SSA. They focused on intermediate (medical/health) and socio-economic determinants using data for 28 countries from international databases such as the World Bank, UNAIDS (Joint United Nations Program on HIV/AIDS), the UN, DHS, international and national statistical offices. Their study used bivariate correlation and other non-parametric analyses, such as Kendall's tau-c values and regression, to establish a relationship between the determinants and the maternal mortality ratio. The result showed a significant relationship between GNP (gross national product) per capita, life expectancy, health expenditure, and maternal mortality

Table 4. 1 Empirical studies on determinants of maternal mortality

Author(s) name and year	**Data source**	**Model type and scope**	**Major findings**	**Determinants**
Osemwengie, P. K., & Shaibu, I. (2020).	WDI of World Bank	Panel Fixed Effect and Random Effect 43 SSA countries 1994-2015	The study found labor force participation, female employment, per capita health expenditure, and secondary school enrolment to be significant determinants of maternal mortality base on both the random and fixed effects estimates	Socio-economic

Palimbo, A., Salmah, A. U., & Sari, A. (2019)	Participants health profile, Banjar Regency Hospital	Chi-Square test Banjar Regency, South Africa	The findings of the study showed that most of the maternal death recorded in Banjar Regency was not cause by the risk of age, risk of parity or the gynecologist that attended to the pregnant woman during labor	Health & Medical
Meh, G.; Thind, A.; Ryan, B. & Terry, A. (2019).	Demographic and Health Surveys	McCarthy and Maine framework Multivariate logistics regression 200-2013 North and Southern, Nigeria	The study found a negative and statistically relationship between media exposure, level of education, and maternal mortality in Northern Nigeria and also a negative and statistically relationship between the contraceptive method used, type of residence, and wealth index and maternal mortality in the Southern region of Nigeria	Socio-economic
Tlou B. (2018)	African Health Research Institute (AHRI)	Mosley and Chen model, Cox regression 2000-2014	The results of their analysis show that maternal death has a relationship with the period of death and the number of deliveries. The analysis further shows that the high risk of maternal death is associated with poor wealth index and death period.	Socio-economic & Intermediate (Medical or health)
Azuh et al. (2017)	Primary data from structured questioner a focus group discussion, Ado-Odo/LGA, health-impacting sector	Regression and Correlation Analysis Correlation Analysis 2008-2016	The result from their analysis shows that maternal mortality is significantly influenced by place of consultation, who pays the cost of treatment, awareness of pregnancy complications, and knowledge of the place of antenatal care treatment.	Socio-economic Socio-cultural & Intermediate (Medical or Health)

Bishai et al. 2016	eight distinct health-impacting sectors from146 low- and middle-income countries (LMICs) eight distinct health-impacting sectors	Regression Models 1990-2010 182 developing countries	The result of their analysis shows that improvement in nationwide coverage of health sector determinants reduced the maternal mortality rate by 89% to 100%. This is based on an estimate from the regression model.	Socio-economic & Intermediate (Medical or Health)
Bayati, M., Vahedi, S., Esmaeilzadeh, F., Jamali, Z., Rajabi, A., (2016).	WHO website	Panel Fixed Effect Model 2004-2011 22 EMR countries	The estimates from the panel fixed effect model indicate a negative statistically significant relationship between GDP per capita, health expenditure, female literacy rate, birth attended by skilled personnel, and maternal mortality	Socio-economic& Health or medical
Adjiwanou, V., &LeGrand, T. (2014)	Demographic Health Survey(DHS)	Multilevel Structural Equation Modelling 2003-2006 4 Sub-Saharan African Countries 2003-2006	The analysis of the study showed that women in Ghana and Uganda, who live in areas where gender norms are relatively tolerant of violence against women are less likely to use skilled birth attendants and timely antenatal care.	Socio-economic &cultural
Dersarkissian, M.; Thompson, C. A. & Arah, O. A. (2013).	WHO, UN, NAMA, IHME and World Bank	correlation, negative binomial, and mixed Poisson regression 1990-2005 49 African countries	The study found evidence of a positive relationship between low GDP per capita, low female primary school enrolment, and maternal mortality in Africa. The results from the mixed models further showed a positive and statistically significant relationship between HIV prevalence rate, total fertility rate, and maternal mortality	Socio-economic & Medical or health

Author(s) name and year	Data source	Model type and scope	Major finding(s)	Determinants
Pillai, V. K., Maleku, A., & Wei, F (2013)	World Bank	Latent Growth Curve Analysis 1970-2000	The results of the study showed that rates of change in female literacy and maternal mortality ratios are negatively related	Socio-economic and Socio-cultural
Aseweh et al. (2011)	Demographic and Health Survey(DHS)	Probit and ordered probit regression models July-October,2006,	The utilization of maternal health services and intensive use of antenatal care services is influenced by factors such as the age of mother, type of birth, education of mother, ethnicity, economic status	Socio-economic Socio-cultural & Intermediate (Health or medical)
Bouvier-Colle et. al. (2001)	Multivariate regression December 1994-June 1996		The maternal mortality rate for the seven West African countries was estimated to be 311 based on a 95% confidence interval. 29% of the deaths recorded were due to Hemorrhages, which is an obstetric death, uterine rupture, eclampsia, and infectious disease accounted for 13% and11% respectively.	Socio-economic Socio-cultural & Intermediate (Health or medical) Intermediate (Medical or health)

Source Authors own construction

Some research gaps were identified during the empirical review process (see Table 4.1). Most of the studies done on the determinants of maternal mortality focused on either the socio-cultural, socio-economic, and intermediate (medical or health). Also, most of the

studies were either conducted in developed or developing countries. Those studies that integrated both the socio-economic, socio-cultural, and health or medical determinants in their analysis adopted correlation, logistic, probit, multilevel regression, and panel regression. Again some of the studies conducted in SSA performed their analysis based on a single country in the region, but the maternal mortality problem is better addressed holistically. Studies that focused on Sub-Saharan Africa and investigated the effects and relationships between socio-economic, socio-cultural, and health or medical determinants used either regression or correlation analysis. These estimation methods fail to estimate simultaneously, both the direct and indirect effects of these determinants on maternal mortality.

However, the estimation method adopted in these studies could not integrate these determinants and at the same time estimate the magnitude of their effect in their proposed model. This study fills these gaps by adopting an estimation method that integrates these determinants, examines both their direct and indirect effect on maternal mortality simultaneously, and at the same time estimates the magnitude of these effects in the model.

4.4 Methodology

In this section, we discussed the interactions among the determinants and their effect on maternal mortality using PLS-SEM analysis. In the PLS-SEM analysis, a factor and regression analysis are run simultaneously, enabling us to analyze the direct and indirect effects of the latent constructs. The PLS-SEM technique was chosen because it can be used in cases of small sample sizes and non-normally distributed variables (Hair et al. 2012). Thus, it gives meaningful results even when the sample size is very small (Chin–Newsted, 1999).

The PLS-SEM analysis with the smartPLS3 software is used to estimate both the measurement model (that represents the relationship between each construct and its associated indicators) and the structural model (that represents the structural path between constructs). The fitness of the measurement of the outer model is evaluated by the internal consistency of the model, measured by the composite reliability. The convergence validity of the specified model is assessed using indicator reliability, average variance explained, and discriminant validity. The structural or inner model is evaluated using the Pearson coefficient, R^2 (the coefficient of determination) which measures the percentage of the given construct that can be explained by the other dependent constructs and the

independent variables affecting it; the f^2 measures the size of the variable effect (Chin–Marcolin–Newsted,1996). The latent variables and their manifesting variables are presented in Table 4.2.

Table 4. 2 Latent variables and their manifesting variables

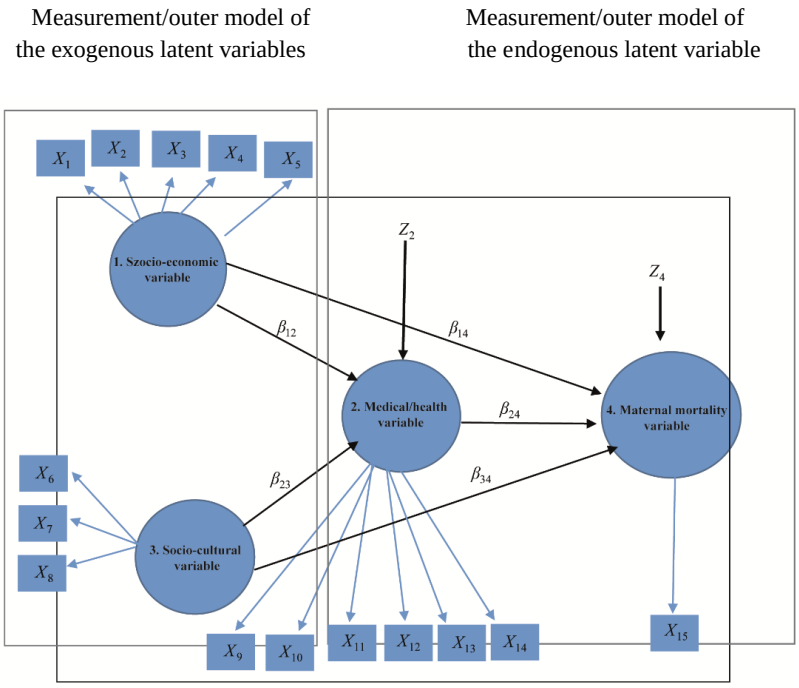
Latent variable	Manifest variable
Maternal mortality variable	Maternal mortality ratio
Socio-economic variable	GNI per capita
	Female occupation
	Female unemployment
	Percentage of urban residence
	Education index
Socio-cultural variable	Female literacy
	Female secondary education
	Gender index
Medical/health variable	Antenatal coverage
	Skilled birth attendant
	Access to an improved water source
	Contraceptive prevalence rate
	Life expectancy at birth
	Total fertility rate

4.4.1. Data and sources

The data in our study are primarily secondary data drawn from the World Bank (World Development Indicators) and UN online databases such as UNICEF, DHS, and UNDP.

The dataset was cross-checked with other various sources, such as the WHO, international, and country statistical offices, for consistency and was proven to be consistent before being used in the analysis. The dataset consisted of cross-sectional data from 2008 to 2015 for 35 SSA countries. We used available current year data for each country for the study period. In addition to the current years of the survey, the availability of data on variables used in the analysis for a particular country in a particular year of the survey is considered. These cross-sections are based on the demographic health survey which is conducted every five years preceding the year of the survey for each selected country. The the definitions and sources of variables used in examining the effect of determinants (i.e. socio-economic, socio-cultural, and medical or health) on maternal mortality are discussed in chapter three of this dissertation. The selection of variables considered in the empirical analysis is based on the empirical literature review.

Figure 4. 2 Proposed structural model for predicting the determinants of maternal mortality in SSA



Source: Authors own construction

Note. $X_{1–15}$: manifest variables; Z_2 and Z_4: error terms that reflect the sources of variance in the structural model, not captured by the respective antecedent construct(s); β-s refer to the strength of the relationships between latent variables.

We estimated the latent construct, which is represented by the circle in Figure 4.1 using

equations (11.1) to (11.4) from Figure 4.1

The latent variable y_1 representing socio-economic exogenous variable is estimated using equation 4.1.1 as expressed below

$$y_1 = y_1 + 0 \tag{11.1}$$

Where y_1 is the socio-economic exogenous latent variable.

We estimated y_2 which represents the health endogenous latent variable by using equation (4.1.2)

$$y_2 = \beta_{12} y_1 + \beta_{22} y_3 + z_2 \tag{11.2}$$

Where y_1 and y_3 represent the socio-economic exogenous latent variable and health endogenous latent variable. The coefficientsβ_{12} and β_{13} also represents the path relation between the socio-economic exogenous latent variable, health endogenous latent variable, and exogenous socio-cultural variable respectively, whiles z_2 is the error term associated with the health endogenous latent variable.

y_3 which stands for the exogenous socio-cultural variables also estimated using equation (11.3) expressed below

$$y_3 = y_3 + 0 \tag{11.3}$$

Where y_1 is the socio-economic exogenous variable

Finally, we estimated y_4, which represents the endogenous maternal mortality latent variable. This is estimated using equation (11.4)

$$y_4 = \beta_{14} y_1 + \beta_{24} y_2 + \beta_{34} y_3 + z_4 \tag{11.4}$$

Where y_1 and y_3 represent the socio-economic exogenous latent variable and health endogenous latent variable. The coefficientsβ_{12} and β_{13} also represents the path relation between the socio-economic exogenous latent variable, health endogenous latent variable, and exogenous socio-cultural variable respectively, whiles z_2 is the error term associated with the health endogenous latent variable.

Where y_4 is the maternal mortality endogenous latent variable. $\beta_{12}, \beta_{14}, \beta_{23}, \beta_{24}$ and β_{34} represents the path coefficients. z_2 and z_4 are the error terms. To understand the

relationship between the socio-economic, socio-cultural, and medical or health determinates and their effect on maternal mortality,

We estimated the direct, indirect, and total effect of the latent variables in the model using equations (11.5) to (11.12). The variables and the coefficients in the equations are the same as explained above.

The total effect of socio-cultural on Medical

$$y_3 = \beta_{23} + 0 \tag{11.5}$$

The total effect of Medical or Health on maternal mortality

$$y_2 = \beta_{24} + 0 \tag{11.6}$$

The total effect of socio-economic on medical or health

$$y_1 = \beta_{12} + 0 \tag{11.7}$$

The total effect of socio-economic on maternal mortality

$$y_1 = \beta_{14} + \beta_{24} * \beta_{12} \tag{11.8}$$

The total effect of socio-cultural on maternal mortality

$$y_3 = \beta_{34} + \beta_{24} * \beta_{23} \tag{11.9}$$

Total Indirect effect of socio-economic on maternal mortality

$$y_2 = \beta_{24} * \beta_{12} \tag{11.10}$$

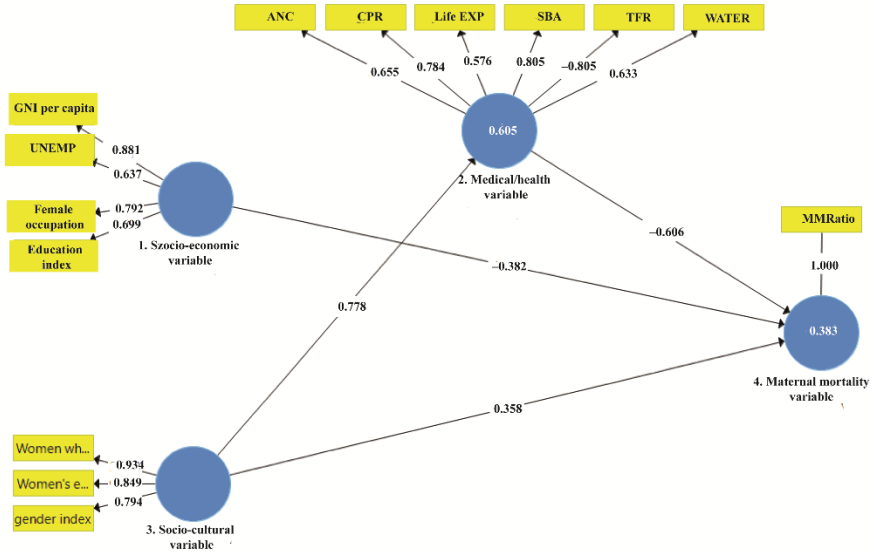
Total Indirect effect of socio-cultural on maternal mortality

$$y_3 = \beta_{24} * \beta_{23} \tag{11.12}$$

4.5 Results and discussion

The validity of the structural model is determined by the R^2. This coefficient, which measures the percentage of the variance in the endogenous variable explained by the structural model. (See Figure 2.) Thus, it represents the quality of the adjusted model. The analysis in Table 4.4 shows that the variance explained by the endogenous medical/health latent construct is 60.5 percent and by the maternal mortality latent variable is 38.3 percent. According to Cohen (1988), and R^2 2 percent in social and behavioral sciences is considered a small effect while 13 percent and 26 percent are classified as medium and large effects, respectively. Based on Cohen's (1988) classification, we conclude that the endogenous latent variables medical/health and maternal mortality have a large effect on our model.

Figure 4. 3 Final models predicting the effect of determinants of maternal mortality in Sub-Saharan Africa



Note. *ANC*: antenatal coverage; *CPR*: contraceptive prevalence rate; *Life EXP*: life expectancy at birth; *SBA*: skilled birth attendant; *TFR*: total fertility rate; *WATER*: access to the improved water source; *UNEMP*: female unemployment; *MMRatio*: maternal mortality ratio, Women wh: Female literacy. *Women's e; female education*

Source: Own estimation using smartPLS v.3.

In Table 4.3, the predictive validity values of 0.275 for the endogenous latent construct medical/health and 0.268 for the maternal mortality variable are greater than zero (that is, our path model's predictive accuracy is acceptable; see Hair et al. (2014). The effect size (f^2) which evaluates how useful each construct is to the adjustment of the proposed model is medium for the latent construct socio-cultural and large for the medical/health, socio-economic variables (i.e. 0.291, 0.323, and 0.462, respectively (Table 4.3). The results showed that the endogenous (medical/health and maternal mortality) variables are useful in the adjustment of the proposed model.

Table 4. 3 Indicator validity and effective predictive size

Latent variable	**Validity** (Q^2)	**Effect size** (f^2)
Medical/health variable	0.275	0.323
Maternal mortality variable	0.268	–
Socio-economic variable	–	0.462
Socio-cultural variable	–	0.291

Note. Evaluation criteria: $Q^2 > 0$; 0.02, 0.15, and 0.35 are considered small, medium, and large effects, respectively. *Hair et al*. (2014).

Source: Own estimation using smartPLS V3.

As indicators for the adjustment quality of the model, *AVE* (average variance explained), *CR* (composite reliability), and R^2 are used. Instead of Cronbach's alpha, we chose the *CR* as it is most fitting for PLS analysis; it orders the variables according to their reliability. In Table 4.4, *AVE* is greater than 0.5, *CR* is greater than 0.7, thus they are adequate for the construct, validating the model according to Hair et al. (2009).

Table 4. 4 Indicators for the adjustment quality of the model

Latent variable	AVE	CR	R^2
Medical/health	0.515	0.705	0.605
Maternal mortality	1.000	1.000	0.383
Socio-economic	0.741	0.895	–
Socio-cultural	0.531	0.847	–

Note. *AVE*: average variance explained; CR: composite reliability. Evaluation criteria: *AVE* > 0.5 and *CR* > 0.7.

Source: Own estimation using smartPLS V3.

Table 4.5 reports the discriminant validity based on the Fornell-Larcker criterion, an indicator to assess the validity of the structural model. According to Fornell–Larcker (1981), for the validity of the structural model, the square root of the Average variance explained by each construct should be greater than its absolute correlation coefficient. The discriminant value is obtained by finding the square root of the average variance explained (AVE) of the latent constructs, shown on the main diagonal, and comparing the value to its correlation coefficient in each column. The results show that the square root of the average variance explained (AVE) for all latent constructs is higher than the absolute values of the correlation coefficients of the constructs. Based on the above analysis, we conclude that the discriminant validity of the measurement model exists.

Table 4. 5 Discriminant reliability for latent variables

Latent variable	Discriminant value			
	Medical/ Health	Maternal mortality	Socio-economic	Socio-cultural
Medical/health	0.718			
Maternal mortality	–0.538	1.000		
Socio-economic	0.778	–0.359	0.861	
Socio-cultural	0.548	–0.485	0.637	0.729

Source: Own estimation using smartPLS V3.

The significance of the path coefficient is tested using a bootstrapping algorithm. The number of sub-samples used for the bootstrapping was 5,000 based on the assumptions of Hair et al. (2011). Table 4.6 shows that the socio-cultural exogenous latent construct has a positive relationship with maternal mortality and the medical/health construct, while the socio-economic endogenous construct has a negative relation with maternal mortality (the exogenous latent variable). (See Figure 2 for the path coefficient of the constructs and their direct effects.). The positive relationship between socio-cultural determinants and maternal mortality means that persistent bad cultural practices, religious beliefs, and discrimination again women concerning health care use and access will increase maternal mortality. This result is consistent with the findings of Adjiwanou (2014). He found a high level of gender equality in rural communities in Africa countries like Ghana, Tanzania. Uganda and Kenya concerning health care use and access contributed to the high level of maternal mortality in these rural communities. Again the negative relationship between the health or medical determinants and maternal mortality also supports the finding of Alvarez et al 1999, they also found a negative relationship between health or medical determinants such as antenatal care, access to a skilled birth attendant, improved water, contraceptive use and maternal mortality in SSA.

Table 4. 6 Bootstrapping algorithm results for path significance coefficient testing

Casual relation	Original Sample	Sample Mean	Standard Deviation	Test statistics	*p*-value
Medical/health – Maternal mortality	–0.606	–0.625	0.241	2.511	0.012
Socio-cultural – Medical/health	0.778	0.802	0.050	15.423	0.000
Socio-cultural – Maternal mortality	0.358	0.382	0.178	2.004	0.046
Socio-economic – Maternal mortality	–0.382	–0.401	0.154	2.477	0.014

Note. Significance level: 0.05.
Source: Own estimation using smartPLS V3.

According to Table 4.7, the total effect of the socio-cultural construct on the medical/health construct comprises solely its direct effect on it ($\beta = 0.788$). The medical/health construct and the socio-economic construct also have only a direct effect on maternal mortality ($\beta = –0.606$, $\beta = –0.382$, respectively). The total effect of the socio-cultural construct on maternal mortality ($\beta = –0.114$) is the sum of its direct ($\beta = 0.358$) and indirect effects ($\beta = –0.472 = –0.606 * 0.778$; this latter is made through the medical/health construct).

Table 4. 7 Total effects and significance testing in the model

Casual relation	Original Sample	Sample Mean	Standard Deviation	Test statistics	*p*-value
Medical/health –Maternal mortality	–0.606	–0.625	0.241	2.511	0.012

Socio-cultural – Medical/health	0.778	0.802	0.050	15.423	0.000
Socio-cultural–Maternal mortality	–0.114	–0.118	0.143	0.795	0.427
Socio-economic–Maternal mortality	–0.382	–0.401	0.154	2.477	0.014

Note. Significance level: 0.05.
Source: Own estimation using smartPLS V3.

Table 4.8 presents the total indirect effect of maternal mortality (β = –0.472), which comes from the direct effect of the socio-cultural construct on the medical/health construct and the direct effect of the medical/health construct on maternal mortality – as it was mentioned earlier.

Table 4. 8 Total indirect effects and significance testing in the model

Casual relation	**Original Sample**	**Sample Mean**	**Standard Deviation**	**Test Statistics**	***p*-value**
Medical/health – Maternal mortality	–	–	–	–	–
Socio-cultural – Medical/health	–0.472	–0.500	0.197	2.392	0.000
Socio-cultural – Maternal mortality	–	–	–	–	–
Socio-economic – Maternal mortality	–	–	–	–	–

Note. Significance level 0.00.
Source: Estimated results using smartPLS V3.

4.6 Conclusion

The study examined the causal relationships among determinants of maternal mortality and their effects on maternal mortality by applying PLS-SEM modeling to cross-sectional data from international databases, spanning 2008 to 2015. The model structure and measurements were verified for the causal model. (See Figure 4.2.) The verification of the latent constructs was performed by examining convergence validity, AVE, CR, and factor loading (Hair,2009). The results in Table 4.3 show that CR > 0.7 and AVE > 0.5 for each latent variable and that the factor loadings are greater than 0.5, thus, all the factor loadings for the constructs are reliable. The discriminant validity was justified by Table 4.5 as the discriminant values of the latent variables are greater than the square of the correlation between the latent and other constructs (for the criterion, see Fornell–Larcker, 1981).

The analysis of the validity of the structural model in Table 4.3 showed that the latent constructs, maternal mortality and medical/health, had higher predictive relevance since the predictive validity $\left(Q^2\right) > 0$ and that the effect size $\left(f^2\right)$ for the latest medical/health, socio-economic and socio-cultural constructs were considered medium and large (for f^2 values, see Hair et al. (2014). According to the R^2 results, maternal mortality is affected by three latent constructs, namely, medical/health (endogenous variable), socio-economic (exogenous), and socio-cultural (exogenous). This means they explain 60.5 percent of the variance of maternal mortality. The latent construct medical/health is also affected by the socio-cultural and socio-economic constructs with an R^2 value of 0.383, that is, 38.3 percent of the variation in the medical/health latent construct is explained by these two exogenous latent constructs.

The results for the total effects of the latent constructs on maternal mortality show that the medical/health latent construct (β = –0.606, p = 0.012) has a negative and statistically significant effect on maternal mortality. It is associated with inadequate health care facilities, the inadequate number of health care professionals with sufficient training to provide required health care services, and poor health behavior on the part of pregnant mothers. Studies have shown that women who attend care during early and late pregnancy stages versus those who do not attend such care differ in factors e.g. education, unwanted pregnancy, maternal age, among others that impact pregnancy outcomes (Thomas–Golding–Peter, 1991). The path coefficient, that is, the total effect of the socio-economic latent construct (β = –0.382, p = 0.014) on maternal mortality is greater than the total effect of the socio-cultural construct on maternal mortality (β = -0.114, p = 0.427), which

is negative and not significant. The effect of the socio-economic latent construct on maternal mortality is negative and statistically significant. The socio-cultural latent construct has the greatest effect, and this effect is on the medical/health latent construct. It is due to cultural and religious beliefs associated with the use of modern medical care, female literacy, and gender inequality in accessing medical care in Africa where SSA is not an exception. (Malhotra–Schuler 2005, Das Gupta 1990, Gibbs et al. 2012, Obse–Mossie–Gobena, 2013). The results on the effect of socio-economic, medical or health, and socio-cultural determinants on maternal mortality supports the findings of Buor& Bream (2004); Alvarez et al 2009, Girum&Wiase (2017). Though our findings are consistent with these studies, our method of estimation can estimate both the direct and the indirect effects of these determinants on maternal mortality.

Our results also show that the socio-cultural latent construct has both direct and indirect effects; It has a direct effect on maternal mortality and an indirect effect through the health/medical; however, the former (β = –0.472) is greater than the latter (β = –0.114, p = 0.427), which is negative and not significant. Its significant direct effect on maternal mortality is associated with low economic status, which relates to lack of access to health care and less utilization of health care delivery services; these factors result in poor health outcomes (Ahnquist–Wamala–Lindstrom 2012; Pickett–Pearl, 2001). Poverty also contributes to this effect since it prevents women, especially pregnant women, from receiving proper and sufficient medical attention due to their inability to afford good antenatal and prenatal care services. These results support the finding of Alvarez et al.2009 who also found a negative and direct effect of socio-economic indicators such as unemployment rate, GNI per capita on maternal mortality. The PLS-SEM results show that there is value in integrating the socio-economic, socio-cultural, and medical determinants in models to assess their effects on maternal mortality. To reduce maternal mortality in SSA, policies, and interventions should focus on these three determinants. Our results confirm the results in the studies by Girum–Wasie (2017) and Azuh et al. (2017), which show that the medical/health, socio-economic and socio-cultural determinants have a significant effect on maternal mortality.

Brief chapter summary

This chapter examined the determinants(socio-economic, socio-culture and health/medical) and their effect on maternal mortality by employing Partial Least Squares(PLS) Structural Equation Modelling (SEM), a multi-dimensional statistical

estimation technique, as well as a cross-sectional dataset on 35 Sampled SSA countries spanning between 2008 and 2015. The sesult of the empirical analysis revealed that the socio-economic and social cultural determinants have both direct and indirect effect on maternal mortality, whiles the health or medical determinants have direct effect on maternal mortality. The empirical results based on the PLS-SEM further indicates that socio-cultural determinants have medium effect on maternal mortality, whiles the socio-economic and health or medical determinants have large effect on maternal mortality in terms of magnitude. The study found a negative relationship between socio-economic determinants and maternal mortality, positive relationship between socio-cultural determinants and maternal mortality and negative relationship between health/medical determinants and maternal mortality. Based on this results the study fails to reject the hypotheses that improvement in socio-economic determinants reduces the level of maternal mortality in SSA, improvement in health or medical determinants reduces the level of maternal in SSA and improvement in socio-cultural determinants reduces the level of maternal mortality in SSA. The study obtained the following thesis based on the findings from the empirical analysis.

- **There is a negative and statistically significant relationship between socio-economic determinants and maternal mortality in SSA.**
- **There is a negative and statistically significant relationship between the health or medical determinants and maternal mortality in SSA.**
- **There is a negative and statistically significant relationship between socio-cultural determinants and maternal mortality in SSA.**

CHAPTER FIVE

SOCIAL DEVELOPMENT AND MATERNAL MORTALITY IN SUB-SAHARAN AFRICA: A CAUSE-EFFECT MODEL ASSESSMENT

Introduction

Social development an indicator reflecting social policies such as the building of education and health care infrastructure and other social relations among people in a society, is key in maternal mortality reduction, through reproductive freedom according to Sen. Maternal mortality, an indicator for assessing the performance of the health system of a country is still high in Sub-Sahara African region despite specific government and global interventions. This study investigated the causal effect of social development on maternal mortality in SSA by employing, the PLS-SEM, a multidimensional statistical estimation method on a cross-sectional dataset on 35 sampled SSA countries. This objective is achieved by answering the research question, to what extent can social development influence maternal mortality in Sub-Saharan Africa? The following hypotheses are also tested in relation to the objective of the study, H_4: Increasing the rate of social development, will improve the rate of. reproductive capability/freedom and reduce the level of maternal mortality in SSA and H_5: Increasing the rate of reproductive capability/freedom, will decrease the rate of maternal mortality in SSA. The chapter begins with a piece of background information on the topic which is captured in section 5.1. A brief discussion on conceptual models for analyzing maternal mortality is presented in section 5.2. The conceptual model, the data type, and sources, estimation method and procedure, and the empirical model are present in section 5.3 and its sub-sections. The results of the empirical analysis are presented and discussed in section 5.4. The conclusion which is the final part of this chaper is presented in section 5.5

5.1 Background of the study

The death of a mother during pregnancy and childbirth is a key population development challenge facing developing countries since women are seen as the backbone of the family. Maternal mortality is a health variable that measures the differences between developed and less developed countries, and for this reason, it was seen as an important target for the Millennium Development Goals (MDG's) and a key indicator for Sustainable Development Goals (SDG's). According to WHO report 2017, daily almost

808 women die as a result of complications due to pregnancy and childbirth. The threat of a woman from a low-income economy dying due to pregnancy and childbirth-related complications during her lifetime is almost 120 times more than a woman from a high-income economy (WHO, 2017).

Approximately, Sub-Saharan Africa and South Asia recorded 542 and 225 of these maternal deaths respectively. The statistics from the World Health Organisation (WHO) for 2015 report that developing countries recorded 99% (302,000) of the world's estimates of maternal deaths. Sub-Saharan Africa recorded over half of these maternal deaths, representing 66 percent (201,000) The same statistics reports indicates that 18 Sub-Saharan Africa countries have high maternal deaths estimates ranging between 500 and 999 deaths per 100,000 live birth (WHO,2015, Pg.2). Despite the commitment by governments and international organizations to eradicate maternal mortality, a reproductive health-related death, it continues to be a misfortune for Sub-Saharan Africa countries. The most worrying situation is that almost all the pregnancy and childbirth-related deaths which occur in low-income countries are preventable, thus, it is necessary to undertake new measures to reduce the level of maternal deaths among women in Sub-Saharan African countries. Even though Behavioural scientists such as McCarthy and Maine (1992), Thaddeus and Maine (1994), and UNICEF have developed conceptual frameworks for analyzing the connection between high maternal mortality rates and inadequate health infrastructure, low skill birth attendant rates, the status of women in the community, level of education and lack of information on pregnancy and childbirth-related complications that contribute to high maternal mortality, it continues to be a challenge in low-income countries.

According to Mukami et al.2016 factors such as women's status in society, education, quality health care, and access if considered in maternal health intervention will contribute to low maternal mortality. Again Shen and Williamson (1999) have also argued that communities where a woman has high social status such as education, tend to have low fertility and maternal mortality rate. Okwan and Kovacs (2019), also found that social determinants (economic and cultural) have a direct and indirect effect on maternal mortality. However aside from these studies, and conceptual frameworks developed for analyzing maternal mortality, recent social scientists such as Dejong (2006) and Robeyns (2002) have applied Amartya Sen's Development theory in reproductive health research, and found that maternal mortality reduction, is also contributed by social development

through reproductive capability and freedom. Amartya Sen has argued that social development indicators reflecting social policies such as the building of education and health care infrastructure and other social relations among people in society could influence maternal mortality through reproductive capability and freedom, a condition that could contribute to long life span or cause death. Again other authors such as Marchie (2019); Tlou B. (2018); Rana (2018); Girum & Wasie (2017) and Gonzalez (2017); Bayati (2016); Eghieye (2014); Cheng (2012); Buor and Bream (2004) have examined the effect of these indicators reflecting social development, reproductive capability and freedom on maternal mortality, but there is no single study on maternal mortality focusing on Sub-Saharan African region that has attempted to investigate the effect of social development on maternal mortality by exploring the Amartya Sen's social development theory in relation to reproductive health, to understanding the link between maternal mortality and social development and also recommend policies based on its findings to address the high maternal mortality in Sub-Saharan African, which is contributed by a low level of indicators reflecting social development and reproductive capability and freedom. The purpose of this study is to propose a conceptual model for predicting the effect of social development on maternal mortality and also examine the causal relationship between these latent variables in the Sub-Saharan Africa region using Amartya Sen's development theory as theoretical background.

5.2 Conceptual frameworks for analyzing maternal mortality

This section discusses the various conceptual frameworks developed to analyze maternal mortality and formulate policies and interventions for its reduction. This section discusses in detailed the three important conceptual models that have been used to implement interventions for the reduction of maternal mortality. The three conceptual models which have been demonstrated to be most effective in analyzing maternal mortality are the conceptual model for analyzing maternal mortality, neonatal mortality, and morbidity developed by UNICEF (2008), the three phases of delay framework known as the Three Delayed Model by Thaddeus and Maine (1994) and a conceptual model for analyzing determinants of maternal mortality by McCarthy and Maine (1992).

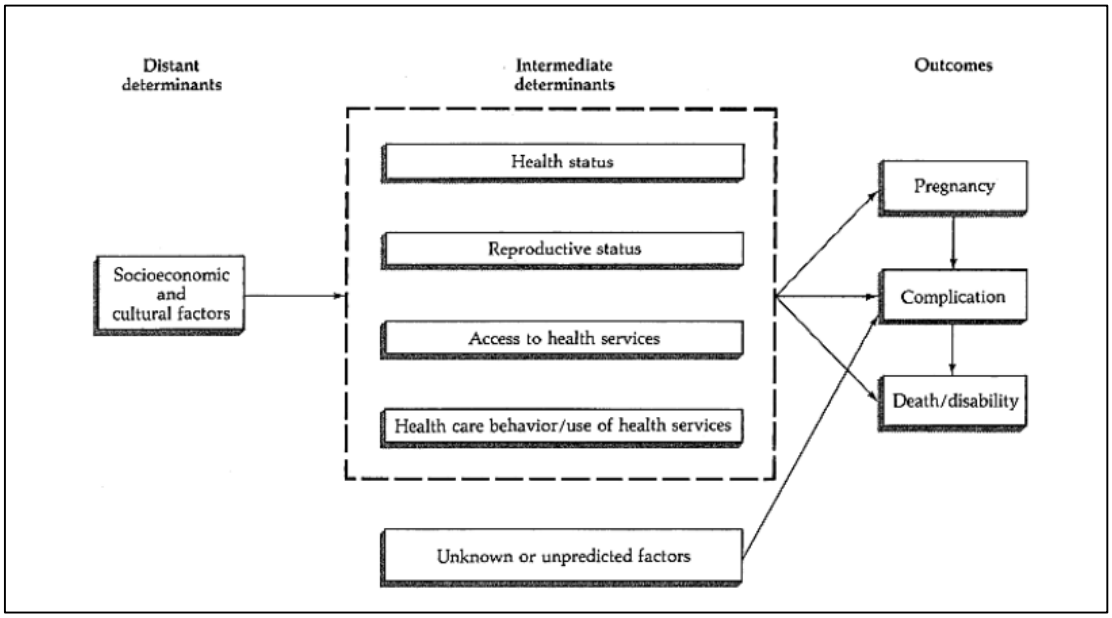
To understand how the direct and indirect factors influencing maternal mortality, McCarthy and Maine (1992) developed a framework to analyze the determinants of maternal mortality. They adopted and modified the frameworks developed by Davis and Blake (1956), Bongaarts (1978), and Mosley and Chen (1984). Davis and Blake (1956)

first developed their framework by classifying how intermediate variables, which are influenced by social factors, can impact the level of fertility. They conceptualized eight intermediate fertility variables, namely, proportion married, contraception, induced abortion, locational infecundity, frequency of intercourse, sterility, spontaneous intrauterine mortality, and duration of fertility. Bongaarts (1978) later reviewed this social structure and fertility analytical framework. In his research for analyzing the proximate determinants of fertility, he reduced the eight intermediate fertility variables grouped by Davis and Blake (1956) to three. Its intermediate variables were exposure factors, deliberate fertility control factors, and natural marital fertility factors. Mosley and Chen (1984) also proposed an analytical framework to analyze child survival. In their framework, they used both the social and biological factors and incorporated methods employed by early social and medical scientists, such as Davis and Blake (1956) and Bongaarts (1978) to analyze child survival in developing countries. McCarthy and Maine (1992) developed a new analytical framework based on the research of earlier authors by including socio-cultural, unknown, and predicted factors in their framework. They conceptualized their determinants into three; namely, distant determinants, intermediate determinants, and health determinants. In their framework, the sequence of health outcomes involved pregnancy, implications, and disabilities. The intermediate determinants comprised health status, reproduction status, access to health services, health care behavior, use of health care services, and unknown and predicted factors. The distant determinants were the socio-economic and socio-cultural status of the pregnant woman and her community. Thaddeus and Maine (1994) also developed a conceptual framework popularly known as the Three Delay model to address the various delay that leads to maternal death as; Delay in reaching an equipped health care facility(transport) (Delay 2), Delay in receiving adequate care by the individual or family once at the health facility (Delay 3). In 2008, UNICEF also proposed a conceptual framework for analyzing the determinants of maternal mortality by address the three-level of maternal mortality outcomes as basic (society level), community/household, and district level.

According McCarthy and Maine (1992) determinants contributing to maternal death are many and based on that they developed a conceptual framework for analysing maternal mortality determinants, their framework categorises these determinants into three namely: (1) Distant (social, economic and cultural) determinants which are measured by factors such as a woman's status in her family and community, the status of

her family in the community and the level of development in her community; (2) Intermediate determinants also measure by factors such as the health status of the woman, her reproductive status, her access to health care services and her behaviour and use; (3) pregnancy outcome (complication) which focuses on reducing the probability of a woman becoming pregnant, reducing the risk of complication during pregnancy and reducing the outcome for pregnant women with complications The intermediate determinants in the framework have direct effect on the chance of a woman becoming pregnant, developing a complication during pregnancy, developing a disability or dying. The distant determinant measured by social, economic, and cultural factors has an indirect effect on maternal mortality. The distant determinants influence the risk of poor maternal health outcomes through the intermediate determinants. Since the distant factors influence the risk of poor maternal health outcomes, addressing these two determinants, will reduce the risk of a woman developing pregnancy and childbirth complications and also reduce the complication risk for pregnant women (see Figure 5.1).

Figure 5. 1 Conceptual model for analyzing determinants of maternal mortality and morbidity



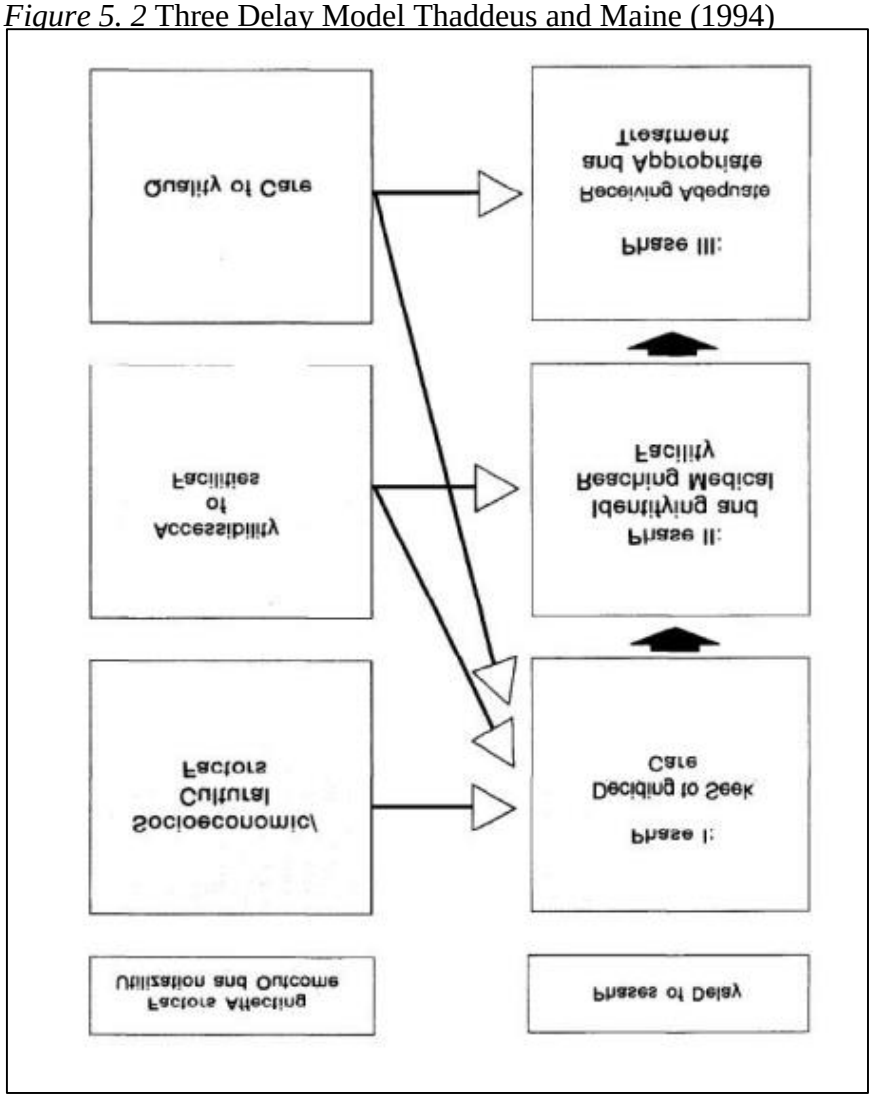
Source: McCarthy and Maine (1992)

However, to address the maternal mortality problem, like any other health challenge, it is important to view its causes by using a broad population approach by not considering only the medical cause but also consider the individual, community, and health factors that cause maternal death. The conceptual framework developed by Thaddeus and Maine (1994) popularly known as the Three Delay model recognizes the various obstacles

women face in accessing effective and timely health assistance required to avoid the occurrence of pregnancy, postpartum, and death during childbirth. The authors have argued that three phases of delay in accessing sufficient healthcare are important determinants that account for about 75 percent of maternal deaths in low-income countries.

Thaddeus and Maine (1994) linked inadequate care to important factors as such as; the delay in getting the needed care from the individual or family, when the need arises (Delay1), Delay in arriving at an equipped medical facility – transportation (Delay 2), Delay in getting adequate care once at the medical facility (Delay 3) as presented in Figure 5.2. Their framework gave a new method of analyzing maternal mortality and its outcome to understand the delays associated with obstetric emergencies management (Pacagnella et al.2012). The conceptual model proposed by Thaddeus and Maine (1994) assisted in identifying community and health delivery factors associated with maternal death and also their importance in the development of interventions meant for preventive purposes. In the first delay phase, four obstacles are seen as the main factors determining whether a mother will decide between seeking care or not. The four obstacles include distance to the health facility, cost, quality of care, and other socio-cultural determinants as well. The next stage of delay comprises where the health facilities are located, the distance traveled, and transportation. This phase also takes into consideration actual health service accessibility. The third phase of the delay focuses on accessing quality treatment and categorizes them under the following factors; shortage of hospital staff and indispensables resources such as drug and equipment supply (UNICEF.2008)

Figure 5. 2 Three Delay Model Thaddeus and Maine (1994)

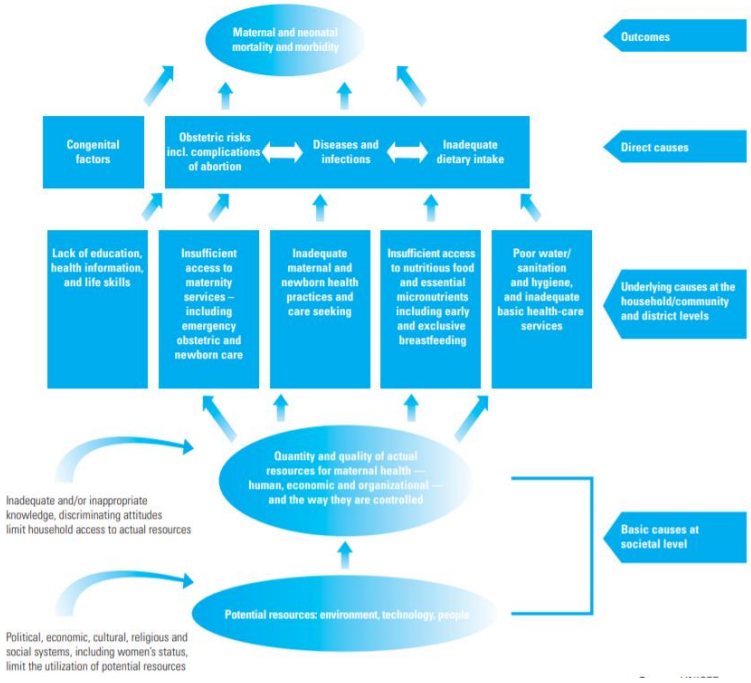


Source: Thaddeus and Maine (1994),

The conceptual model developed by UNICEF for analyzing the causes of maternal and newborn deaths shows that in determining health outcomes, interrelated health determinants such as nutrition, water, health delivery services, and behaviors, hygiene and sanitation, disease control, and other health-related factors should be key. These health-related determinants are defined as proximate, which are classified as individual, categorized under household or community, district; and basic as a society. The determinants for a particular stage of the framework affect other stages. This conceptual model developed by UNICEF has been demonstrated to be effective in the assessment and analysis of the causes of maternal and newborn mortality and morbidity. This model has been identified as effective for implementing action plans that will enhance neonatal and maternal health.

The conceptual framework provided by UNICEF, depicted in Figure 5.3, consists of three different levels that define maternal outcomes. The first level of the framework comprises maternal mortality causes that are basic, which are at the society level. The use of resources at the society level for maternal health purposes is determined by social systems that consist of a woman's status in society, political, religious, economic, and cultural factors. However, other factors such as inadequate or unsuitable knowledge and personal behaviors like discrimination hinder access to community resources. These community resources are channels through which pregnant women will have access to the support needed before and or after child labor and delivery. The accessibility of these resources depends on the lowest level which is made up of the basic causes of maternal mortality at the society level. The maternal mortality rate is always lowered when community resources are available for a woman to access and utilize. The next stage for the conceptual model consists of the basic causes of maternal mortality at the household or community and district level. The resources at this level, are classified by factors such as lack of education, inadequate access to maternity services, adequate access to nutritious food, inadequate information relating to health and life skills; and poor drinking water, hygiene, and sanitation. Factors contributing to high maternal mortality in a country or region are classified as basic factors. Direct causes such as obstetric risk, disease and infections, congenital factors, and insufficient dietary intake which affect maternal mortality rate are included in the framework

Figure 5. 3 Conceptual models for analyzing maternal and new-born mortality and morbidity



Source: UNICEF (2008)

5.3 Methodology

5.3.1 Conceptual model based on Amartya Sen's development Theory

Scientific contributions to social and human development approaches and theories are many, and academic professionals such as Amartya Sen and Al Haq, and social work scholar Brij Mohan have made an argument based on social and human development theories, perspectives, and approaches (Mohan,2010,2007; Sen, 2007,1999; and Huq,1995). Human development is defined by scholars such as Haq, as a means to improve the human condition and also broaden the choices of individuals (Haq,1995, P.4). Economists such as Sen also defined it as the process of enlarging a person's ''functioning and capabilities to function, the range of things that a person could do and be in her life,'' and further stressed the need to improve on people wellbeing, freedom, and capability (Sen, 1992,1993,1999, p.43). Apart from the argument by these scholars, Mohan also claimed that the result of human development should be centered to take care of the inhabitants' actual life situation, their dignity, and maximum value of life (Mohan,2007a). However, one of the most important antecedents to a complete social change is to ensure that human development and social freedom are implemented in a situation that suits social and innovations policies (Mohan,2010). There have been numerous discussions on

the diverse comparative methods used in analyzing the relevance and applicability of social and human development, but this study focuses on Sen's theory in relation to the current discussions on its applicability in the area of reproductive health, with emphasis on Sub-Saharan African countries

We hypothesized based on Sen's theory that social development should improve reproductive freedom or capability and wellbeing. We can state that social development is key in terms of development to reproductive capability and reduction of maternal mortality levels. Again, other development components such as economic and political development also influence reproductive capability and maternal mortality. This effect is through social development efforts. This study will seek to either validate or invalidate Sen's social development theory in Sub-Saharan Africa by using economic and political development as control variables. The under-listed hypothesis will be tested in relation to capability in terms of reproductive health, in this case, maternal mortality.

(1) Increasing the rate of social development, will improve the rate of reproductive capability/freedom and reduce the level of maternal mortality.
(2) Increasing the rate of reproductive capability/freedom will decrease the rate of maternal mortality.

5.3.2 Data and sources

We investigate the objective of the study using secondary data drawn from the online database of World Development Indicators (WDI) of the World Bank (2019), WHO database, United Nations Development Programme (UNDP), Demographic Health Survey (DHS), and Economist Intelligence Unit (EIU) report.

The dataset for the study is cross-sectional data for 35 sub-Saharan African countries for the period 2008 to 2015. The cross-sectional data is sourced from the demographic health survey which collects accurate and representative data on population, health, HIV/AIDS, and nutrition. These datasets are collected five years preceding the survey and it is conducted in over 90 countries in the world. The survey data for the selected countries are based on the current year of the survey and the availability of data on selected variables. Our target is all the 47countries in Sub-Saharan Africa, but due to lack of data on some of the variables targeted for the study, only 35countries were included in the analysis.The definitions and sources of variables used in examining the effect of social development on maternal mortality are selected based on the social

development theory by Sen and studies conducted by authors who examined the relation between these indicators and maternal mortality. The theoretical basis and empirical studies supporting the selected indicators measuring the latent variables are discussed in chapter two of this dissertation

5.3.3 Estimation technique and Procedure

The study used PLS-SEM structural equation modeling techniques proposed by Wold (1975) to assess the effects of the latent variables on maternal mortality. This estimation technique has three components; the structural model, the measurement model, and the weighting scheme. The use of PLS-SEM is appropriate for the study since it consists of factor analysis and regression analysis, and does not impose distributional assumptions on the data set used. It also gives meaningful results in the case of a small sample size.

The study estimated the measurement model, the structural model, and the weighting scheme using the PLS-SEM algorithm. The fitness of the measurement or the outer model is evaluated using the internal validity of the model which is measured by composite reliability and average variance explained in the case of this study. The convergence validity of the specified model is assessed using discriminant validity. The discriminant validity of the PLS structural equation model (SEM) could be assessed using the Fornell and Lacker criteria (1981) and Heterotrait-Monotrait Ratio (HTMT) by Henseler, Ringle, and Sarstedt (2015). This study used the Fornell and Lacker criteria to assess the discriminant validity of the final model. In this case, we compared the square root of the average variance explained (AVE) for each construct with the correlation between the latent constructs (Fornenell and Lacker,1981).

The fitness of the structural model is evaluated by the coefficient of determination (R^2), which accounts for the proportion of the given latent variable that can be explained by the other latent variables and the independent variables affecting it. The size and the significance of the path coefficient is measured using f^2 (Chin, Marcolin, and Newsted,2003).

5.3.4 Model Specification and estimation

The path model for the study is reflective as specified in Figure 5.4. In this case, the arrows are directed towards the boxes. The circle in the above Figure represents the latent variables or constructs. The boxes are the indicator variables. The arrows pointing to the circles measure the causal relationship between the independent or exogenous and the dependent or endogenous latent constructs (i.e. the structural model) represented by

$\beta_{12,}$ β_{14}, β_{23}, $\beta_{24,}$and β_{34}. The arrows pointing to the boxes measure the correlation between latent variables (LVs) and manifesting variables (MVs) or indicators (i.e. measurement model) represented by $X_{1,}$……, $X_{14.}$

Table 5.1 presents the latent construct and the manifesting variables considered for the analysis.

Table 5. 1 Latent constructs and their indicator variables(MVs)

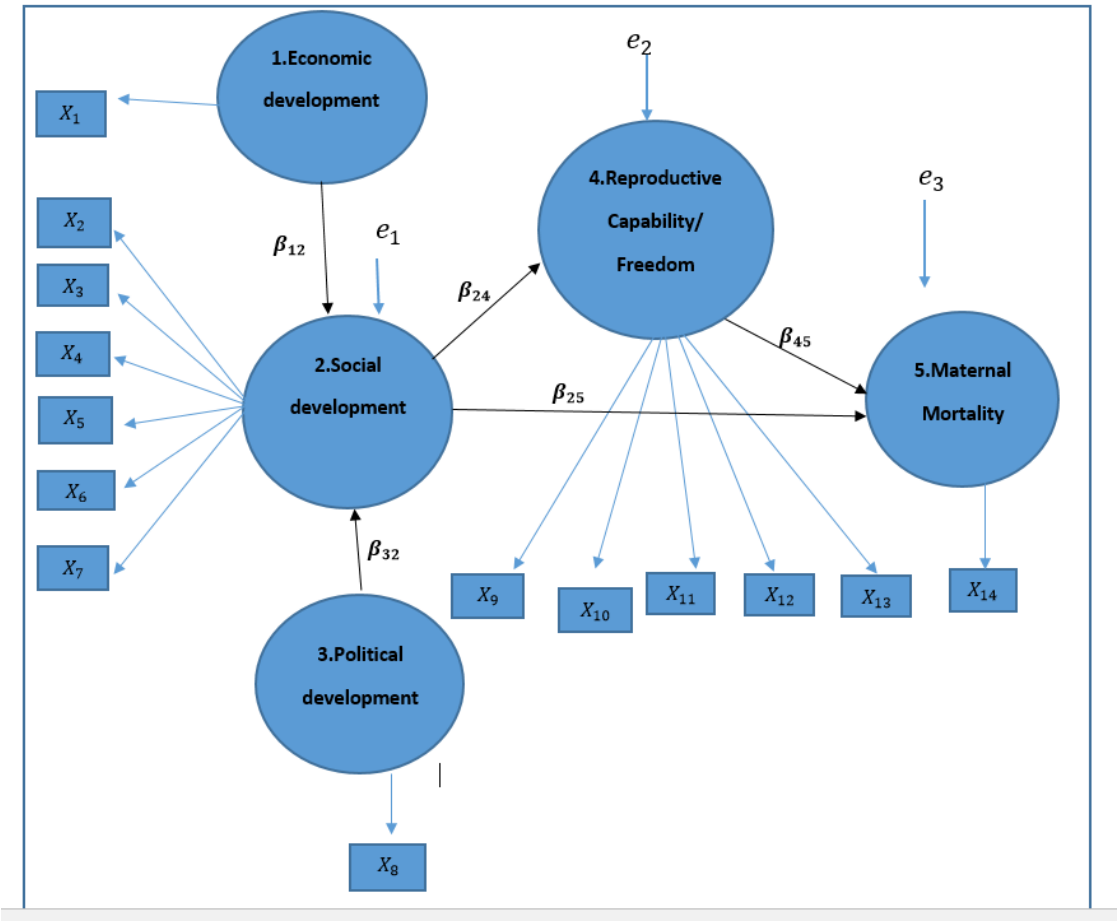
Latent construct	**Indicator variable**
Maternal mortality construct	Maternal mortality ratio
Economic development construct	GNI per capita
Political development construct	Dem index
Social development construct	Access to an improved water source
	Public health expenditure
	Adult literacy rate
	Mobile phone users
	Internet users
	Human development index
Reproductive capability/freedom construct	Skilled birth attendant
	Contraceptive prevalence rate
	Antenatal care
	Early marriage
	Percentage of mother received all vaccinations (Immunization)

Note: GNI: Gross National Income; Demindex: Economists Intelligence Unit's Index of Democracy; HDI: Human Development Index

Source: Author(s) own construction

skilled birth attendant contraceptive prevalence rate, antenatal care early marriage

Figure 5. 4 Causal model for predicting the effect of social development on maternal mortality



Source: Authors own construction based on Sen's theory

Note. X_{1-14} *represents manifest variables;* e_1, e_2 *and* e_3 *are the error terms and the β-s are coefficients measuring the strength of the interactions between latent variables.*

We estimated the latent construct for our model using equation (13.1) to (13.5) from Figure 5.4.

The latent variable y_1 representing economic development latent variable (exogenous variable) is estimated using equation 13.1 as expressed below

$$y_1 = y_1 + 0 \qquad (13.1)$$

We estimated y_2 representing social development latent variable (endogenous variable) which is measured by indicators $X_{2,}$…….$X_{7,}$ representing access to an improved water source, public health expenditure, adult literacy rate, mobile phone users, Internet users, human development index using equation 13.2 as expressed below

$$y_2 = \beta_{12}y_1 + \beta_{32}y_3 + e_1 \qquad (13.2)$$

Where y_1 and y_3 stands for economic development latent variable(exogenous) and political latent variable(exogenous). The coefficients β_{12} and β_{32} also represents the path relation between the economic development(exogenous latent variable), social development(endogenous latent variable), and political development(exogenous latent variable) respectively, whiles e_1 is the error term associated with the social development(endogenous latent variable).

y_3 which represents political development (exogenous latent variable) measured by manifesting variable, X_2 represented by Demindex is also estimated using equation (13.3) expressed below.

$$y_3 = y_3 + 0 \qquad (13.3)$$

Where y_3 represents social development (endogenous latent variable) and

The endogenous latent variable reproductive capability/freedom represent by y_4, which is measured by manifesting variables $X_9, \ldots\ldots\ldots, X_{13}$ indicated by Skilled birth attendant, contraceptive prevalence rate antenatal care, early marriage, and immunization is also estimated using equation(13.4) as shown below

$$y_4 = \beta_{24}y_2 + e_2 \qquad (13.4)$$

Where y_2 stands for social development(endogenous latent variable) measured by manifesting variables, access to an improved water source, public health expenditure, adult literacy rate, mobile phone users, Internet users, whiles β_{24} coefficient represents the path relation between social development(endogenous latent variable) and reproductive capability/freedom(endogenous latent variable) and e_2 is the error term associated with reproductive capability/freedom(endogenous latent variable).

Endogenous latent variable y_5, representing maternal mortality(endogenous latent variable) measured by manifesting variable X_{13}, which stands for maternal mortality ratio(MMR) is estimated using equation 13.5 as expressed below

$$y_5 = \beta_{25}y_2 + \beta_{45}y_4 + e_3 \quad (13.5)$$

Where y_2 andy_4 represents social development(endogenous latent variable)and endogenous latent variable reproductive capability/freedom. The coefficients, β_{25} and β_{45} represents the path coefficients, whiles e_3 represents the error term associated with maternal mortality(endogenous latent variable).

Finally, we estimated the direct, indirect, and total indirect effect of the latent variables using equations (13.6) to (13.15)

The total effect of Economic development on Social development

$$y_1 = \beta_{12} + 0 \quad (13.6)$$

The total direct effect of Political development on Social development

$$y_3 = \beta_{32} + 0 \quad (13.7)$$

The total direct effect of Social development on Reproductive capability/freedom

$$y_2 = \beta_{24} + 0 \quad (13.8)$$

The total direct effect of Social development on Maternal mortality

$$y_2 = \beta_{25} + \beta_{24} * \beta_{45} \quad (13.9)$$

The total direct effect of Reproductive capability/freedom on Maternal mortality

$$y_4 = \beta_{45} + 0 \quad (13.10)$$

The total indirect effect of Reproductive capability/freedom on Maternal mortality

$$y_4 = \beta_{45} + 0 \quad (13.11)$$

The total indirect effect of Economic development on Reproductive capability/freedom

$$y_1 = \beta_{12} * \beta_{24} \quad (13.12)$$

The total indirect effect of Political development on Maternal mortality

$$y_3 = \beta_{24} * \beta_{32} * \beta_{45} \quad (13.13)$$

The total indirect effect of Social development on Reproductive capability/freedom

$$y_2 = \beta_{34} * \beta_{32} \quad (13.14)$$

The total indirect effect of Social development on Maternal mortality

$$y_4 = \beta_{24} * \beta_{45} \quad (13.15)$$

Table 5.2 presents the definitions and sources of variables used in examining the effect of social development on maternal mortality.

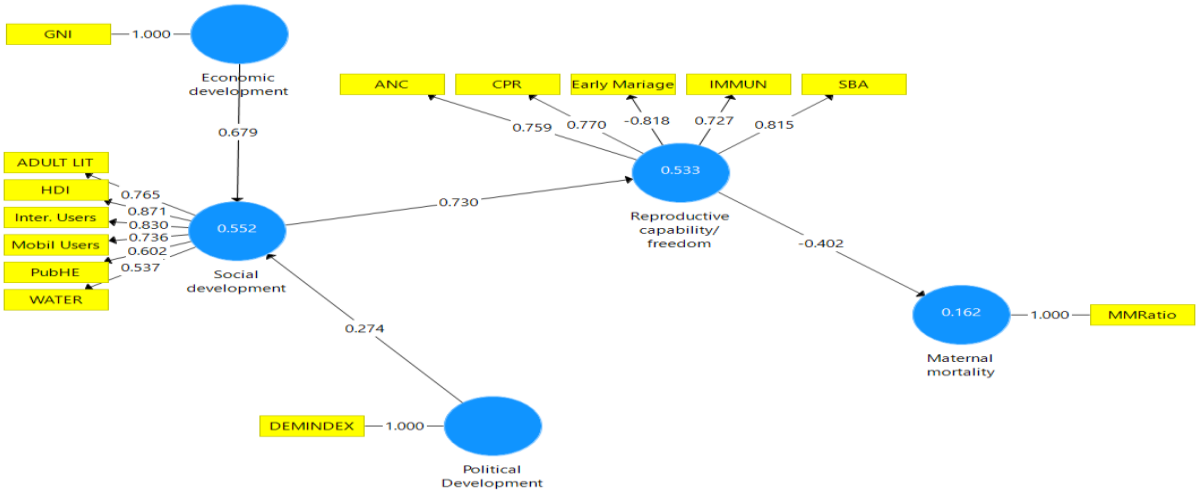
Note: the empirical and theoretical relationship of the selected indicators measuring the latent variables and maternal mortality are discussed in Chapter three. The methodological chapter of the dissertation.

5.4 Results and discussion

Figure 5.5 represents the results of the PLS-SEM algorithm. It shows the measurement model with the correlated values between the indicator and the latent construct. It also presents the results of the coefficient of determination (R^2) and the path coefficient between the latent constructs. The coefficient of determination (R^2) which measures the overall effect size of the structural model, is used in this case to represent the quality of the adjusted model. As indicated in Figure 5.5, 52.5% of the variation in the model is explained by social development, 53.3% and 16.2% by reproductive capability/freedom and maternal mortality respectively. The variations in maternal mortality, explained by social development and reproductive capability are large.

Based on the classification by Cohen (1988) a coefficient determination (R^2) of 2% in social and behavioral science is classified as small, 13 percent as a medium, and 26 percent as large. The results of the analysis on the coefficient of determination shows that political and economic development constructs explain 53.3% of the variations in the social development construct, 55.2% of the variations in reproductive capability/freedom is explained by social development, political and economic, and 16.2% of the variation in maternal mortality is explained by political, economic, social development and reproductive capability/freedom respectively.

Figure 5. 5 Final causal model for predicting the effect of social development on maternal mortality in Sub-Saharan Africa



Note.; contraceptive prevalence rate(CRP); skilled birth attendant (SBA); antenatal coverage (ANC); human development (HDI) index; access to an improved water source (WATER); adult literacy (ADUL LIT); maternal mortality ratio (MMRatio); immunization (IMMUN: internet users (inter. Users); public health expenditure (PubHE); gross national income (GNI):

economist intelligence unit's index of democracy (DEMINEX)

Source: Own estimation using smartPLS v.3.

The internal validity of our causal model is assessed using the composite reliability (CR) and Average variance explained (AVE). The reliability of our measurement model is assessed using the composite reliability, instead of the Cronbach's alpha, since its most appropriate for PLS-SEM estimation (Bagozzi & Yi, 1988). The composite reliability of our final model is greater than 0.7, showing that the constructs of our model are adequate (Henseler, Ringle, & Sarstedt, 2012: 269). The convergent and divergent validity of our model exists, since the average variance explained by our model is greater than 0.5 as proposed by Chin, 1996; Höck & Ringle, 2006 (Table 5.2).

Table 5. 2 Indicator for the adjustment of validity of the final model

Latent Construct	Composite Reliability	Average Variance	R Square
Economic development	1.000	1.000	-
Maternal mortality	1.000	1.000	0.162
Political development	1.000	1.000	-
Reproductive capabilit/freedom	0.721	0.606	0.533
Social development	0.872	0.537	0.552

Source: Own estimation using smartPLS v.3.

The discriminant validity of our final model is assessed by comparing the square root of the average variance explained the value for each latent construct as represented on the main diagonal with correlation coefficient for each construct in the column (Table 5.3). The results in table 5.4 showed that the square root of the average variance explained by the latent construct is superior to the correlation coefficient of each latent construct. Based on the Fornel and Lacker criteria, we conclude that discriminant validity exists between a given pair of our reflective constructs.

Table 5. 3 Discriminant validity

Latent Construct	Discriminant value				
	Economic development	**Maternal mortality**	**Political development**	**Reproductive capability/ Freedom**	**Social development**
Economic development	1.000				

Maternal mortality	-0.392	1.000			
Political development	0.042	-0.128	1.00		
Reproductive capability/freedom	0.247	-0.402		0.799	
Social development	0.691	-0.510			0.733

Source: Authors own estimation using smarPLS V3

The predictive validity and the effective predictive size of our final model is measured using Stone-Geisser Indicator (Q^2), which assess the model predictive quality and Cohen's Indicator (f^2) which also assesses the usefulness of each latent variable in the adjustment of the model. The result of the analysis based on the Blindfolding module of the PLS-SEM algorithm shows that the final model is accurate and the latent constructs (reproductive capability/freedom, social development, and maternal mortality) are important for the overall adjustment of the model. The Cohen's Indicator (f^2) value of 0.389 for reproductive capability/freedom construct and 0.337 for social development social indicates a large effect (see Table 5.4). This means the effect of dropping these latent constructs from the final model is large.

Table 5. 4 Indicators validity and effective predictive size of the final model

Latent Construct	Validity(Q^2)	Effect size(f^2)
Economic development	-	-
Maternal mortality	0.137	-
Political development	-	-
Reproductive capabilit/freedom	0.265	0.389
Social development	0.249	0.337

Source: Authors own estimation using smarPLS V3

Note. Evaluation criteria: $Q^2 > 0$; 0.02, 0.15, and 0.35 are considered small, medium, and large effects, respectively

The path coefficients are used in evaluating the hypotheses of the study. The significance of the path coefficients is tested using bootstrapping as proposed by Helm et al., (2009). The bootstrapping algorithm used a sub-sample of 5000 according to the assumptions of Hair et al. (2011) to obtain the path coefficients for the latent construct. The results showed in Table 5.5 supports the hypotheses for the study. The results showed a positive and statistically significant relationship between economic development and social development (β = 0.697, p <0.05), political development and social development ((β = 0.274, p <0.05), social development and reproductive capability/ freedom (β = 0.730, p <0.05). The results also indicated a negative and statistically significant relationship between reproductive capability/freedom and maternal mortality (β = -0.402, p <0.05).

Thus, increasing reproductive capability by one unit will reduce maternal mortality by 0.402 units. This also means, increasing reproductive capability such as antenatal care, birth attended by skilled personnel and contraceptive prevalence rate will reduce maternal mortality in the sub-Saharan Africa region. This result also supports the findings of previous studies conducted in the Sub-Saharan Africa region (Okwan and Kovacs, 2019; Alvarez et al, 2009). The results further showed that increasing social development by a unit will increase reproductive capability/ freedom by 0.730 units. This shows the importance of social development and how it relates to a woman's reproductive capability/freedom such as having access to quality health care services (Sen,2007).

Table 5. 5 Path coefficients of the final model

Path	Path Coefficients	Test Statistics	P-value
Economic development→Social development	0.697	7.941	0.000
Political development→Social development	0.274	1.996	0.046
Reproductive capabilit/freedom→Maternal mortality	-0.402	3.231	0.001
Social development→ Reproductive capabilit/freedom	0.730	11.270	0.000

Source: Authors own estimation using smarPLS V3

Table 5.6 presents, the direct, indirect, and total effect of the latent constructs. The results showed that social development has a direct effect on reproductive capability/freedom (β = 0.730, p <0.05). This is the greatest effect compared to all the other direct effects in the model. This is followed by the direct effect of economic development on social development (β = 0.697, p <0.05) and reproductive capability/freedom on maternal mortality (β = -0.402, p <0.05) (i.e. negative). The effect of political development on social development is the lowest. The direct effects in the model are the same as the path coefficients between the latent constructs. The results further indicate an indirect effect of economic development on reproductive capability/freedom (β = 0.496, p <0.05); social development on maternal mortality (β = 0.274, p <0.05) and economic development on maternal mortality (β = -0.200, p <0.05) respectively. The indirect effects of economic development and social development on maternal mortality are negative. In absolute terms the direct effect of economic development on reproductive capability/freedom (β = 0.496, p <0.05) is the greatest, followed by the effect of social development on maternal mortality (β = 0.274, p <0.05) and economic development on maternal mortality (β = -0.200, p <0.05). The negative effect of indicators reflecting economic and social development on maternal mortality has been found in studies conducted by Batist (2019); Tlou B. (2018);

Gruim &Wasie (2017), Gonzalez (2017). The uniqueness of our results is that we can estimate the magnitude of the effects based on our estimation method.

The direct effect of social development on reproductive capability/freedom and maternal mortality shows that increasing the level of social development will increase reproductive capability and freedom and in the long run reduce the level of maternal mortality. This result supports the proposed hypothesis for the study and findings of previous studies (Okwan and Kovacs,2019; Marchie (2019); Rana (2018); Girum and Wasie, 2017). They found that increasing social development indicators such as public health expenditure, literacy rate, internet, and mobile phone usage, will improve antenatal care visits, increase conceptive rate, increase immunization, increase the number of birth attended by skilled personnel, and through these channels will reduce maternal mortality. These results also indicate the importance of social development in the improvement of women's reproductive capability, and also contribute to the reduction of maternal outcomes in Sub-Saharan Africa. The direct effect of economic development and political development on social development also indicates that these constructs are key in the improvement of social development to reduce maternal mortality in Sub-Saharan Africa. The result supports the argument that it is economic wealth that generates human wellbeing but not economic growth per se, but its enhancement through social development is what makes economic growth a key factor (Sen,2007). In addition, studies conducted by Almasi (2015); Walker & Szafron, 2015; Neal & Falkingham (2014) also found the direct effect of indicators reflecting political and economic development such as the Demindex and GNI per capita on maternal mortality.

The significant and indirect effect of social development on maternal mortality through reproductive capability/freedom reported in Table 5.7 supports Sen's paradigm that, the basic aim of development is freedom, and he emphasized that the purpose of every development is to achieve wellbeing, and this can be done through the enhancement of freedom and capability (Sen.1999). He further explains the essence of the indirect effect of social development on human wellbeing in this case maternal mortality reduction through capability/freedom(Sen,2007). These results give evidence of the need to improve social development in the Sub-Saharan Africa region to reduce maternal mortality through reproductive capability/freedom as argued by Sen (2007)

Table 5. 6 Decomposed causal effect of the final model

Path	Direct	Indirect	Total
Economic development→Maternal mortality		-0.200*	-0.200
Economic development→ Reproductive capability/freedom		0.496*	0.496
Economic development→Social development	0.679*		0.679
Political development→Maternal mortality		-0.081	-0.081
Social development→ Reproductive capability/freedom		0.200	0.200
Political development→Social development	0.274*		0.274
Reproductive capabilit/freedom→Maternal mortality	-0.402*		-0.402
Social development→Maternal mortality		-0.294*	-0.294
Social development→ Reproductive capability/freedom	0.730*		0.730

Source: Authors own estimation using smartPLS V3

*Note: *p<0.05*

5.5 Conclusion

The study investigated the effect of social development on maternal mortality in Sub-Saharan Africa by exploring Sen's theory on social development. The study used the PLS-SEM modeling approach and Sen's theory to examine the causal effect of social development on reproductive health, in this case, maternal mortality in Sub-Saharan Africa. The study sourced cross-sectional data for 35 Sub-Saharan African countries from international online databases such as the World Health Organisation (WHO), Demographic Health Survey (DHS), World Development Indicators (WDI) of the World Bank, Economist Intelligence Unit (EIU), and the United Nations Development Programme (UNDP) to validate the hypotheses for the study. The fitness of the structural and measurement model is verified. The outer model (measurement model) fitness is assessed using composite reliability (CR), average variance explained (AVE), and discriminant validity. The results in Table 3 showed that the CR>0.5, AVE>0.7, and the square root of the average variance is greater than the correlation coefficient of each

construct. This shows that the fitness of the structural model is validated. The fitness of the structural model is also assessed using the coefficient of determination(R^2), predictive validity(Q^2) and the effect size $\left(f^2\right)$. The result in Table 5.4 showed that 53.3% of the variations in reproductive capability/freedom construct is explained by social development construct, economic development construct, and economic development constructs, 55.2% of the variations in social development construct is explained by economic development construct and economic development construct. The results show that maternal mortality is affected by four constructs and they explain about 16.2% of the variations in the maternal mortality constructs. The results on the predictive validity of the structural model show that the latent constructs, maternal mortality, reproductive capability/freedom, and social development are accurate and important for the overall adjustment of the model. The results on the effective size of the model also showed that the latent construct reproductive capability/freedom and social development have a large effect on the model.

The results on the effect of the constructs in the model showed that social development has a direct effect on reproductive capability and an indirect effect on maternal mortality through reproductive capability. The direct effect of social development is greater than the indirect effect. The results call for more emphasis on social development in an area such as education, health, communication, and environment. Improving the adult literacy level, increasing basic social amenities such as access to potable water and a clean environment, and increasing internet and mobile communication network will increase reproductive capability /freedom. The increasing of resources in the health sector by training more health personnel, equipping health facilities with modern equipment's and increasing medical supplies will increase health care use and access. This in effect, will improve reproductive/capability and freedom and further reduce maternal mortality.

The results on the direct effect of political development and economic development have also shown the importance of economic development in the enhancement of wellbeing. The Political development effect on social development shows that the likelihood of democratic government in the region to engage in social development to reduce reproductive health in the case of maternal mortality is high. The results showed that good governance will increase health spending and also reduce maternal mortality (Sajedinejad, et al. 2015). The results support the arguments of Sen (Sen,1999). This result supports the

finding of Ruiz-Cantero et al. 2019 who also saw the need not only to develop the political system in general but also the political willpower of women since it can contribute to the reduction of maternal mortality. These results have also confirmed the reason behind the high maternal mortality in some Sub-Saharan African countries like Liberia and Sierra Leone that have experience political instability for a longer period. The political instability in these countries affected the provision of social infrastructure necessary to improve the health system in these countries.

The results showed that all the hypotheses have been validated by the path analysis and the final model. The result also supports the applicability of Sen's theory in the investigation of the causal relationships between social development and reproductive health, in this case, maternal mortality in Sub-Saharan Africa. This indicates that increasing social development through reproductive capability/freedom will reduce the level of maternal mortality in the SSA region. The empirical analysis has shown that to reduce maternal mortality, governments in Sub-Saharan Africa region, should be engaged in social development projects in the area of health, education and also enhance the provision of basic social amenities for poor communities, where maternal mortality is high. Studies conducted in Sub-Saharan Africa by Alvarez et. al 2009 and Buor,2004) indicated the need for governments to include improvement in social conditions as part of interventions to address high maternal mortality in the region.

Brief chapter summary

This chapter examined the causal effect of social development on maternal mortality in SSA by employing, the PLS-SEM, a multidimensional statistical estimation method on cross-sectional dataset on 35 sampled SSA countries. The results of the PLS-SEM estimates showed that social development has an indirect effect on maternal mortality through reproductive capability and freedom. Reproductive capability and freedom is also found to have a direct effect on maternal mortality. The results further indicate that both social development and reproductive capability and freedom have large effect on maternal mortality in terms of magnitude. The empirical analysis also showed a positive relationship between social development and reproductive capability and freedom; and negative relationship between social development and maternal mortality through reproductive capability. Based on this results the study fails to reject the hypothesis that increasing the rate of reproductive capability, will decrease the rate of maternal mortality in SSA and increasing the rate of social development, will improve the rate of reproductive

Capability/freedom and reduce maternal mortality in SSA. The study obtained the following thesis based on the findings from the empirical analysis.

- **There is a positive and statistically significant relationship between social development and reproductive capability/freedom in SSA.**
- **There is a negative and statistically significant relationship between social Development and maternal mortality through reproductive capability/freedom**

CHAPTER SIX

HUMAN DEVELOPMENT AND MATERNAL MORTALITY IN SUB-SAHARAN AFRICA: A DYNAMIC PANEL ANALYSIS

Introduction

Human development level has become one of the key criteria used in measuring the performance of a country in terms of its social and economic development. In addition, maternal mortality reduction has also become a key target for sustainable development. The motivation for this study is that the SSA region has recorded low average human development and high average maternal mortality ratio for the past two and half decades. Employing both the fixed effect and the two-step system GMM estimation methods and panel dataset on 35 sampled SSA countries for the period 1990 to 2015, this study set out to examine the relationship between human development and maternal mortality. The study answered the following research question, Is there any significant relationship between human development and maternal mortality in SSA? And tested the hypothesis that H_6: There is no significant relationship between human development and maternal mortality in SSA to achieve the objective of the study. The chapter begins with a background of the topic, which is covered by section 6.1. Section 6.2 and its sub-sections capture empirical literature and relationship between human development and maternal mortality. The method of estimation, the specification of the empirical model, and issues related to the data and their sources are also discussed in Section 6.3 and its sub-sections. Section 6.4 focuses on the empirical results and its discussion. The last section of this chapter, section 6.5 presents the conclusion of the study.

6.1 Background of the study

For many centuries, the sub-Saharan African region has been confronted with numerous social and economic problems; and the lack of interventions to address these challenges have contributed to high levels of poverty, maternal mortality, infant mortality, unemployment, and inequality. The persistent increase in these social and economic challenges has been reflected in the development report on the region. The UN-economic commission for Africa reports for 2015 showed that the number of people in the region living below $1.25 a day has increased consecutively by a population of 100 million from 1990 to 2011. The number of the population living under $1.25 in 1990 was 290 million and finally increased to 414 million in 2015 (UN-Economic commission for Africa Report 2015). The United Nations Millennium development goal report for 2015 also indicated

that the region has the highest maternal mortality ratio of 546 per 100,000 live which is more than half of the global maternal mortality ratio of 216 per 100,000 live births (WHO 2016, 1). Again the sustainable development report for 2017 published by WHO recorded a high maternal mortality estimate of 542 maternal deaths per 100,000 live birth (WHO 2017,1) However, irrespective of the recent improvement and commitment by international organizations to reduce maternal mortality, it is still high in developing countries, especially sub-Saharan African. What is most worrying, is that about 94% of the death related to pregnancy and childbirth that occurs in low-income countries such as Sub-Saharan Africa are preventable.

The United Nations Development Program report on the human development index (HDI) categorized 35 countries in the sub-region as low human development countries (UNDP 2011, 127-130). Again in 2018, the United Nations Development report for 2017 on Human Development indicators ranked the region as the lowest among developing regions such as Arab states, East Asian and the Pacific, South Asia, Latin America and Caribbean, Central Europe and Central Asia (UNDP online database 2018). Human development became more important in the economic literature in the 20th century when Kuznet who proposed GDP as a measure of economic growth warned against using it as a measure of economic wellbeing (Kuznet, 1934). However, to assess how rich a country is, in terms of the total well-being of its inhabitant, indicators such as health, economic and social status should be of interest. One measure which captures the overall well-being of the inhabitants of a country is the Human Development Index (HDI). The human development index is a statistical measure used to assess the level of well-being and the quality of the inhabitants of a country. The index consists of three components; namely health, education, and income. The health aspect of the index is measured by life expectancy at birth, which aggregates the long and healthy life of the population. The education component also captures how knowledgeable the inhabitants are, is measured by adult literacy and their level of education. The income component which also captures the standard of living of the population is measured by per capita gross domestic product (GDP).

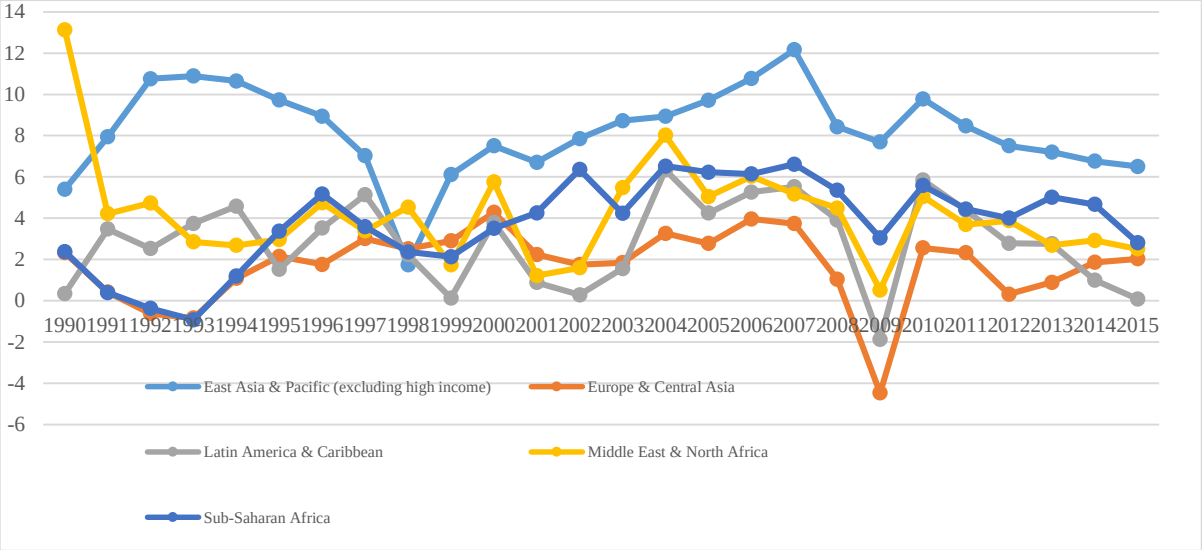
The Human Development Index has been found both in the economic and population development literature to explain maternal mortality and it has been estimated to account for about 80 to 82% of differences in maternal mortality among countries, especially the developing ones (Lee et al.1997). Maternal mortality which is a misfortune

event for many developing communities and a key health indicator for a country's development is also predicted by factors such as economic status, education, and health care. These population development measures have received attention in the economic and public health literature, and have been addressed in the Millennium Development Goals and the Sustainable Development Goals. Though the relationship between human development is important as established in a study conducted by Asefzadeh (2013) in Iran, he found a negative relationship between human development and maternal mortality, but there is still a lack of academic research on the relationship between maternal mortality and human development measured by the human development index in Sub-Saharan African region, a region that has recorded a low average human development and high maternal mortality ratio for the past two and half decades(i.e. from 1990 to 2017), however, several studies have investigated the relationship between human development indicators such as education, income, and life expectancy and maternal mortality (Bhalotra and Clarke 2014; Amiri and Gerdtham 2013; Buor and Bream 2004). We sought to answer the following research question, is there any significant relationship between human development and maternal mortality in SSA? It is against this background that the study is conducted to investigate if there is any significant relationship between human development and maternal mortality in the Sub-Saharan African region.

Trend analysis on economic growth and human development index(HDI) in SSA

This section presents a trend analysis on economic growth and the human development index in SSA. It further presents an analysis of the components of the HDI.

Figure 6. 1 Trend of economic growth in Sub-Saharan African compared to other regions in the world (1990-2015)



Source: Authors own construction from world Bank online database 2019.

Aside from the progressive improvement in economic growth in the sub-region during the global financial crisis in 2007 and 2008 (Figure 6.1), the region still lags in two important social and economic indicators for both the millennium development Goals and Sustainable Development Goals. A critical observation of the United Nation Development program report for 2018, showed that the region's performance was not impressive in all the three statistical measures of the Human development index (Table 6.1). For instance, the health component of the index captures the health of the individual and population as a whole. This component is very important, in the sense that it indicated the physical conditions of the inhabitant of a nation. According to Kumar (2011), a population with wealthier people can pay for private medical care and have a longer life. Comparing the life expectancy at birth for Sub-Saharan Africa (60.7rs) with other sub-regions such as South Asia (69.3yrs), Arab States (71.5yrs), East Asia and Pacific (74.7yrs), Europe and Central Asia (73.4yrs) and Latin America and the Caribbean (75.7yrs) shows that Sub-Saharan Africa has the lowest which is very worrying. The results confirm the argument

that the long and healthy lifestyle of the poor mainly depends on factors such as public health, nutrition, environment, and sanitation services. The region has been battling with all these conditions hence the low life expectancy at birth. Again the education component which is measured by literacy rate, capturing productive skill and knowledge of the inhabitant is also very low comparing it with South Asia and other sun-regions. Sub-Saharan Africa recorded 10. 1 year for expected years of schooling and 5.6years for means years of schooling. In this measure of the index, sub-Saharan Africa is ranked the lowest among all the other sub-regions. This shows that performance in terms of education is very low in sub-Sub-Saharan Africa. The income index, constructed from the GNI per capita measures the standard of living of the population. The income component of the index for Sub-Saharan Africa ($3,399) is very low compared to South Asia ($6,473), Arab States ($15,837), East Asia and Pacific ($13,688), Europe and Central Asia ($15,331), and Latin America and the Caribbean ($13,671). the figures in Table 6.1 shows that the income measure of the Human development index for Sub-Saharan Africa ($3,399) is almost two times lower than that of South Asia ($6,473) and almost five times lower than that Arab States($15,837), East Asia and Pacific ($13,688), Europe and Central Asia ($15,331). The low human development for the sub-region is contributed by the low rank in all the three measures of the human development index as presented in Table 6.1.

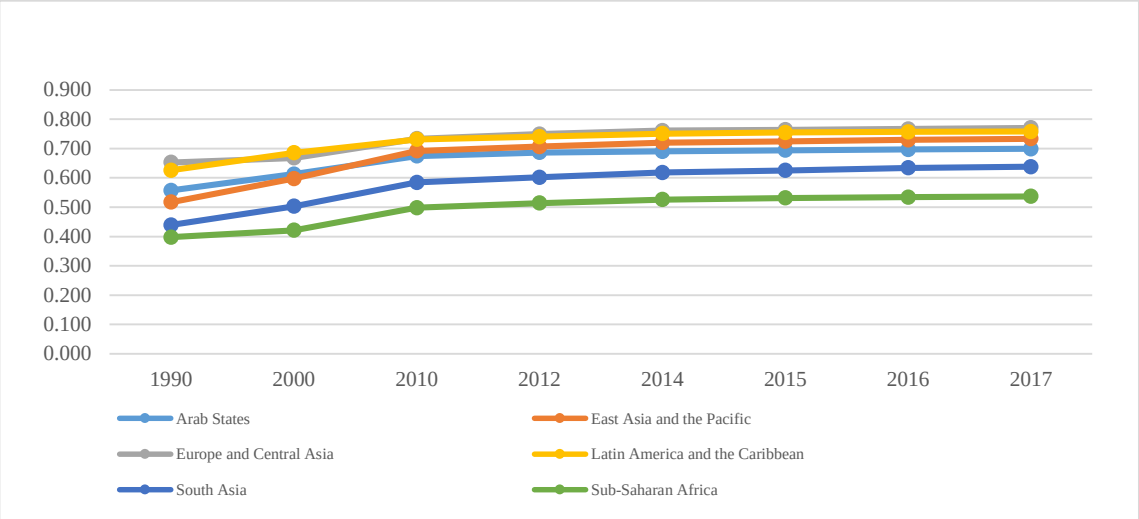
Table 6. 1 Component of Human Development Index in Sub-Saharan African compared to other regions in the world

Regions/indicators	Human Development Index (HDI)	Life expectancy at birth(years)	Expected years of schooling(years)	Mean years of schooling (years)	Gross national income (GNI) per capita(2011 PPP $)
Arab States	0.699	71.5	11.9	7.0	15,837
East Asia and the Pacific	0.733	74.7	13.3	7.9	13,688
Europe and Central Asia	0.771	73.4	14.1	10.3	15,331
Latin America and the Caribbean	0.758	75.7	14.4	8.5	13,671
South Asia	0.638	69.3	11.9	6.4	6,473
Sub-Saharan Africa	0.537	60.7	10.1	5.6	3,399

Source: UNDP online database 2019

The trend of the Human Development Index for the region, from 1990 to 2017 shows a low performance in terms of the index as compared to other regions in the world (Figure 6.2). The region has the lowest Human Development Index which measures overall wellbeing. From Figure 6.1, the economic performance for the region was impressive during the economic crisis in 2007, 2008, and afterward, but this was not the case, in terms of well-being measured by the Human Development Index.

Figure 6. 2 Trend of Human Development Index in Sub-Saharan African compared to other regions in the world (1990-2015)



Source: Authors own construction from UNDP online database 2019

6.2 The relationship between human development and maternal mortality

The connections between the differences and privileges in society can best be explained by the gender stratification theory. It's one theory that is different, but likewise, has relations with other aspects of inequalities that emphasize social class and ethnicity. The gender stratification theorists are of the view that a society where women are self-sufficient and autonomous is probable of having lower maternal mortality than a society dominated by low status and more dependent women. The reason is that women with high status in society, have high incomes and the right to decide on the number of children to have. Societies with women who are self-sufficient, autonomous, and with a high level of income will have a lower maternal mortality rate because these women are probable of having improved nutrition and access to improved maternal health care services during pregnancy. According to Shen and Williamson (1999) women who are more dependent and have low status in society are probable of having too many children. These women start childbearing at tender ages and end at the later stages of their reproductive life, hence exposing them to high maternal mortality risk. These notions of gender stratification theorists and; Shen and Williamson (1999), were not considered as important in the modernization theory.

From the modernization theorist perspective, the status of a woman will be enhanced through the provision of more labor participation opportunities, which in the long run increase her access to improved income and maternal health care services, and her control over these resources should lead to a decline in maternal mortality and

mortality in general. According to theorists, these can be achieved through industrialization and modernization. The assumptions of the modernization theory have been challenged by finding from studies conducted by (Abraham 1988; Boserup, 1970). Thus, the United Nations report, 1995 supports the argument of the gender stratification theorists that a decrease in fertility through access to education, employment, and contraceptive usage reduces the risk of a woman dying from pregnancy and childbirth-related complications (UN, 1995)

The neoclassical economic theory and the modernization theory which are both development theories are closely linked from the theoretical and empirical points of view. These two important theories see economic development as a link to the gap between developed and underdeveloped countries through a derived process. The demographic transition theory which is developed from the modernization theory observes fertility and maternal mortality to be associated with each other. According to this theory, a community such as the Sub-Saharan African community where fertility is high will have a higher maternal mortality rate. This is because a high level of education will lead to a low maternal mortality ratio. Again economic development will contribute to high living standards and modern medical technology that is associated with lower fertility and maternal mortality (Shen and Williamson, 1999). Theoretically, as the health status of the population, in the form of maternal mortality decreases, economic development achieved through human development increases. According to Kelly and Cutright 1980; Van de Walle and Knodel 1980, the process of maternal mortality influencing economic development needs a greater level of industrialization, urbanization, and education. The effort to improve the usage of family planning is linked to modernization from the perspective of modernization theory. The theory also hypotheses that a higher level of modernization in a country increases the drive of a woman to control birth which is also achieved through human development in the form of education. The high level of modernization also decreases the probability of exposing women to pregnancy and child-birth-related deaths (Kelly and Cutright, 1980). The theory further argues that economic development obtained as a result of human development is associated with improved welfare and highly trained medical professionals will lead to lower maternal mortality and fertility rate. From the modernization theory perspective, countries that have experience modernization will have lower fertility rates which will result in a lower maternal

mortality rate. Thus, a decline in maternal mortality which is a key health status indicator of the population should improve the level of economic development.

6.2.1 Empirical literature on the human development and maternal mortality

Table 6.2 presents empirical studies on maternal mortality and human development proxied by the HDI. The empirical studies cover studies conducted both in developed and developing countries. We chose to summarize the empirical studies in a table form for easy understanding. The summarized empirical studies capture the author(s) name and year of publication, sources of data, variables considered in the study, the model type and scope, and major findings of the study.

Table 6. 2 Empirical studies on the relationship between human development measured by HDI and maternal mortality proxied by maternal mortality ratio

Author(s)	Nature of examination	Country	Timeframe	Estimation Technique	Major Finding(s)
Alimohamadi, Y., et al. (2019	HDI, under-five mortality, and maternal mortality	West Asian Countries West Asian Countries	1980-2010 1980-2010	Correlation Analysis	The results showed a negative relationship between HDI, maternal mortality. HDI increased in the period of study. This result in a decrease in MMR and U5MR
Nuhu, K. M., et al. (2018	HDI, maternal mortality, neonatal mortality, and healthcare spending	188 countries	2010-2014	Latent Growth Curve Model(LGCM)	The result of the latent growth model showed a negative relationship between HDI, MMR, and NM. The results further showed that increasing health spending will improve HDI and also reduce MMR and NM
Larroca, S. G. T., et al (2017)	Human Development index and perinatal outcomes	Spain	2010-2016	Multiple Logistic Regression	Women from countries with a low human development index have significant neonatal outcomes.

Premakumara , G. S., & Kavitha, S. V. (2017).	Maternal mortality and HDI	15 medium Human development countries	2015	Regression, Correlation and Factor Analysis	The results showed a significant association between HDI and maternal mortality. HDI accounts for the variations in MMR in medium development countries
Almasi-Hashiani, A., Sepidarkish, M., Vesali, S., & Omani Samani, R. (2016).	HDI, total fertility rate, IMR, and MMR	188 World countries	2014	Correlation Analysis	The study found a negative and statistical relationship between total fertility rate, IMR, IMR, and HDI in the 188 world countries
Lalthapersad-Pillay, P. (2014)	Maternal mortality and non-medical factors such as HDI	African countries	2010-2013	Logistics regression	Countries with low HDI are 3times more probable of having a high maternal mortality rate than countries with high human development Index.
Asefzadeh, S., Alijanzadeh, M., & Nasiri, A. M. (2013)	Maternal mortality and HDI	135countries in the world	1990-2010	Correlation Analysis	The results of the correlation analysis showed a statistically significant relationship between GNI per capita, life expectancy, education, HDI, and maternal mortality in the 135 world countries.
Tajik, Parvin, et al. 2012	Maternal mortality and inequality	Iran	2004-2006	Regression and correlation analysis	The results of the regression analysis showed a significant association between

					HDI and maternal mortality.
McAlister, Chryssa, and Thomas F. Baskett (2006)	Female education and maternal mortality	148 countries in the world	2003	Polynomial regression analysis	The findings of the study showed that HDI is the most powerful predictor of variations in maternal mortality.
Lee, Kwang-sun, et al (1997)	Human development index, maternal mortality and infant mortality	Countries in the world	1987-1990	Regression and correlation analysis	Components of the Human development index is strongly correlated with IMR and MMR

Source: Author(s) own construction

The summary of the empirical studies examining the relationship between human development proxied by HDI and maternal mortality as presented in Table 6.2 shows that there is no single study that employed a panel dataset in their empirical analysis. The studies were conducted in high, middle, and low-income countries, but there is no single study on the sub-Saharan African region. The studies used estimation methods such as correlation analysis, factor analysis, latent growth curve model, and logistic regression. The period for some of the studies was out of date (1997-1990). There is no single study that used panel dataset as well as employing panel regression analysis. This study first, fills the time gap in the literature on the relationship between human development and maternal mortality in SSA. Again, it is the first study conducted on the region to examine the relationship between human development and maternal mortality by using panel data and also employing pane regression estimation methods such as the system GMM. It is the only study that tests for the cross-sectional dependence in the panel dataset for the examination of the relationship between human development and maternal mortality.

6.3 Methodology

The general conclusion drawn from the empirical and the theoretical literature presupposes a negative relationship between human development measured by the Human development index and maternal mortality. The channel of this linkage is observed through the modernization theory and the gender stratification theory. Based on these

propositions, the study tested the hypothesis that there is no significant relationship between human development measured by the human development index and maternal mortality in Sub-Saharan Africa. Therefore, to investigate this relationship, a dynamic panel data estimation method is adopted.

6. 3.1 Model specification and estimation

According to Baltagi (2008), dynamic economic phenomena can be best explained using panel data estimation techniques. These dynamic relationships are normally derived by adding lagged terms of the dependent variable as a predictor variable, which is expressed as follows:

$$y_{it} = \psi y_{i,t-1} + x_{it}\beta + \varepsilon_{it} \quad i = 1, \ldots\ldots, N \; t = 1, \ldots\ldots, T \qquad (14.1)$$

Where y_{it} represent the dependent variable, $y_{i,t-1}$ represent the lagged term of the dependent variable, ψ is a scalar, x_{it} is 1x P explanatory variables, β is P x 1 and ε_{it} is the error term. Making the assuming that ε_{it} is a one-way error component model, then Eq. (14.2) can be expressed as follows

$$\varepsilon_{it} = \mu_i + z_{it} \qquad (14.2)$$

where$\mu_i \sim iid(0, \sigma_\mu^2)$ and $z_{it} \sim iid(0, \sigma_z^2)$ are independent of one another and among each other as well. Eq. (1) is a dynamic panel model considered as autocorrelation due to the existence of the individual effects considered by the heterogeneity among variables and the presence of the lagged term of the dependent and explanatory variables. According to Baltagi (2008), these problems make the Ordinary Least Squares(OLS) estimators inconsistent and biased, hence, rendering the fixed effect estimates biased as well. To address this problem of biasedness and inconsistency of the OLS estimators, Keane and Runkle (1992); Arellano and Bond (1991), proposed a dynamic panel model estimation procedure that is more efficient.

This study examined the relationship between human development measured by the human development index and maternal mortality in SSA countries by employing a dynamic panel model estimator proposed by Arellano and Bond (1995) and finally developed by Blundell and Bond (1998). Based on this, the study adopted a dynamic panel framework by David and Ampah (2018) to examine the relationship between human development measured by the human development index and maternal mortality as expressed in Eq. (14.3) below:

$$Human\ Dev_{it} = \alpha_0 + \varphi Human\ Dev_{it-1} + \beta_0 LMMR_{it} + \beta_1 LIMR_{it} + \partial Z_{it} + \emptyset_i + \varepsilon_{it} \quad (14.3)$$

Where Human development is denoted by a human development indicator, LMMR is the natural log of maternal mortality, LIMR is the natural log of infant mortality. Z denotes a vector of other control variables considered in the study, ϕ represents the unobserved country-specific time-invariant effect, ε denote the usual constant error term. The parameters φ, β, ∂ are coefficients of the prior value of the human development indicator, maternal mortality, infant mortality, and other control variables to be assessed. The subscript i in the model represents a particular country and t representing the time period. The Z variables, which represent the control variables are chosen based on the theoretical and empirical literature.

$$Z = f(TFR, LLEXP, GDPPP) \quad (14.4)$$

Where TFA represents the total fertility rate, LLEXP represents the natural log of life expectancy at birth and GDPPP is the GDP per capita.

This study examined the relationship between human development measured by the human development index and maternal mortality by using System GMM proposed by Arellano and Bond (1995) and finally developed by Blundell and Bond (1998). The reason for using the System Generalized Method of Moments panel data framework is that the ordinary least squares estimators are biased and inconsistent because of the error associated with the unobserved time-invariant country effect (Baltagi, 2008). The System GMM addresses the inefficiencies of Ordinary Least Square estimators. Again, the parameter estimates from System GMM regression are efficient and consistent since the regressors are not always exogenous, since the current and past errors are correlated in a way that will call for the existence of heteroscedasticity and autocorrelation within individuals (Roodman, 2009a,). Another advantage of System GMM according to Nickell (1981), is that it eliminates the bias in dynamic panel data and also addresses the problem of fixed effect and endogeneity of the regressors. This is done through the introduction of instrumental variables that are uncorrelated with the fixed effect. Lastly, comparing the estimates of the System GMM estimators to the Difference GMM estimators developed by Arellano and Bond (1991), estimates of the System GMM estimators are consistent and efficient since it permits for the introduction of more instrumental variables and

additional assumptions which allows for the first differences of the instrumented variables to be uncorrelated with the fixed effect (Roodman, 2009a).

The overall System GMM model data generating process is for our estimation given as follows.

The panel model for the first-order autoregressive is express in Eq. (14.5) below

$$y_{it} = \varphi y_{i,t-1} + \lambda X_{it} + \omega_{it}$$

$$\omega_{it} = \pi_{it} + \Omega_{it} \qquad (14.5)$$

Where X_{it} represent the vector of the dependent variables, ω_{it} represents the constant error term., the subscripts i in the model represent a particular country, and t representing the time period. The parameters π_{it} and Ω_{it} stands for the fixed effect and the individual shocks respectively. They are assumed to have a one-way component error with the following assumptions as specified in Eq. (14.6) to (14.12)

$$\mathrm{E}(\pi_{it}) = 0, \mathrm{E}(\mathrm{i}\Omega_{it}) = 0, \ \mathrm{E}(\pi_{it}, \Omega_{it}) = 0 \ \ \mathrm{i} = 1, \ldots, \mathrm{n}; \mathrm{t} = 2, \ldots\ldots, \mathrm{T} \qquad (14.6)$$

$$\mathrm{E}(y_{i1}, \Omega_{iv}) = 0 \ \ \mathrm{i} = 1, \ldots, \mathrm{n} \text{ and } \mathrm{t} \neq \mathrm{v} \qquad (14.7)$$

The initial condition provides for the following assumptions to hold, as expressed in Eq. (6.1.8) and (6.1.9)

$$\mathrm{E}(\pi_{it}, \Omega_{iv}) = 0 \quad for\ all \quad \mathrm{t} \geq 2 \qquad (14.8)$$

$$\mathrm{E}(\pi_{it}, \Delta y_{i2}) = 0 \qquad (14.9)$$

The linear moment conditions expressed by Eq. (6.2.0) and (6.2.1) hold under assumptions (6.3.6), (6.3.7), (6.3.8), and (6.3.9)

$$\mathrm{E}\left(y_{i,t-v}\, \Delta\omega_{it}\right) = 0 \quad for \quad \mathrm{t} \geq 3 \quad and \quad \mathrm{v} \geq 2 \qquad (14.10)$$

$$\mathrm{E}\left(\omega_{it} y_{i,t-1}\right) = 0 \quad for \quad \mathrm{t} \geq 3 \qquad (14.11)$$

Based on the assumptions and conditions specified in equations (5) to (11) and the two key conditions for consistency of System GMM estimations by Roodman (2009a), and

Hansen (1982), the study estimated the following dynamic panel equation using System GMM as expressed below

$$HDI_{it} = \beta_0 HDI_{it-1} + \beta_1 LMMR_{it} + \beta_2 LIMR_{it} + \beta_3 TFR_{it} + \beta_4 LLEXP_{it} + \beta_5 GDPPP_{it} + \emptyset_i + \pi_t + \upsilon_{it} \quad (14.12)$$

Where HDI denotes the Human Development Index, LMMR is the natural log of maternal mortality ratio, LIMR is the natural log of infant mortality rate, TFA represents total fertility rate, LLEXP represents the natural log of life expectancy at birth and GDPPP is the GDP per capita. The parameters $\emptyset_i$ andπ_{it} denote the individual country fixed and time effect respectively.

represent the constant noise term.

6.3.2 Data and Sources

The dataset for the study is primarily secondary data drawn from the World Bank (World Development Indicators), WHO, and UNDP online databases. The data used for the analysis is panel data set for thirty- five (35) Sub-Saharan African countries spanning between 1990 and 2015. The definitions and sources of the variables employed in the empirical analysis are discussed in chapter three of this dissertation. The variables considered in the empirical analysis are based on the empirical literature.

6.4 Results and Discussions

Table 6.3 report the summary statistics of the variables in the study. The descriptive statistics reported are the mean, maximum and minimum values, standard deviation, skewness, kurtosis, and normal distribution. The overall mean of the annual Human Development Index for the region is 0.432 which indicates that the region can achieve only 43.2% in Human Development. This is very low compared to other regions in the world. The mean value for maternal mortality is 686 maternal deaths per100,000 live birth which is also higher compared to the global maternal mortality. The overall mean of annual Infant mortality, life expectancy, total fertility, and GDP per capita for the SSA region are 74 infant deaths per 1000 live birth in a year, 54.529 years per 1,000 adults, 5.4 births per 1,000 females, and 1.168% of annual growth respectively. The standard deviation values showed that all the variables deviate narrowly from their mean. The number of maternal deaths ranges between a minimum of 23 and a maximum of 2900 death per 100,000 live birth which is very high. The Human Development Index for the region ranges between a minimum of 0.196 and a maximum of 0.782. The normal

distribution, reported by Jarque-Bera statistic shows that all the variables are not normally distributed. A critical observation of the descriptive characteristics of the variables showed that most of the variables leptokurtic having a kurtosis value of less than three (3). The total number of observations for the empirical analysis is 910 as indicated in the summary statistics results

Table 6. 3 Summary statistics

	HDI	**MMR**	**IMR**	**TFR**	**LEXP**	**GDPPP**
Mean	**0.432**	**689.557**	**74.089**	**5.4307**	**54.528**	**1.168**
Median	0.423	648.000	70.600	5.570	54.700	1.568
Maximum	0.782	2900.000	160.600	7.772	74.353	37.535
Minimum	0.196	23.000	12.500	1.360	27.610	-47.503
Std. Dev.	0.114	406.1319	28.586	1.227	6.823	5.196
Skewness	0.489	2.103655	0.434	-0.81200	-0.12800	-1.299
Kurtosis	2.958	11.35527	2.886	3.866	3.925	20.202
Jarque-Bera	36.431	3318.162	29.008	128.4672	35.012	11477.02
Probability	0.000	0.000	0.000	0.000	0.000	0.000
Observations	910.00	910.000	910.000	910.000	910	910.000

Source: Authors construction from Eviews 10

Results for Correlation Analysis

The level of relationship among the variables is determined by performing correlation analysis. Table 6.4 reports the results of the correction analysis. The results showed that none of the variables is highly correlated. Variables with the highest correlation are IMR

and LEXP with a correlation coefficient of (-0.829) and the lowest correlation is between HDI and GDPP with a coefficient of (0.112).

Table 6. 4 Correlation Matrix

	HDI	**IMR**	**LEXP**	**MMR**	**GDPPP**	**TFR**
HDI	1					
IMR	-0.820	1				
LEXP	0.734	-0.829	1			
MMR	-0.658	0.742	-0.703	1		
GDPPP	0.112	-0.113	0.124	-0.105	1	
TFR	-0.870	0.708	-0.608	0.570	-0.116	1

Source: Source: Authors construction from Eviews 10

The cross-sectional dependence test results in Table 6.5 using Breusch-Pagan LM (1980, Pesaran CD (2004) and Pesaran (2008) test for the group variables, rejects the null hypothesis of "no cross-sectional dependence" at a 1% level of significance. This result confirms that our data for the panel analysis suffers from cross-sectional dependence.

Table 6. 5Cross-sectional dependence test results

Test	**Statistic**	**d.f.**	**Prob.**
Breusch-Pagan LM	5386.47	595	0.000
Pesaran scaled LM	138.8978		0.000
Pesaran CD	2.809856		0.005

Source: Source: Authors construction from Eviews 10

Since the cross-sectional dependence test by Breusch-Pagan LM (1980, Pesaran CD (2004), and Pesaran (2008) confirm the existence of cross-section dependence in our data, the study employed the augmented cross-sectional Pesaran, Shin, and Shin (2007) unit root test to ascertain the stationarity properties of the dataset used for the study, since it addresses the problem of cross-sectional dependence in panel data. Table 6.6 presents the

results for the unit root test. The results showed that all the variables considered for the empirical analysis are stationary at levels, that is I (0).

Table 6. 6 Unit root test results

Variable	Ztbar	CIPS (trend and intercepts)
		C-value (5%)
HDI	-9.869	0.000
LMMR	-21.205	0.000
LIMR	-5.668	0.000
TFR	-7.396	0.000
LEXP	-4.112	0.000
GDPPP	-18.760	0.013

Source: Source: Authors construction from Stata 15

The Hauman test results presented in Table 6.7 favored the fixed effect model. These results showed that the fixed effect model is appropriate for the study population. The rejection of the null hypothesis also supports the assumption that there is a correlation between the individual heterogeneity term and the regressors of the model for the sampled countries

Table 6. 7 Hausman test results

Test Summary		**Chi-Sq. Statistic**	**Chi-Sq. d.f.**	**Prob.**
Cross-section random		9.492403	5	0.001
Cross-section random effects test comparisons:				
Variable	**Fixed**	**Random**	**Var(Diff.)**	**Prob.**
LMMR	-0.11658	-0.10946	0.00003	0.21340

LIMR	-0.15546	-0.15158	0.00001	0.25360
TFR	-0.02437	-0.02582	0.00000	0.01900
LEXP	0.00307	0.00316	0.00000	0.37170
GDP_PPP__	0.00030	0.00030	0.00000	0.33860

Source: Source: Authors construction from Stata 15

Results for Fixed effect and System GMM

The study employed both the fixed effect (FE) and system GMM estimation techniques to show estimation efficiency and also indicate how results differ when econometric problems such as dynamic panel biases and endogeneity are considered. System GMM is seen as one of the best panel dynamic estimation techniques that address the problem of endogeneity. The empirical results for both the fixed effect (FE) and the two-step system GMM are presented in Table 6.8a and 6.8b.

Table 6.8a Results of the fixed effect(FE) model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.020	0.045	-0.450	0.653
HDI(-1)	0.930	0.022	42.915	0.000***
LMMR	-0.015	0.011	-1.355	0.176
LIMR	-0.001	0.012	-0.105	0.917
TFR	-0.004	0.002	-2.410	0.016**
LEXP	0.001	0.000	3.071	0.002**
GDPPP	0.000	0.000	7.343	0.000***
R-squared	0.995			
F-statistic			4611.160	0.000***
Durbin-Watson stat			1.186	

Note: *, **, *** represents Significant level at 10%,5% and 1% respectively.

Source: Authors construction from Eviews 10

The result in Table 6.8a shows a negative relationship between Human development measures by the HDI, maternal mortality ratio(MMR), and infant mortality rate(IMR) which is consistent with prior assumptions but not statistically significant. This meaning that maternal mortality and infant mortality have a negative and statistically significant relationship with human development, from the two-step GMM estimation, but in the case of the 35 sampled countries in Sub-Saharan Africa, there is no significant relationship between maternal mortality, infant mortality and human development based on the panel fixed effect estimation. The results on the relationship between human development measured by HDI, total fertility rate, Life expectancy, and GDP per capita a proxy for economic growth are statistically significant at 1% and 5%; and consistent with the prior assumptions. The results also indicate that GDP and Life expectancy have a positive and statistically significant relationship with human development, while total fertility has a negative and statistically significant relationship with human development measured by the Human development index in SSA. These results support the findings of previous studies (Islam 1995; Furuoka, 2009).

Table 6. 8b Two-Step System GMM results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
HDI(-1)	0.867	0.014	63.343	0.000***
LMMR	-0.023	0.007	-3.251	0.001***
LIMR	-0.019	0.009	-2.212	0.027**
TFR	-0.008	0.001	-6.027	0.000***
LEXP	0.001	0.000	5.795	0.000***
GDPPP	0.0004	0.000	17.182	0.000***
AR(1)	-0.0024	-0.0199	8.239	0.0014**
AR(2)	0.0004	0.0053	12.875	0.9997
J-statistic	318.475			

Prob (J-statistic)	0.156			

Note: *, **, *** represents Significant level at 10%,5% and 1% respectively.

Source: Authors construction from Eviews 10

To address the biasedness and inconsistencies in the results of the fixed panel, OLS estimation, a two-step system GMM estimation method is employed. The coefficient of the lagged dependent is statistically significant at 1% and positive. This indicates that the model is dynamic. We also used the Hansen over-identifying test to examine the consistency of our estimators, confirm the validity of our instrument, and check for the lack of serial correlation (Arellano and Bond, 1991). Our result found no evidence of rejecting the null hypothesis that our model is appropriate and the instruments used are valid ($p > 0.05$, i.e. $p = 0.156$). The two-step system GMM estimation showed that both maternal mortality and Infant mortality are statistically significant and have a negative relationship with human development. These results are also consistent with the prior assumptions. The results also showed a percent increase in maternal mortality will reduce human development by 0.023 percentage points in the 35 sample countries in Sub-Saharan Africa. The results showed a negative and statistically significant relationship between maternal mortality and Human development. This result is consistent with the findings of Hasan (2021), and Gonzalez et al. (2017); Asefzadeh (2013. They found that countries with high maternal mortality ratios have low HDI. The fining of Hasan et al 2021 is based on their panel fixed effects model estimates, while that of Gonzalez et al. (2017 is based on their correlation analysis. Though we found a negative and statistically significant relationship between maternal mortality, our result is robust since we used a more robust estimator, and again we tested for cross-sectional dependence which is a major problem associated with panel regression. These results also confirm the arguments by the gender stratification theorists, modernization theorists, and the findings of Shen and Williamson (1999).

According to them, increasing the status of women through modernization will reduce fertility and will also reduce maternal mortality, and finally improve human development. The coefficient of total fertility rate is also negative and statistically significant at the 1% level. The negative sign exhibited by the total fertility rate coefficients shows an inverse relationship between fertility and human development measures by HDI in SSA. This means that a percent increase in the total fertility rate in SSA would result in an 8% decrease in Human Development measured by the HDI in

SSA. These results also indicate a negative and statistically significant relationship between human development and maternal fertility is consistent with the finding of Furuoka 2009 and also contradicts the findings of Myrskylä et al. (2009) and Harttgen (2014). They found that countries with HDI greater than 0.9 have higher fertility rates. Shen and Williamson (1999) have also found that countries with higher fertility rates tend out having higher mortality rates due to low status would result in low human development. The higher fertility rate for the Sub-Saharan Africa region also contributed to the low human development and the higher maternal mortality for the region as compared to other regions in the world. The coefficient of GDP per capita, a measure for economic growth has a positive sign and is statistically significant at the 1% level. Thus a percent increase in GDP per capita also increases human development measured by HDI by 0.4%. This result authenticates the findings of Islam (1995), his studies showed that HDI is sensitive to GDP per capita in low-income countries. The also supports the argument of the modernization theorist. They are of the view that urbanization, industrialization, and education influence maternal mortality which will intend to increase human development. They also argue that countries that are modernized have low maternal mortality and improved economic development. This argument contradicts the situation in Sub-Saharan Africa. The analysis in Figure 6.1 showed that the sub-region had a high economic performance during the global financial crisis in 2007 and 2008; and even beyond, compared to other regions in the world. The analysis in Figure 2.3 shows that the region has the highest maternal mortality compared to other regions of the world. This result authenticates the argument of Kuznet (1934), that GDP cannot measure economic wellbeing. This could be associated with the reason why the region grew at 3 percent even during the global financial crisis and still have a high maternal mortality rate compare to other regions in the world. This result indicates that increasing economic growth, without a corresponding increase in HDI, will result in high maternal mortality, hence the high maternal mortality and low human development in the region. This shows that the low human development in the region is contributed by the high maternal mortality ratio.

6.5 Conclusion

This study investigated the relationship between human development measured by the human development index (HDI) and maternal mortality in Sub-Saharan Africa. The

empirical analysis is conducted on 35 Sub-Saharan African countries using a panel dataset spanning between 1990 and 2015. The study used fixed effect(FE) and two-step system GMM to find evidence for the relationship between human development measured by HDI and maternal mortality in Sub-Saharan Africa. We found that the result of the two-step system GMM estimators is more robust than that of the dynamic fixed effect (FE) estimators. The empirical results of the two-step system GMM showed a negative and statistically significant relationship between human development and maternal mortality in Sub-Saharan Africa. In addition, infant mortality and total fertility rate also had a negative relationship with the human development index, a measure for human development in SSA. This result indicates that increasing infant mortality and total fertility rate will reduce human development in the SSA region. The correlation analysis conducted on the variable for the empirical analysis shows that none of the variables is highly correlated with each other. This also shows the absence of multicollinearity. The Hansen J-statistic test also showed that the instruments used in the model are valid, there is no serial correlation and the model is well specified. The study finally concludes that there is a statistically significant relationship between maternal mortality and human development index a measure for human development in Sub-Saharan African. These results which also conform to results of the study by Hasan (2021); Gonzalez et al. (2017), show the need to reduces the level of maternal mortality since it's a contributing factor to low human development measured by the HDI for SSA. This also shows that reduction in maternal mortality is indirectly linked to increasing standard of living, life expectancy, and education enrolment and attainment.

Employing both the fixed effect and the two-step system GMM estimation methods and panel dataset on 35 sampled SSA countries for the period 1990 to 2015.

Brief chapter summary

This chapter examined the relationship between human development measured by the HDI and human development in SSA by mploying both the fixed effect and the two-step system GMM estimation methods and panel dataset on 35 sampled SSA countries for the period 1990 to 2015. The empirical analysis based the two step system GMM showed that reduction in maternal mortality is essential for human development in SSA. The study found a negative and statistically significant relationship between maternal mortality.Based on the empirical result the study rejects the hypothesis that there is no significant relationship between human development and maternal mortality in Sub-

Saharan Africa. The study obtained the following thesis based on the findings from the empirical analysis.

- **There is a negative and statistically significant relationship between human development and maternal in SSA**

CHAPTER SEVEN

SUMMARY, CONCLUSION, AND POLICY IMPLICATIONS

7. Introduction

This chapter is the final chapter of the dissertation. It discusses, the summary of the findings, the conclusion, and policy implications based on the empirical analysis conducted using 35 sampled Sub-Saharan African countries. Section 7.1 provides a summary of the key findings of the study. Section 7.2 covers the conclusion of the study. This section discusses how the hypotheses formulated for the study were evaluated and the objectives of the study achieved. The policy implications based on the outcome of the study are also discussed in section 7.3. Section 7.4 and 7.5 also present the limitations of the study and some areas for further studies.

7.1 Summary of findings

The effects of maternal mortality on population development have been a major challenge for policymakers in developed and developing countries. Several researchers, both academic and professional have tried to formulate models and embark on empirical studies to understand the effects and relationships of maternal mortality in relation to its determinants, social and human development. The inclusion of maternal mortality as a specific target in both the Millennium Development Goals (MDGs) and the Sustainable Development Goals (SDGs) call for the need for professionals in the health, demographic development, economics, and academic fields in Sub-Saharan Africa, where the situation is worse to put in more effort for a better understanding of the effects and relationships of maternal mortality in relation to its determinants, social and human development.

The study set three main objectives. The first objective is to investigate the effect of determinants (i.e. socio-economic, socio-cultural, and health or medical) on maternal mortality in Sub-Saharan Africa. To achieve this objective, the study draws insight from the Neighborhood theory by Ellen et al. (2001) and the conceptual model for analyzing the determinants of maternal mortality and morbidity by McCarthy and Maine (1992). The effects and relationships of the socio-economic, socio-cultural, Health or Medical,

and maternal mortality were estimated using Partial Least Square(PLS) Structural Equation Modelling (SEM) approach. The second is to examine the effect of social development on maternal mortality in Sub-Saharan Africa and finally examine the relationship between human development and maternal mortality in Sub-Saharan Africa.

The first object of the study is to examine the determinants of maternal mortality in Sub-Sub, specifically their relationship and effect on maternal mortality. The results from the empirical analysis showed that socioeconomic, medical or health, and socio-cultural determinants have a significant effect on maternal mortality. The socio-economic and social-cultural determinants have both direct and indirect effects. The health or medical determinant has a direct effect on maternal mortality. The size of the effect of socio-cultural determinants on maternal mortality is medium and the size of the effect of socio-economic and health or medical on maternal mortality is large. These results also showed a negative and statistically significant relationship between socio-economic determinants and maternal mortality. There is also a negative and statistically significant relationship between the health or medical determinants and maternal mortality. The results further established a negative relationship between socio-cultural determinants and maternal mortality through the health or medical determinants.

The results of the empirical analysis imply that improving the health or medical, socio-cultural, and socio-economic determinants will reduce maternal mortality. Thus increasing the number of skilled birth attendants, antenatal coverage, contraceptive prevalence rate having improved water source, reducing total fertility rate, increasing gross national products(GNP) per capita income, reducing female unemployment, increasing urban residency, increasing education enrolment and attainment, increasing female skilled workers, increasing female literacy and reducing gender inequality will reduce maternal mortality in Sub-Saharan Africa. The medium and large effect of the determinant indicates that none of these determinants should be left out when addressing the problem of maternal mortality.

The second objective examines the effect of social development on maternal mortality in Sub-Saharan Africa. The study examined the effect of social development on maternal mortality by drawing some ideas from the neighborhood theory by Ellen et al. 2001 and also Sen's (1999) theory on social development as the theoretical framework to achieve this objective. The effects and relationship of social development and maternal

mortality were estimated using the PLS-SEM method. The result of the empirical analysis showed a negative and statistically significant relationship between social development and maternal mortality through reproductive freedom/capability. The results also showed that social development has an indirect effect on maternal mortality, while reproductive capability/freedom has a direct effect on maternal mortality.

The findings of the study also indicated that the size of the effect of social development and reproductive capability/freedom is large. The results of the analysis imply that improving social factors such as adult literacy rate, water sources, human development, mobile phone subscribers, internet users, and increasing public health expenditure by building health infrastructure, training of more health personnel, and procuring modern medical equipment will reduce maternal mortality through reproductive capability and freedom. The result also indicates that improving reproductive capability/freedom through increasing the number of birth attended by skilled personnel, antenatal coverage, contraceptive prevalence rate, immunization and also reducing early marriages will reduce maternal mortality in Sub-Sub-Saharan Africa. The large size of the effect of social development and reproductive capability/freedom suggests that reduction in maternal mortality is driven by social development and reproductive capability/freedom, and these indicators cannot be ignored when considering interventions for maternal mortality in Sub-Saharan Africa.

The third objective of the study investigates the relationship between human development and maternal mortality in Sub-Saharan Africa. This objective was achieved by drawing some insight from the modernization and gender stratification theory. The relationship between maternal mortality and human development measured by the HDI index was examined using the two-step System Generalized Method of Moment (GMM). The result of the empirical analysis on 35 sampled Sub-Saharan African countries indicates a negative and statistically significant relationship between maternal mortality and human development in Sub-Saharan Africa. Thus high maternal mortality levels reduce human development, measured by the HDI index. This also implies that high maternal mortality will contribute to the poor standard of living, reduce education attainment and enrolment and affect life expectancy at birth which are indicators for both economic and social development in Sub-Saharan Africa.

Apart from the major findings, the following findings are also worth noting when addressing the problem of maternal mortality in Sub-Saharan Africa.

Socio-economic and health or medical determinants have a direct effect on maternal mortality in SSA. The effect of health or medical determinant on maternal mortality is greater than the effect of socio-economic on maternal mortality, in terms of magnitude. This greater effect is associated with inadequate health care facilities, the inadequate number of health care professionals with sufficient training to provide required health care services, and poor health behavior on the part of pregnant mothers.

Socio-cultural determinants have both direct and indirect effects on maternal mortality. The indirect effect is significant and greater than the direct effect in terms of magnitude. The high indirect effect of the socio-cultural determinant on maternal mortality through the health or medical determinants is a result of bad cultural practices and religious beliefs associated with the use of modern medical care, female literacy, and gender inequality in accessing medical care in SSA.

Economic development has both direct and indirect effects on the model. The direct effect is on social development and the indirect effect is on maternal mortality. The direct effect is greater than the indirect effect. The greater and direct effect of economic development on social development indicates that high economic development reflects in social indicators such as basic social amenities, communication networks, health infrastructure, and education. This supports the argument of Sen's 1999, that economic growth is key through social development.

The results of the empirical analysis on the 35 sample SSA countries also revealed that political development has both direct and indirect effects. The direct effect is on social development and the indirect effect is on maternal mortality. The direct effect is greater than the indirect effect. The high effect of political development on social development indicates that a democratically elected government in SSA has a higher probability of engaging in social development to reduce maternal mortality in the region.

7.2 Conclusion

The study has examined the relationships and effects of maternal mortality determinants, social and human development in Sub-Saharan Africa(SSA). Three specific objectives were formulated in this study, first to examine the determinants of maternal mortality, specifically the effect of socio-economic, health, or medical and socio-cultural determinants on maternal mortality; to investigate the effect of social development on maternal mortality and finally to examine the relationship between maternal mortality and

human development in SSA. The study sampled 35 SSA countries, a cross-sectional dataset spanning between 2008 to 2015 and a panel dataset for the period 1990 to 2015 were used in the study.

The study examined the effect of socio-economic, health or medical, and socio-cultural determinants on maternal mortality using the neighborhood theory by Ellen et al. (2001) and the conceptual model for analyzing the determinants of maternal mortality and morbidity by McCarthy and Maine (1992) as the conceptual and theoretical justification. The PLS-SEM estimation method was used to examine the effects and relationships of the socio-economic, health, or medical determinants and maternal mortality.

To achieve this objective, the study formulated six hypotheses and responded to these hypotheses as follows.

1. H_1: Improvement in socio-economic determinants reduces the level of maternal Mortality in SSA.

   The empirical results presented in chapter four indicates that there is a negative relationship between socio-economic determinants measured by GNP per capita determinants such as gross national products(GNP) per capita income, female unemployment, urban residency, increasing education enrolment and attainment, female occupation, and maternal mortality in SSA, implying that improving socio-economic determinants by increasing gross national products(GNP) per capita, reducing female unemployment, increasing urban residency, increasing education enrolment and attainment and female occupation will reduce maternal mortality in SSA. Therefore, based on the empirical evidence, this study fails to reject the null hypothesis that improvement in socio-economic determinants reduces the level of maternal mortality. This also means that there is a direct relationship between the socio-economic determinants and maternal mortality in SSA. These results also support the findings of Germ–Wasie (2017) and Azuh et al. (2017).

   Based on the specific objectives, research questions, the above hypothesis, and empirical results, we obtained the first thesis as

Thesis 1: There is a negative and statistically significant relationship between socio-economic determinants and maternal mortality in SSA. We fail to reject hypothesis 1.

2.H_2: Improvement in health or medical determinants reduces the level of maternal in SSA.

The evidence from the empirical analysis also shows that there is a negative relationship between the health or medical determinants measured by skilled birth attendants, antenatal coverage, contraceptive prevalence rate, improved water source, total fertility rate, and maternal mortality in SSA. This result indicates that improving the health or medical determinants by increasing the number of skilled birth attendants, antenatal coverage, contraceptive prevalence rate, having improved water source, reducing total fertility rate will reduce maternal mortality in SSA. These results support the findings obtained from studies by Ahnquist–Wamala–Lindstrom (2012); Pickett–Pearl (2001); Buor and Bream (2004). Therefore, based on the empirical result, this study fails to reject the null hypothesis that improving heath or medical determinants, reduces the level of maternal mortality in SSA. This implies that there is a direct relationship between socioeconomic determinants and maternal mortality in SSA

Based on the specific objectives, research questions, the above hypothesis and empirical results, we obtained the second thesis as

Thesis 2: There is a negative and statistically significant relationship between the health or medical determinants and maternal mortality in SSA. We fail to reject hypothesis 2.

3.H_3 : Improvement in socio-cultural determinants reduces the level of maternal Mortality in SSA.

The empirical evidence from chapter four suggests that there is a negative relationship between socio-cultural determinants and maternal mortality. This relationship is through the health or medical determinant. This means that increasing female literacy reducing inequality in access to health care and increasing the status of women by giving them more opportunities to occupy decision-making positions will improve medical or health determinants such as skilled birth attendants, antenatal coverage, contraceptive prevalence rate,

improved water source and total fertility rate. This means that there is an indirect relationship between socio-cultural determinants and maternal mortality in SSA. Thus, this study fails to reject the null hypothesis that improving socio-cultural determinants reduces the level of maternal mortality in SSA.

Based on the specific objectives, research questions, the above hypothesis and empirical results, we obtained the third thesis as

Thesis 3: There is a negative and statistically significant relationship between socio-cultural determinants and maternal mortality in SSA. We fail to reject hypothesis 3

4. H_4: Increasing the rate of social development, will improve the rate of reproductive Capability/freedom and reduce maternal mortality in SSA

The empirical evidence presented in chapter five shows that there is a positive relationship between social development and reproductive capability/freedom in Sub-Saharan Africa. This means that improving social development indicator as adult literacy rate, water sources, human development, mobile phone subscribers, internet users and increasing public health expenditure by building health infrastructure, training of more health personnel and procuring modern medical equipment will reduce maternal mortality in SSA. The results from the empirical analysis support the argument by Sen,2007, social development is important in improving a woman's reproductive capability/freedom such as having access to quality health delivery services. Therefore, based on the empirical evidence, this study fails to reject the null hypothesis that increasing the rate of social development, will improve the rate of reproductive capability/freedom and reduce maternal mortality. The empirical result also indicates that there is a direct relationship between social development and reproductive capability/freedom and an indirect relationship with maternal mortality through reproductive capability and freedom in SSA.

Based on the specific objectives, research questions, the above hypothesis and empirical results, we obtained the fourth and fifth thises as

Thesis 4: There is a positive and statistically significant relationship between social development and reproductive capability/freedom in SSA. We fail to reject our hypothesis 4.

Thesis 5: There is a negative and statistically significant relationship between social

development and maternal mortality through reproductive capability/ freedom in SSA. We fail to reject hypothesis 4

5. H_5: Increasing the rate of reproductive capability, will decrease the rate of maternal Mortality in SSA

The empirical result in chapter five, suggest that there is a negative relationship between reproductive capability/freedom and maternal mortality in SSA. This means that improving reproductive capability/freedom measures such as increasing the of number birth attend by skilled personnel, antenatal coverage, contraceptive prevalence rate, immunization and also reducing early marriages will reduce the rate of maternal mortality in SSA. This result also supports the findings of Alvarez et al. (2009). Based on the evidence gathered from the empirical analysis in chapter five, this study fails to reject the null hypothesis that increasing the rate of reproductive capability, will decrease the rate of maternal and conclude that increasing reproductive capability/freedom indicators such as increasing number birth skilled birth attendants, antenatal coverage, contraceptive prevalence rate, immunization and also reducing early marriages is key in maternal mortality reduction in Sub-Saharan Africa (SSA). The result also implies that there is a direct ta relationship between maternal mortality and reproductive capability/freedom in SSA.

Based on the specific objectives, research questions, the above hypothesis and empirical results, we obtained the sixth thesis as

Thesis 6: There is a negative and statistically significant relationship between reproductive capability/ freedom and maternal mortality in SSA. We fail to reject hypothesis 5

6. H_6: There is no significant relationship between human development and maternal mortality in Sub-Saharan Africa.

The final empirical result from chapter six shows that maternal mortality has a negative and statistically significant relationship with human development measured by the human development index(HDI) in Sub-Saharan Africa. The results from the empirical analysis based on 35 sampled countries in SSA and a panel dataset spanning between 1990 and 2015 shows that increasing the level of

maternal mortality will reduce human development measured by the human development index (HDI). This also means that increasing maternal mortality by a percentage unit will reduce human development measured the HDI by 0.023 percentage points. The results showed that maternal mortality has a negative and statistically significant relationship with human development, implying that human development in SSA is constraint by high levels of maternal mortality, and reducing the level of maternal mortality will increase the standard of living, increase especially female education enrolment and attainment and improve life expectancy at birth for families in SSA that are affected by maternal death. Therefore, based on the empirical evidence drawn from the analysis in chapter six, the study rejects the null hypothesis that there is no significant relationship between human development and maternal mortality in Sub-Saharan Africa and conclude that low standard of living, low female enrolment, and low life expectancy in the region, to some extent, is contributed by the high level of maternal mortality in the region

Based on the specific objectives, research questions, the above hypothesis , and empirical results, we obtained the seventh thesis as

Thesis 7: There is a negative and statistically significant relationship between human development and maternal in SSA. We reject hypothesis 6

7.3 Policy implications

Governments in the region should improve easy access and use of the health systems and train more health professionals in quality health care delivery. To achieve this, Governments in the sub-region should increase investment in health care infrastructure and also increase the incentive for health staff, especially those in rural communities where maternal mortality is high.

Sub-Saharan Africa, could not achieve the Safe motherhood initiative and the millennium development goals target. The region is still struggling to achieve the Sustainable development goals target. This has become difficult because the region lacks a holistic interventional program that integrates, the socio-economic, health, or medical, and socio-cultural to address the high level of maternal mortality in the region. Governments in the region and the African Union the highest body in the region should design a holistic health policy and also enforce its implementation in the addition to the sustainable development goals to reduce the level of maternal mortality in the SSA region

Political leaders in the region should initiate economic programs that will improve the socio-economic conditions of pregnant mothers and their families. Moreover, governments, opinion leaders, and policymakers should enforce policies aimed at abolishing harmful cultural practices against women in the region. In addition, governments in the region should involve social activist groups, policymakers, stakeholders, and the community in the campaign to reduce the level of maternal mortality by organizing seminars involving women social groups and churches for them to understand their human rights and social justice when it comes to the issue of maternal health

Due to the low economic status of women in the region, socio-economic determinants have become key in maternal mortality reduction, since pregnant women are not able to pay for antenatal and post-natal services, hence increasing their risk of dying from pregnancy and childbirth complications. Governments in the sub-region should implement a free and mandatory health insurance scheme for women when pregnant to help reduce their medical costs to avoid the high risk of complications and reduce the probability of pregnancy-related deaths. These results imply that the Sub-Saharan African countries can increase their human development index proxy for human development if maternal mortality is reduced through the implementation of programs that will increase the income status of women, education enrolment for women, and also increase funds allocated to the health sector, especially maternal health care to reduce pregnancy and childbirth complications. This is because high income and education will result in low fertility rates and maternal mortality.

Education enrolment and attainment are found to increase the status of women, reduce fertility and also reduce the level of maternal mortality in the region. Governments in the region should introduce free and compulsory basic, junior, and senior high school education, especially for female girls, and also include maternal health education in the education curriculum at the basic, junior and senior high school level to create awareness of the effects of poor maternal healthcare especially during pregnancy.

Governments in Sub-Saharan Africa should be engaged in social development projects in the area of health, education and also enhance the provision of basic social amenities for poor communities, where maternal mortality is high. Social development alone is not enough, they should also strengthen the democratic process in the region to promote

economic growth which is made key through social development. In addition, the study also suggests that aside from governments in the region embarking on social development, good governance should also be a priority since it's key in maternal mortality reduction

Contribution to existing knowledge

This thesis adds to the existing literature on the relationships and effects of maternal mortality, its determinants, social development, and human development in the SSA region as follows:

1. On the determinants and maternal mortality
    a) The study adds to the existing knowledge on the effects of maternal mortality determinants on maternal mortality in SSA. Concerning empirical analysis on the effects of maternal mortality determinants on maternal mortality. The study is the first and foremost to examine the effects using the partial least square structural equation modeling approach. The results of our findings showed that socio-economic determinants have a direct effect on maternal mortality. The socio-economic determinants have a birth direct and indirect effect. The indirect effect is through the health or medical determinant and finally, the health or medical determinants have a direct effect on maternal mortality in SSA.

    b) Secondly, the study is the first to add new literature on the relationship between maternal mortality determinants and maternal mortality using the PLS-SEM algorithm. All other studies used ordinary least square regression. The results of our finding indicated that socio-economic determinant has a negative relationship with maternal mortality, health or medical determinants has a negative relationship with maternal mortality, while the socio-cultural determinants have a direct and indirect negative relationship with maternal mortality. The indirect negative relationship is through the health or medical determinants. This is a new contribution to the empirical literature.

    c) Lastly, on the determinants, no study has examined the size of the effect of the determinants of maternal mortality in SSA. The findings of our empirical analysis show that the size of the effect of the socio-economic and the health

or medical is large and that of the socio-economic determinant is medium. These empirical results indicated that the socio-cultural, socio-economic, and health or medical determinants are important when considering intervention to reduce maternal mortality in SSA. This is a new contribution to the empirical literature on maternal mortality in SSA.

2. On social development and maternal mortality.

a) The study adds to the limited studies on social development on maternal mortality, specifically in SSA. This is the first and foremost study that examines the effect of social development on maternal mortality in SSA, which uses the PLS-SEM estimation method, neighborhood theory, and Sen's development theory as the theoretical and conceptual framework to understand the connection between maternal mortality and social development. The empirical evidence drawn from studies shows that social development is important in the reduction of maternal mortality in SSA. This result is new in the empirical literature on maternal mortality.

b) The study has found empirical evidence of the effect of political development and economic development on social development, and the effect of social development on maternal mortality, through reproductive capability/freedom. The study is the first to examine the size of the effects of social development and reproductive capability/freedom in maternal mortality reduction in SSA. The study found that social development and reproductive capability have a large effect. This indicates that social development and reproductive capability/freedom are important in maternal mortality reduction, there is no single study that applies Sen's development theory on reproductive health, in this case, maternal mortality in SSA.

c) This study is a detailed study on the effect and relationship between social development and maternal mortality in SSA, all other studies on maternal mortality estimated the effect and relationship between social development and maternal mortality used ordinary least square regression. This is the only study that examined the effect and relationship between social development using PLS-SEM estimation to understand the direct and indirect interactions between social development and maternal mortality.

3. On human development and maternal mortality

a) This is the most current and up-to-date study on the relationship between human development and maternal mortality in SSA. This is the only study that used the current data set, spanning from 1990 to 2015, and two-step system GMM to investigate the relationship between human development, measured by the human development index, and maternal mortality. This study is the first and foremost study that examines the relationship between maternal mortality and human development, using the gender stratification and modernization theory, as theoretical justification. The empirical results indicate that there is a negative relationship between maternal mortality and human development measure by the human development index, implying that maternal mortality reduction plays an important role in the improvement of human development in SSA.

b) The study adds to the limited empirical study on the relationship between maternal mortality and human development, particularly in SSA. To the best of my knowledge, the only studies in SSA that examine the relationship between maternal mortality and human development by using System GMM which eliminates the bias in dynamic panel data and also addresses the problem of fixed effect and endogeneity of the regressors. In addition, it is also the first study to test for the cross-sectional dependency of the panel dataset used in examining this relationship. The empirical results from this study are new in the empirical literature on the relationship between human development and maternal mortality studies in SSA.

7.4 Further studies

Since the interactions between maternal mortality and its determinants are very important in the implementation of intervention for maternal mortality reduction, further studies could examine this interaction by using hierarchical structural equation modeling estimation technique to understand the relationships and effects at both micro and the macro level. This study examined the effects and relationships between maternal mortality and its determinants in SSA. Future studies can also build models for the different regions in SSA and compare the results if the effects and relationships differ from each other in terms of the regions. These studies could be used to confirm the results from our studies.

Again this study used Amartya Sen's development theory as the theoretical justification to examine the effects and relationship between social development and maternal mortality in SSA. The first to apply Sen's theory to reproductive health in SSA. Future studies could also investigate these relationships and effects by applying other development theories to understand the interaction between social development and reproductive health in SSA.

Finally, the study used a two-step System GMM to examined the relationship between human development and maternal mortality in SSA because of the short period. Further studies could also examine this relationship by extending the period and estimate with other dynamic panel models such as the Autoregressive Distributive Lag (ARDL) which also addresses the problem of endogeneity, heterogeneity, and cross-sectional dependency in panel data.

7.5 Limitations of the study

It is believed that maternal death is under-reported in low-income countries because most of these maternal death occurs in rural settings where there is lack of health facilities with trained health professionals and also incomplete vita registration systems. Data on maternal deaths are also obtained from surveys that are conducted between 2-3 years. Therefore, some of the data obtained on maternal death and other variables from health surveys may be under-reported. However, since these data are obtained from the country's statistical offices and international organizations with appropriate qualified and trained professionals we assumed that these data are reliable and can be used for the empirical analysis. Again, our main is to include more variables and also cover all the 48 countries in Sub-Saharan Africa but because of lack of data on some of these variables we considered only 35countires in Sub-Saharan African countries in our analysis.

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Ref D - Semmelweis „Savior of Mothers" his statue is placed alongside with Hippocrates in the International Museum of Surgical Sciences in Chicago https://semmelweis.hu/english/2019/07/closing-ceremony-of-the-semmelweis-memorial-year-in-chicago/

APPENDIX

Table A. 1 Names of sampled countries categorized by regions

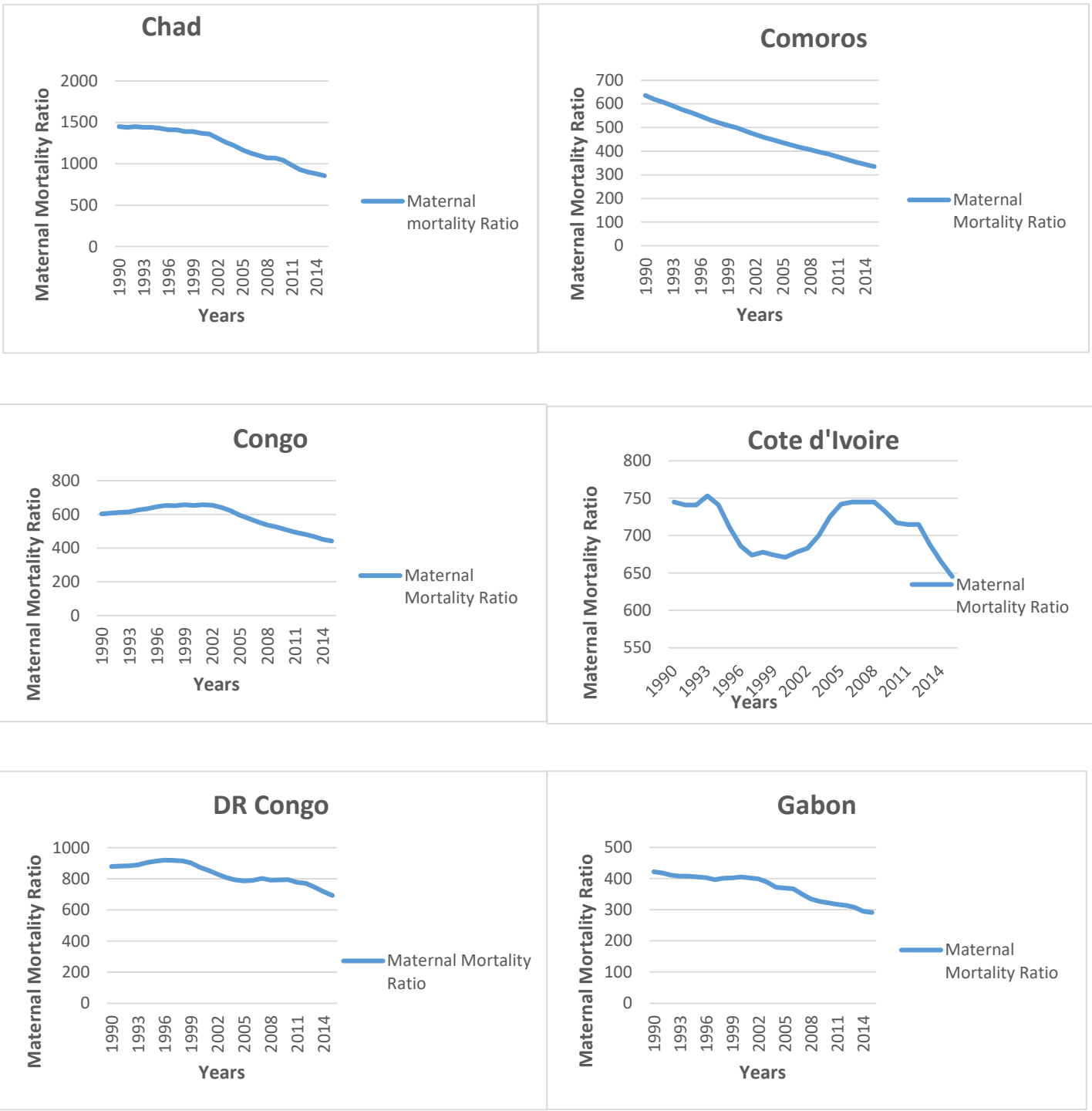
Central Africa (CA)	Easter Africa (EA)	Southern Africa (SA)	Western Africa (WA)
Cameroon	Burundi	Botswana	Benin
Central Africa Republic(CAF)	Kenya	Madagascar	Burkina Faso
Chad	Comoros	Malawi	Cote d'lvore
Congo	Mauritius	Mozambique	Gambia
DR Congo	Rwanda	South Africa	Ghana
Gabon	Sudan	Zambia	Guinea
	Tanzania	Zimbabwe	Guinea-Bissau
	Uganda		Mali
			Mauritania
			Niger
			Nigeria
			Senegal
			Sierra Leone
			Togo

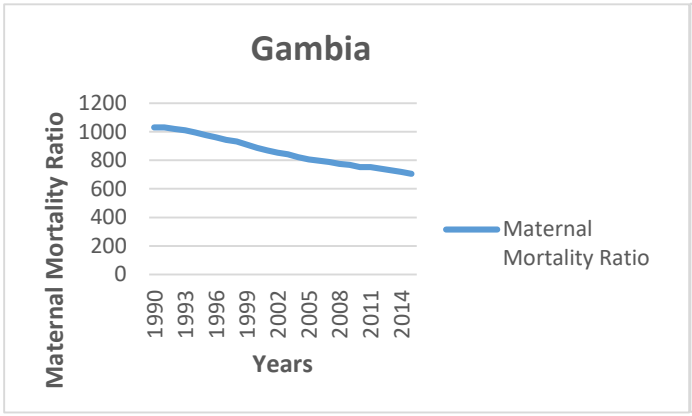
Source: Author(s) own construction

Figure A. 1 Map of SSA regions

Source: Health aid in third world countries (2015)

Figure A. 2 Trend of maternal mortality in the 35 sampled SSA countries

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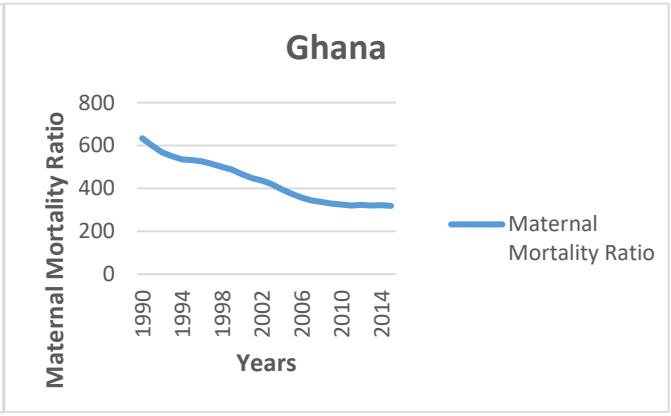
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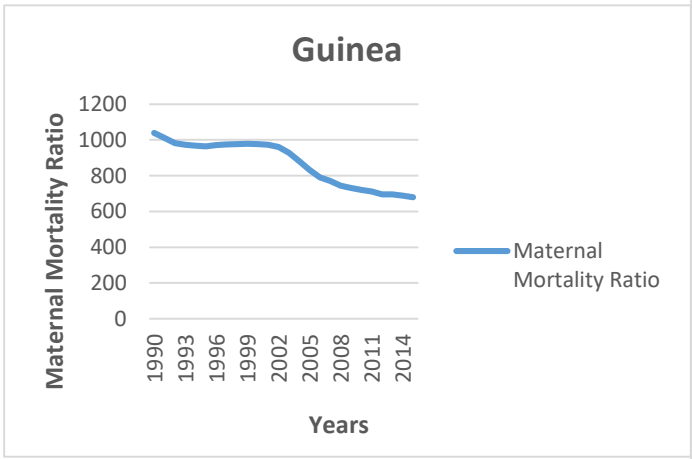
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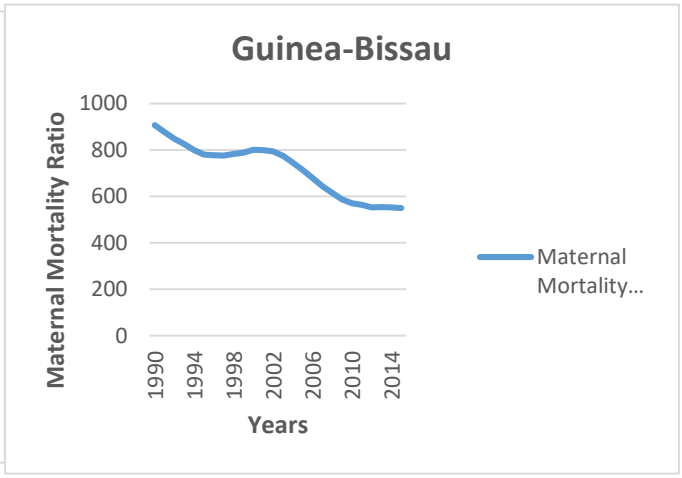
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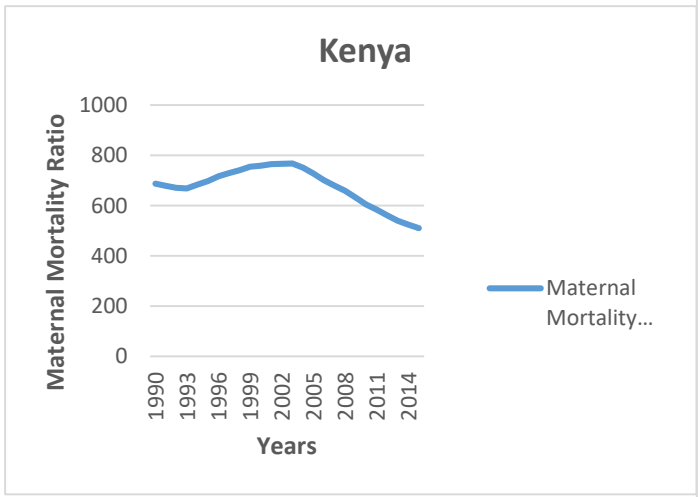
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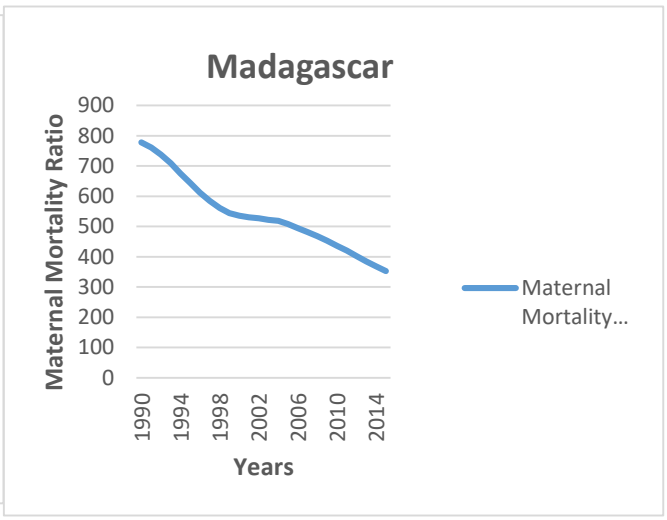
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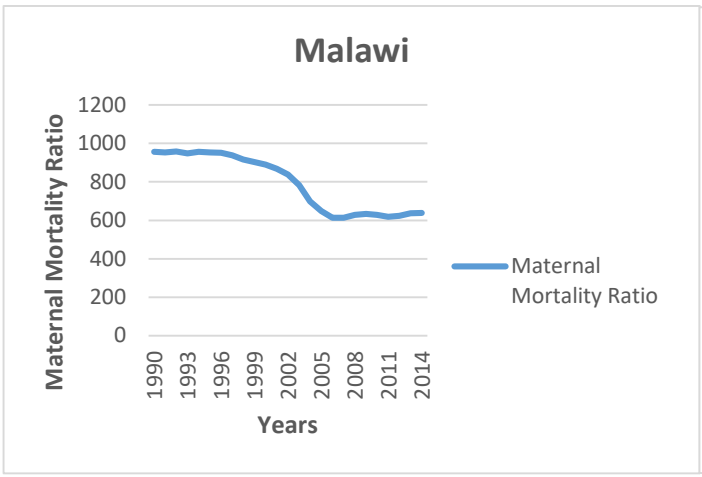
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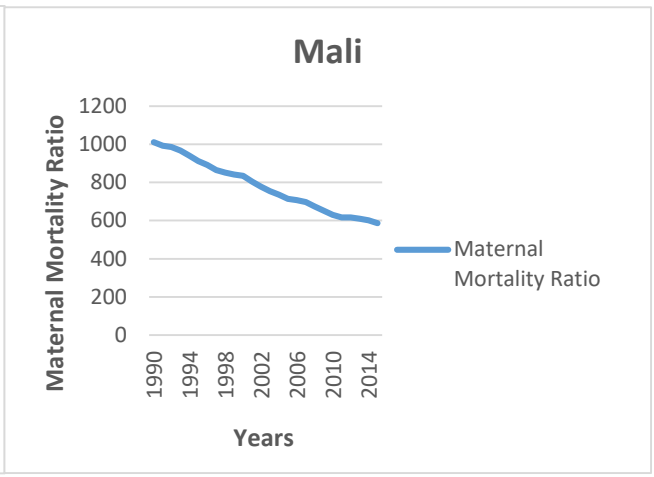
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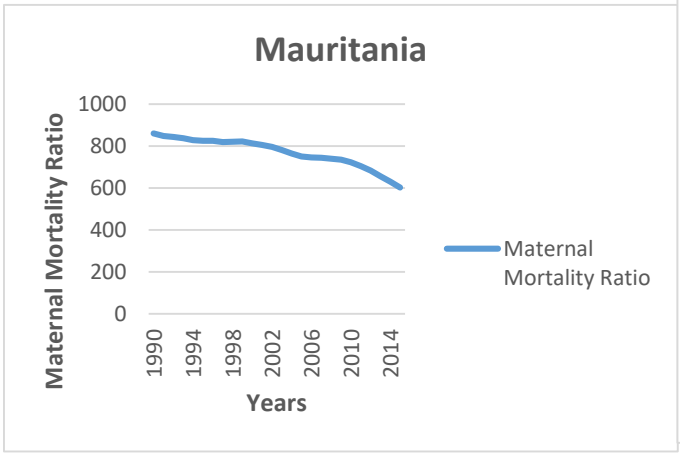
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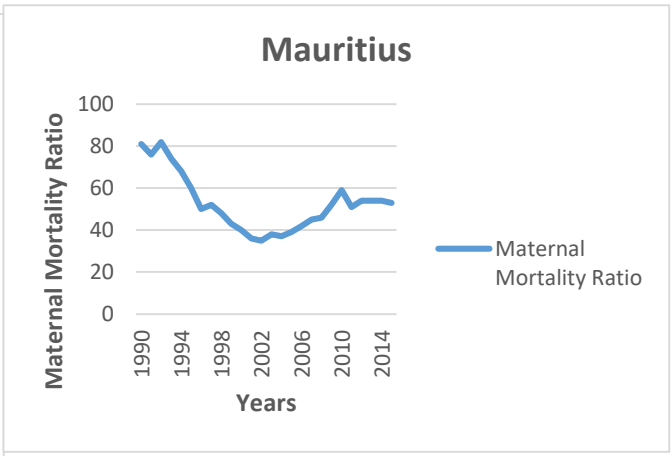
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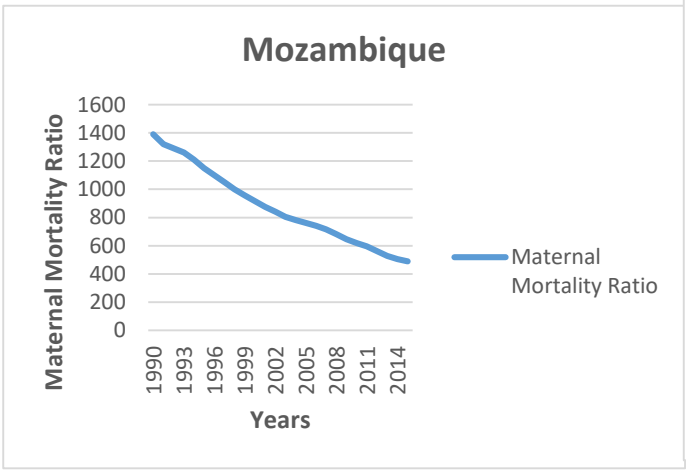
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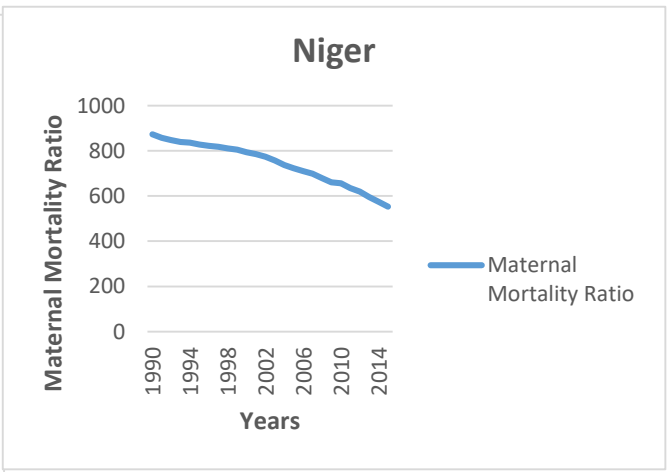
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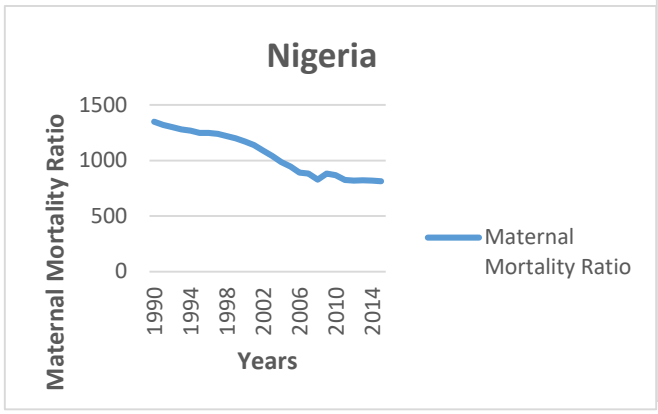
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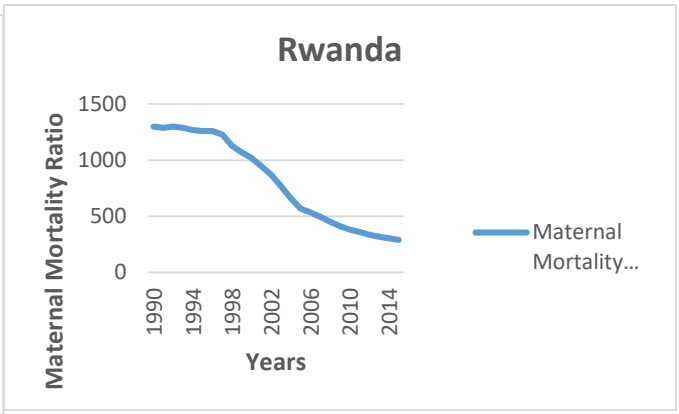
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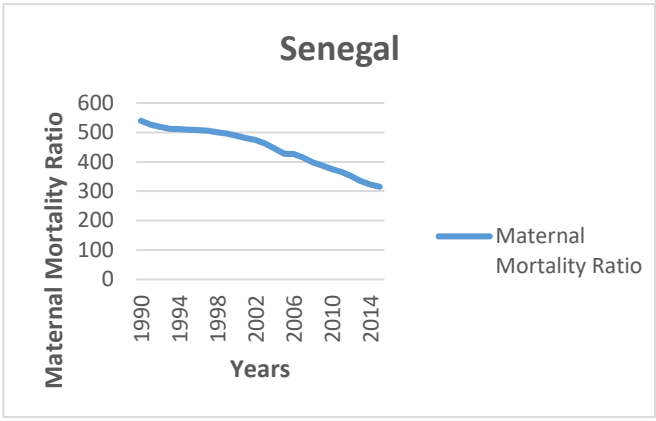
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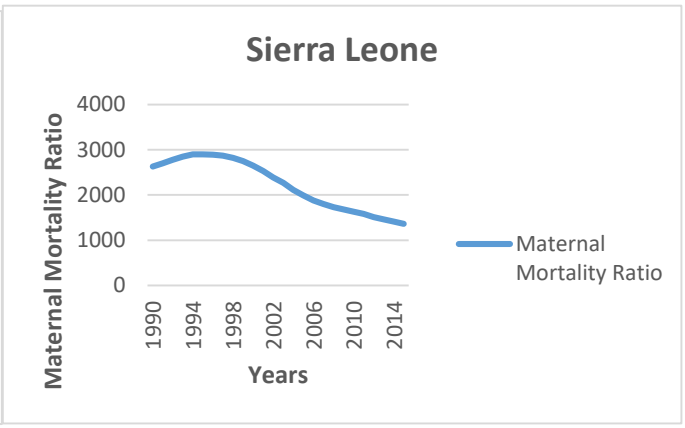
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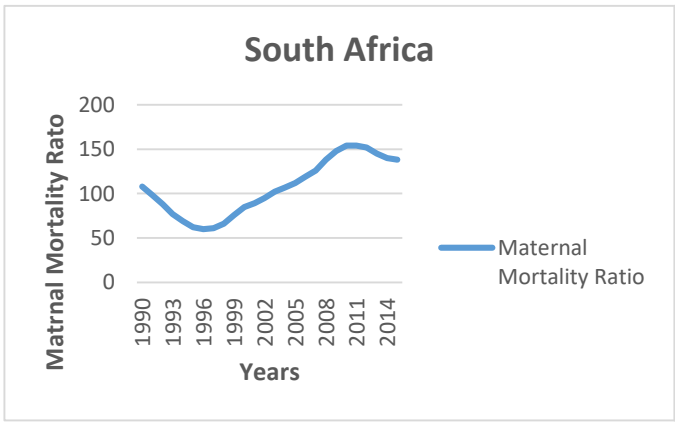
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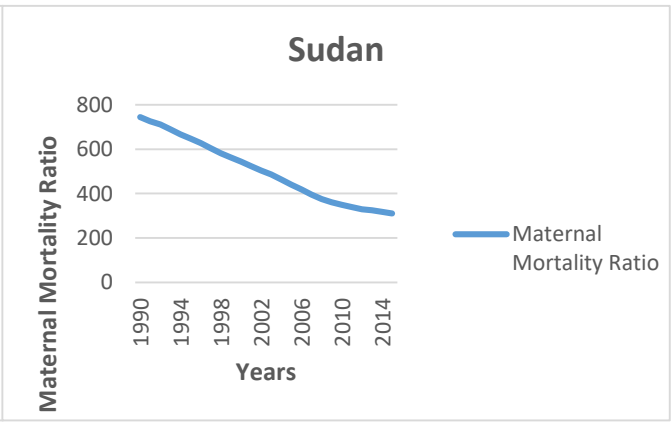
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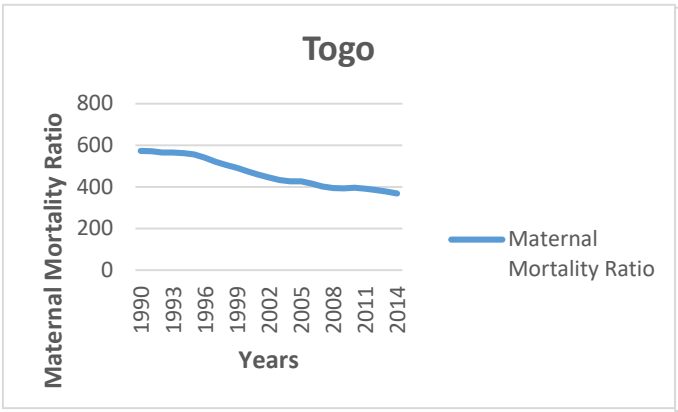
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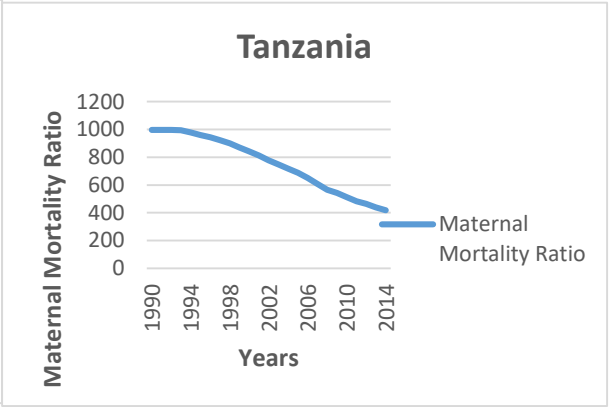
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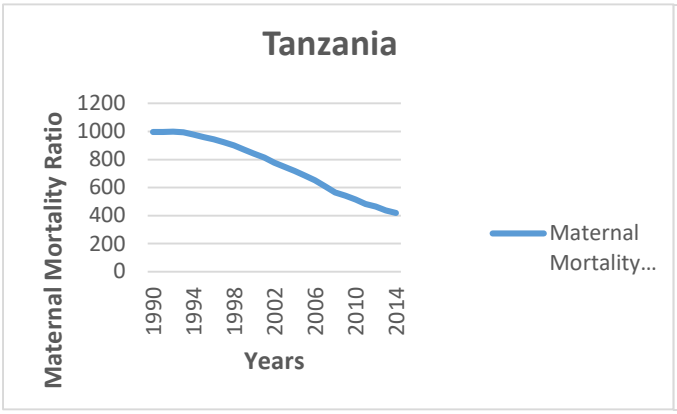
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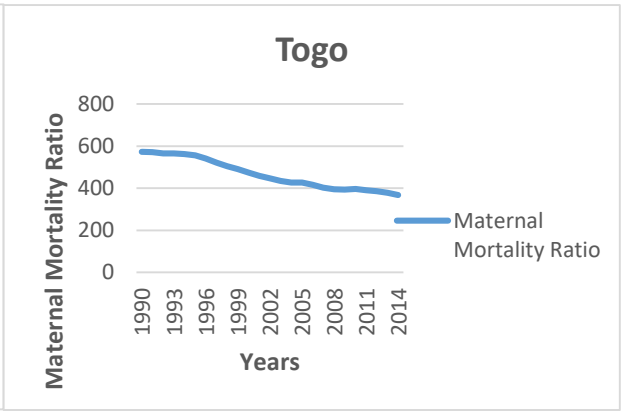
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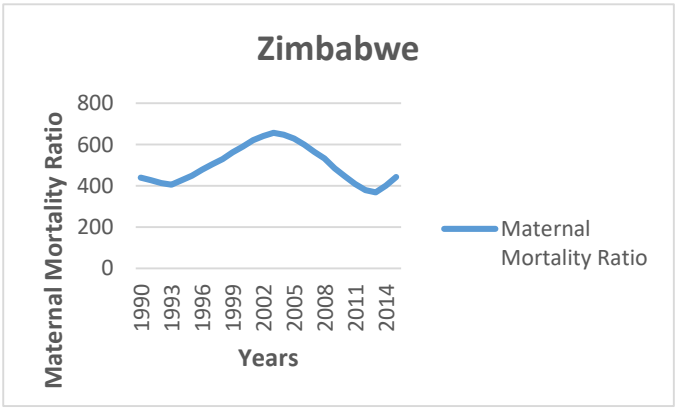
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Figure A. 3 Maternal mortality trend in SSA compared to the world