



ADDIS ABABA UNIVERSITY
SCHOOL OF INFORMATION SCIENCE AND SCHOOL OF
PUBLIC HEALTH
DEPARTMENT OF HEALTH INFORMATICS

**Designing an Integrated Vital Event Registration System in the case of Federal Vital Event
Registration Agency**

Abdi Mekonnen

**A project Submitted to the School of Graduate Studies of Addis Ababa
University in Partial Fulfillment of the Requirement for the Degree of Master
of Science in Health Informatics**

June, 2016
Addis Ababa, Ethiopia

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Dedication

This project is dedicated to my father Mekonnen Terfassa and grandpa Ayis Karageorgadis.

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First of all, I would like to thank God for leading me throughout my life journey and giving me the wisdom and knowledge to finish my study.

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Acronyms

AAMSP	Addis Ababa Mortality Surveillance Program Ethiopia
ACME	Automated Classification of Medical Entities
AIDS	Acquired Immunodeficiency Syndrome
CCVA	Computer Coded Verbal Autopsy
COD	Cause of Death
COPD	Chronic Obstructive Pulmonary Disease
CPR	Central Population Register
CR	Civil Registration
CRS	Civil Registration System
CRVS	Civil Registration and Vital Statistics
CSA	Central Statistical Agency
CSMF	Cause Specific Mortality Fraction
DDBMS	Distributed Database Management System
EDHS	Ethiopian Demographic and Health Survey
ERD	Entity Relationship Diagram
FDRE	Federal Democratic Republic of Ethiopia
FMoH	Federal Ministry of Health
HDSS	Health and Demographic Surveillance System
HIS	Health Information System
HIV/AIDS	Human Immunodeficiency Virus and Acquired Immunodeficiency Syndrome
ICD	International Classification of Disease
IS	Information System
IVERS	Integrated Vital Event Registration System
KA-HDSS	Kilite Awlalo Health and Demographic Surveillance System
MDG	Millennium development Goal
NBoH	National Board of Health
NCDs	Non communicable Diseases
OO	Object Oriented

PCVA	Physician Certified Verbal Autopsy
PHI	Public Health Informatics
PHMRC	Population Health Metrics Research Consortium
PPH	Post-Partum Hemorrhage
PR	Physician Review
RAMOS	Reproductive Age Mortality Studies
RF	Random Forest
RVERA	Regional Vital Event Registration Agency
SAVVY	Sample Vital Registration with Verbal Autopsy
SDG	Sustainable Development Goal
SOA	Service Oriented Architectures
SSA	Sub-Saharan Africa
SSP	Simplified Symptom Pattern
UC	Use Cases
UIP	User Interface Prototype
UML	Unified Modeling Language
UN	United Nations
UNSD	United Nation Statistical Division
VA	Verbal Autopsy
VAI	Verbal Autopsy Interviews
VERA	Vital Event Registration Agency
VR	Vital Registration
VS	Vital Statistics
WHO	World Health Organization

Abstract

Most people in Africa and Asia are born and die without leaving a trace in any legal record or official statistics. The inequalities in registration rates are large; developing countries account for 99% of the estimated 48 million unregistered births, with South Asia and sub-Saharan Africa together accounting for 79% of all unregistered births. Ethiopia is among the countries that have not installed national as well as regional civil registration and vital statistics systems.

The overall objective of the proposed project is to design an integrated Vital Event Registration System (IVERS) for the Federal Vital Event Registration Agency so as to register, birth, marriage, divorce, notification, death and causes of death and certification at national level. This study employed Object Oriented methodology and qualitative cross sectional case study design methods.

User requirement gathering were made through in depth interview and document analysis as major techniques to capture the core business process of the existing manual system. Accordingly, Unified Modeling Language was applied to specify, visualize, construct and document the architecture of a software system. The designed civil registration and vital statistics system registers all births marriage, divorce and deaths, issues birth and death certificates, notifies the authority birth and death from facilities/communities and compiles and disseminates vital statistics, including cause of death information.

The proposed project will have significant impact on the healthcare system, policy makers, legal and administrative users as it is intended to systematically lay a foundation for the implementation of a Civil Registration and Vital statistics system that enables access to easy and much flexible vital event information.

CHAPTER ONE

INTRODUCTION

1.1 Background

Public health decision-making is critically dependent on the timely availability of sound data. The role of health information systems is to generate, analyze and disseminate such data. According to Health Metrics Network Framework and Standards for Country Health Information Systems (2008), in most countries health information systems rarely function systematically. Civil Registration (CR) is one component of the health information system. In the developed world, information on vital events is routinely collected nationally to inform population and health policies. Reliable mortality statistics, the cornerstone of national health information systems, are necessary for population health assessment, health policy and health service planning, program evaluation and epidemiological research (Boerma C. A., 2005).

However, most low and middle income countries have inadequate Civil registration and Vital Statistics Information System (CRVS IS), contributing to the unfortunate situation where many births and deaths are not being registered, described as the “scandal of invisibility” (WHO, 2013). CR is an integrated information system that mainly generates legal, administrative and statistical information that benefits individuals, households, populations, government institutions and non-governmental, regional and international organizations engaged in various socio-economic and other human development endeavors (UNECA, 2012).

The United Nations (UN) defines CR as “the continuous, permanent, compulsory and universal recording of the occurrence and characteristics of vital event provided through decree or regulation in accordance with the legal requirements of each country”(UNSD, 2014 p.65). In 2014, the United Nations Statistical division (UNSD) defined these as comprising “a live birth, death, fetal death, marriage, divorce, adoption, legitimization of birth, recognition of parenthood, annulment of marriage, or legal separation” (United Nations Statistics Division, 2014 p.3).

The main purpose of a CR and VS system is to record the occurrence of key (or vital) events in the lives of the people in a given geographic area. The earliest CRVS was in the form of church or parish registries in Europe (as early as the 14th century) and it monitored births, deaths and

marriages in separate registers. These evolved into civil registries or CRVS in the 19th and 20th centuries (Lucas D, 2003).

Sophisticated computer based techniques of record linkage are now being used in Europe and North America. Most people in Africa and Asia are born and die without leaving a trace in any legal record or official statistic. The inequalities in registration rates are large; developing countries account for 99% of the estimated 48 million unregistered births (UNECA, 2012), with South Asia and sub-Saharan Africa (SSA) together accounting for 79% of all unregistered births (Philip W Setel S. B., 2007).

Absence of reliable data for births, deaths, and causes of death (CoD) are at the root cause of invisibility, which renders most of the world's poor as unseen, uncountable, and hence uncounted. CRVS is nonexistent or incomplete in most of SSA (Yazoume Ye, 2012). In many instances, although Vital Registration (VR) is conducted, there is inefficiency in the compilation of VS, resulting in the scarcity or poor quality of the data generated. As such, statistics regarding adult mortality in SSA are calculated largely using prediction and estimation procedures. In Africa, only the small island states of Mauritius and the Seychelles have complete registration of births, deaths, and CoD (Philip W Setel S. B., 2007). In South Africa and Zimbabwe, studies of death were carried out using CR data of deaths in selected cities (Yazoume Ye, 2012).

Currently Ethiopia's major sources of information on population dynamics (fertility, mortality and migration) are censuses and surveys. CR as source of VS has never existed in Ethiopia. There were only fragmented and non-standard civil status evidence productions such as the issuance of birth certificates. Hence, the primary function of CR systems is the creation and maintenance of legal documents proving the identity of individuals. Since these systems also provide official records of births and deaths, the statistics they produce are essential to understand public-health status in countries and to evaluate possible changes across time. VS generated through CRS is the only source of data for continuous and comprehensive monitoring of public-health programs over time. Our country faces a number of challenges with regard to CRVS, including the large, mainly rural population, and the highly decentralized administrative structures. Prior to 2012, there was no legal framework for CRVS in Ethiopia (WHO, 2014).

1.2 Statement of the Problem

The conventional source for compiling VS is the records of vital events generated through civil registration systems (CRS). However, in situations where CR is either inadequate or deficient, countries' options to data sources other than CR, such as censuses, sample surveys or facility based records are limited. Nevertheless, these provisional data sources only produce estimates on an ad hoc basis and would not provide disaggregated and smaller area estimates that are required for planning for and measurement of national and sub-national development programs. Hence, due to the absence of complete CR, most countries in Africa are unable to provide up to date time series data on population, resulting to discrepancies in the measurement and monitoring of most of the Millennium development Goal (MDG) indicators (Boerma C. A., 2005)

Ethiopia is one of the many African countries that do not have a working CRVS system which, assist various government departments in the country to formulate programs of service and that use and to develop integrated legal and statistical population database that meets national and international standards. There is no universal, compulsory and permanent CR system in Ethiopia (Birru, 2007; Araya, 2012; Ayalew, 2008; Kamu, 2011).

Birth registration is part of a CR system of vital events that also includes marriages and deaths. Births are recorded by hospitals, churches when the child is baptized and municipalities (upon the request of a family). The mere act of recording the birth of a child can be undertaken by hospitals and clinics if this is where the delivery took place. However, not all hospitals and clinics record the births of children and there is no consistency and uniformity in the way they do so (Ethiopia Plan, September 2005). Hospitals and health centers also register births and deaths that occur there and issue certificates. But most of the births and deaths in Ethiopia occur at home. Hence, their contribution for VS is not significant besides, less than 16 per cent of births take place in hospitals and clinics in the first place (Central Statistica Ageny, 2014).

Religions institutions also register baptisms, marriages and burials and provide certificates that serve as evidential support documents for various administrative and legal services. They have no use for statistical purposes because the data is not collected and compiled by the concerned organization. They also don't have legal values related to the recognition and protection of

personal, socio-economic and political rights (prior to 2012, there was no legal framework for CRVS). None of the above registration and certificate issuing administrative exercises has resulted in providing VS data or led to the establishment of a countrywide CR system and VS system (WHO, 2014).

A birth certificate is a legal document issued to an individual by the state to prove that a birth has been recorded. Therefore, birth registration, and the issuing of a birth certificate are two distinct yet interlinked events, wherein birth registration is a prerequisite for issuing a birth certificate in normal circumstances. However, the practice in Ethiopia is to the contrary. The issuance of birth certificates, based on information gathered from other sources (Kebele (local district) identity card, school examination result card, and vaccination card etc.) is the rule rather than the exception. As a result, verification of birth dates is done by different means, including certificates issued by churches and hospitals, testimonials from kebele social courts, vaccination cards, school leaving certificates, kebele IDs and so on (Ethiopia Plan, September 2005). Additional issues that complicate the compilation of valid information on birth are the following:

- the possibility of one person having a number of different birth certificates
- the possibility that even an accurate birth certificate can be contested due to the fact that it was likely to have been issued without reliable verification of date of birth
- the fact that birth certificates are attributed different value and validity when issued from different institutions or from different regions

In conclusion birth registration, as part of CR, is the most accurate way to update population census data collected at ten year intervals. Effective registration that provides detailed information on population growth at every administrative level, from national to local, allows a government to measure not only overall trends in fertility and mortality, but also differentials among population groups and administrative levels (Ethiopia Plan, September 2005). Globally, only about a third of all deaths are registered with age, sex and CoD. The vast majority of these are in developed countries (Philip W. Setel, 2006). Deaths that occur in health facilities or under the supervision of a health worker can be medically certified and coded in accordance with the International Classification of Disease (ICD-10).

Where many deaths occur outside health facilities, verbal autopsy (VA) methods can be used to determine the probable CoD (Vital Events Indicator and Causes of Death, 2013). Cause-specific mortality statistics remain scarce for the majority of low-income countries, where the highest disease burdens are experienced. Neither facility-based information systems nor VR provide adequate or representative data. The development of VR with VA procedures represents the most promising interim solution for this problem. The development and validation of core VA forms and suitable coding and tabulation procedures are an essential first step to extending the benefits of this method (Lu, 2008). Sample Vital Registration with Verbal Autopsy (SAVVY) is one method used to collect vital events data in regions where vital events registration is poor (Sheila S Mudenda S. K., 2011). The implementation of these methods may contribute to the goal of moving from a situation in which no reliable routinely collected VS exist to a long-term goal of having VS derived from CR with high coverage and reliable CoD attribution.

Timely and reliable data on causes of death are fundamental for informed decision making in the health sector as well as public health research. Therefore the proposed system in this study generates information on distribution of causes of death at community level and individual level focused on the potential of using VA in settings where death occur outside the health care system. WHO stated that, four countries presented a case study of their CRVS system progress and strategies, and costed investment plans for their CRVS systems. Philippines is piloting routine VA and considering the most appropriate level of health/community workers to conduct the interview, but have not decided whether or not to use automated coding to ICD causes instead of physician review. Bangladesh is implementing routine VA with automated coding, using health workers and high school graduates as interviewers.

Mozambique is working with research institutions to pilot routine VA in some areas. Ethiopia does not use VA techniques except for few demographic health surveillance systems, which are considered too complex to apply in remote setting (WHO, 2014). This gap in using VA in Ethiopia should be observed in relation to some of the major problems that currently exist in the system among which some are the following (Ayalew, 2008):

- Generating comprehensive statistical report is difficult
- The regionalized and paper-based registration system is inefficient and cumbersome

- Linking the events related to a person is not possible
- Institutions regularly encounter problems accessing reliable data quickly at national and local levels
- The procedure which is manual in nature affects the correctness and reliability of vital event data and
- Manually generating the certificate is subject to errors

Therefore, to fill this gap, this project intends to design a system which will generate information on distribution of causes of death at community level and individual level focused on using VA in settings where deaths occur outside the health care system as well as on vital events like birth, marriage, home death registration and certification where the gap exists in Ethiopia. In general, this project will design a system that integrates and automate the vital registration system including all the four vital events accepted in Ethiopia.

1.3 Research Questions

The following are those questions this project intends to answer.

- What legal, administrative and information related problems exist in relation with vital registration system?
- What business, functional and non-functional requirements are needed in relation with vital registration system?
- How best can an integrated vital registration information system be designed to tackle these problems?

1.4 Objectives of the study

1.4.1 General Objective

The overall objective the proposed project is to:

- Design and develop an integrated vital registration information system (IVERS) for Federal Vital Event Registration Agency (VERA) so as to register birth, deaths, marriage, divorce and causes of death at national level.

1.4.2 Specific objectives

The specific objectives of this project are to:

- Identify the business, functional and nonfunctional requirements;
- Determine legal, administrative and information related problems that exist in relation to vital registration system
- Design integrated vital events registration information system
- Design and implement a prototype system
- Evaluate the system

1.5 Project Scope

According to Ethiopian Federal Democratic Republic Registration of Vital Events and National Identity Card Proclamation No. 760/2012 “vital event” means birth, marriage, divorce or death including adoption, and acknowledgement and judicial declaration of paternity.

The proposed study will be based primarily on VERA level and vital events that have been recognized and enacted on the proclamation (registration of vital events and National Identity Card proclamation NO.760/2012) as main inclusion or exclusion criteria of vital events which means this study will only focus on four of these events including birth, marriage, divorce and death registration and certification.

The study focuses mainly on the design and development of an IVERS on birth, marriage, divorce, death and VA using the Object Oriented (OO) analysis and design method. The main contents of the four major events that shall be registered as particulars of records of birth, particulars of records of death, particulars of records of divorce and particulars of records of marriage defined on proclamation NO.760/2012. For the VA, the standardized WHO VA 2014 questionnaire which includes Prenatal and neonatal (focusing on the newborns below the age of 4 weeks), Child VA questionnaire (focusing on children above 4 week and below the age of 14),

and Adult VA questionnaire (which focuses on people above the age of 15) will be applied as data collection instrument. The 2014 WHO VA instrument contains information on diseases, signs and symptoms, the age and sex of the deceased as well as his or her medical history (if available). To facilitate application in routine (vital event registration) surveillance systems, the 2014 WHO VA instrument was specifically developed to ascertain CoD through automated methods. As a more cost-effective and feasible alternative to physician-coded VA, the WHO recommends the use of automated methods for CoD identification (WHO,2015). This information will be used to assign the causes that led to death. A CoD will be assigned by Tariff method.

Moreover, after the completion of the project, VERA will apply VA by interviewing family members or caregivers on the circumstances leading to death. This could be from witness who/are around the person at time when he/her passed away by using the age dependent questionnaire. Then the information will be analyzed by the developed system to retrieve the underline CoD. Then VERA, will certify and disseminate information about causes of death as per requirement by health managers and policymakers at every level of governance from local to national.

This project explores this issue and endeavors to describe, analyze and document the computational modeling problems associated with the VA process and the steps required to address if computational solutions are to progress. The proposed system will have client server architecture (three tier) for three different kinds of activities around the vital event relating to, recording, notification and registering of the event, birth, marriage, divorce and death (CoD). Since CRVS by definition is multi-sectoral, a variety of actors are involved in the recording, notification and registering of vital events (citizens, health-care workers, doctors, police officers, clerics, and ministries of health, justice and home affairs, for example) and the use of its outputs (such as health authorities, tax authorities and policy-makers). Recording refers to the noting down of all details relating to the event. For example, with respect to birth it will include details relating to the name of the mother, place, type of birth and address. Notification of the event informing the details of the recorded event, which in CoD would also involve details of the CoD, to the authorities responsible for the issue of legal documents will take place after recording and represents the act of official communication of the details of the event to the

authorities (registrar offices) responsible for the issuance of the legal document relating to the event.

Furthermore, the proclamation has also clearly defined the responsibility of FMOH in notifying institutional death and birth. As a result this project will also integrate notification system in settings where many births and deaths take place in health facilities; the health sector may play a proactive role in the notification events. In an effort to build a well-functioning civil and vital event registration system, an interoperable system of notification of births, deaths and causes of death between health sector and VERA is necessary. Registration of the event which involves the issue of the certificate of registration; and generation of VS which involves the generation of aggregate indicators on key health and development indicators by the national authorities. Registration then represents the higher-level function in which the event is legally registered within the CRVS IS. This can be in the regional or national level database, electronic or web-based report which will be considered for the compilation of the VS. The registration then also includes the important act of issuing the certificate of birth, death, marriage and divorce.

1.6 Study significance

To benefit Ethiopia from the opportunity of CR, there were uncoordinated and unorganized administrative attempts that were targeted on the issuance of marriage, birth, and death certificate by different religious institutions and municipalities. One of the major reasons for such uncoordinated effort were the lack of adequate government structure and legal framework for CRVS that hinder to do integrated and sustainable CR and VS systems. However, in the past few years' major diversion in the thinking and practice of CV and VS systems was observed among the judicial bodies as well as policy makers and planners.

Even though there were no mandatory exercises of CR prior to 2012, electronic registration system was designed by few investigators (Ayalew, 2008; Kamu, 2011) and VA validation studies for routine registration system (Araya, 2012). But these systems lack a lot of features to meet the objectives in the Ethiopian setting. The attempted systems were able to handle birth, death, adoption, mirages and divorce events which are not enough details to get administrative, legal, public health services (epidemiological) and to provide complete VS. Furthermore, Federal Democratic Republic of Ethiopia: Ministry of Health (FMOH) (2012) Health Status Indicator

Fact Sheet have revealed that health service utilization is very poor with total outpatient use of government health facilities estimated at 0.25 visits per person per year. Thus, due to poor access to health services and low healthcare seeking behavior, most deaths and births occur outside of health facilities. As a result, birth and mortality data at both health facilities and in communities are lacking. Hence, this work is motivated by the lack of the above features and constrains to have an IVERS in Ethiopia by linking VA and to ascertain CoD in the community and individual level.

The new proposed system design will have significant impact as it is an effort to systematically lay a foundation for the implementation that enables easy and much flexible health information. This can be the generation of information to enable decision makers at all levels of the health system to identify problems and needs, make evidence-based decisions on health policy and allocate scarce resources optimally. Within the domain of public health, data from the CRVS IS are critical, allowing tracking of individual births and building profiles of mortality and causes of death. These data play a fundamental role in planning and monitoring of public health outcomes, for example relating to immunization planning, and monitoring of broader developmental process indicators such as for maternal and infant deaths, sex ratios and fertility rates.

Since the health policy makers and planners will use the proposed system it will help them to ensure enrolment of every child into immunization programs, and VS indicators can be tracked to better support the prevention of avoidable diseases. Moreover, as the system has a notification and death registration VA database, these data also provide rigorous mortality data which are of significant public health concern, including those concerning the Human Immunodeficiency Virus and Acquired Immunodeficiency Syndrome(HIV/AIDS), tuberculosis and malaria.

Moreover, the proposed system will increase birth registration to citizen's development processes other than health, such as relating to social security, literacy and education, law and order, identity and different forms of citizen services. The requirement for a birth certificate for certain services should not impede the enjoyment of rights such as education or health care. A birth certificate can facilitate an individual's access to other identity documents, such as a passport, that are attached to particular rights and benefits. Moreover, where CRVS systems are weak and different sectors are not linked, planning including for health must rely on census data,

which are typically inadequate as they are of decadal frequency and lack the right level of granularity (WHO, 2013).

1.7 Operational Definitions

Live Birth: the complete expulsion or extraction from its mother of a product of conception, irrespective of the duration of pregnancy, which, after such separation, breathes or shows any other evidence of life, such as beating of the heart, pulsation of the umbilical cord or definite movement of voluntary muscles, whether or not the umbilical cord has been cut or the placenta is attached; each product of such a birth is considered live born (all live-born infants should be registered and counted as such, irrespective of gestational age or whether alive or dead at the time of registration, and if they die at any time following birth, they should also be registered and counted as deaths (UNSD, 2014).

Death: “the permanent disappearance of all evidence of life at any time after live birth has taken place (postnatal cessation of vital functions without capability of resuscitation). (This definition excludes fetal deaths, which are defined separately below.)” (UNSD, 2014).

Marriage: “the act, ceremony or process by which the legal relationship of spouses is constituted. The legality of the union may be established by civil, religious or other means as recognized by the laws of each country. Countries may wish to expand this definition to cover civil unions if they are registered; in that case, registered partnership usually refers to a legal construct, registered with the public authorities according to the laws of each country that leads to legal conjugal obligations between two persons” (UNSD, 2014).

Divorce: “the final legal dissolution of a marriage, that is, that separation of spouses which confers on the parties the right to remarriage under civil, religious and/or other provisions, according to the laws of each country. In case a country recognizes registered partnerships, a legal dissolution of a registered partnership refers to the legal final dissolution of such a partnership, according to national laws, conferring on the parties the right to reenter into another partnership or marriage” (UNSD, 2014).

1.8 Organization of the study

This paper is organized in a way that it should provide the readers in easy flow. Therefore, the paper is organized in different chapters. The first chapter of this project presents the overall introduction of the subject matter under study. Chapter two covers the literature reviewed to support the study in general. Chapter three is all about the methodology followed in the execution of the project. The fourth chapter presents discussion of results and the next chapter five is about the system design. The last chapter presents the conclusion and recommendation of the study in general.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

All civilization past and present has common features in compilation of demographics records or data for different motives. The usual purpose of the compilation among the past civilization were in primary to impose taxation, assign military or some other burdensome community services upon those considered to be eligible. The relationship between population, planning and development has a long history which has been well documented back to the 4th century BC in Asia (B.Salawu, 2009). However, the purpose of compiling and keeping records of population in the modern society has moved beyond the imposition of tax and assignment of military duties.

For instance, American registration and VS, introduced by the settlers, were predominantly English, and for the most part followed English customs in the new country (Patrick W. O'Carroll, 2006). They were accustomed to the registration of baptismal ceremony, marriages, and burials, which in England dated back to 1538, when the people who work in religious ministry in all parishes were first required to keep a weekly record of such events. In 1632, the Grand Assembly of Virginia passed a law requiring a minister, official in charge of a prison; from every parish to appear annually at court and present a register of christenings, marriages, and burials for the year. Apparently little or no statistical use was made of such records and there were no thought of using for health purposes (M.Helther, 1997).

Planning thus became the central issue in all known societies no matter their stages of civilization primitive or modern, people plan for population and they need population data for plan. There is a long tradition for registration of vital events and for population statistics in Denmark. Already back in the 16th century events like birth, death and marriage were registered in the church book of every parish (Krogness, 2011). It is possible to find regular statistics on births and deaths back to 1743 and in 1769 the first census was conducted (Carsten Bøcker Pedersen H. G., 2006).

At the early industrialism stages new social institutions needs and advancing knowledge particularly in the fields of health created new demands. For instance, the work of John Snow during the cholera epidemics that ravaged London in the mid-1800s is an early example of an

epidemiological investigation (Friedlander, 2009). Snow's groundbreaking work was made possible by the registers of births and deaths maintained by local authorities in every English parish from the early 1880s. Without information on numbers of deaths from cholera and the street address of each victim, Snow's mapping of mortality in relation to the siting of water pumps would not have been possible (Carla AbouZahr & Ties Boerma, 2005).

In Africa, some countries have histories of CR dating back over 100 years, but in the early years, in the majority of cases the system was intended to serve the interests of the colonizers and therefore lacked the basic elements that drives it to the required coverage and completeness levels (UNECA, 2012). Consequently, most of SSA has very long and uncoordinated history of VR. The first attempt in Nigeria was made in 1863 with Proclamation and regulation. This decree made provision for registration of birth and merge as well as the census of Lagos colony (B.Salawu, 2009). CRVS is either non-existent or incomplete in most of SSA (Yazoume Ye, 2012).

In Ethiopia, provisions for the registrations of vital events were first issued and included in the Ethiopian Civil Code enacted in 1960 (Federal Negarit Gazeta, 1960). The 1960 Civil Code made it compulsory to register births, deaths and marriages. However, Article 3361 of the 1960 Civil Code prohibited those articles pertaining to civil registrations coming into force until an official order was issued. Thus, for several decades, municipalities of big cities and towns had been issuing certificates of births, deaths, marriages and divorces without proper registration anchored in a national law. In 2000, the Revised Family Law (Federal Negarit Gazeta, 2000) was enacted. It had incorporated provisions for the registration of marriages and births. On August 2012, the Federal Democratic Republic of Ethiopia (FDRE) issued the Registration of Vital Events and National Identity Card Proclamation No. 760/2012, referred as the 2012 law, which is a comprehensive and compulsory law on registrations of vital events in Ethiopia (Federal Negarit Gazeta, 2012).

This law repealed Articles 47 to 153 of the 1960 Civil Code, which were provisions on CR that had been suspended indefinitely and therefore never put to any use. As mentioned above, CRVS system did not exist in Ethiopia because the 1960 Civil Code on vital events registration was not functional until 2012.

In today's world, no meaningful socio economic development is visible without adequate knowledge about the population. The role that reliable, timely, and relevant information can play in improving the health of populations is unequivocal (Setel, 2015). Indeed, health outcomes are greatly influenced by bold, informed, and effective health policies and practices, delivered by a health system that makes the most of health resources by maximizing efficiency and promoting greater equality. Alan D Lopez and Philip W Stele (2015) argues that in order to do so , the health system and health policy debates more broadly, rely on a functioning health information system (HIS) that generate critical data when and where need and sufficiently disaggregated to guide policy responses. Additional recent efforts have attempted to identify what information is essential to guide health policy debates and health services delivery. One outcome has been the promotion of a HIS strategy focused on monitoring the effective coverage of key health interventions against the major causes of disease burden in the population.

Likewise, the registration of and documentation of vital events by civil authorities is a key public health function of VSs system. This function, CR or VS ideally serves a dual purpose: first, it meets legal requirements to establish civil status and protect individual rights; second, it should serve as a source of data for informing policy planning. Unfortunately, relatively few VR system produce data suitable for this purposes. Thus, while births are generally registered with sufficient completeness to provide accurate statistics, there are also persistence disparities in death registration and in the equality of medical certification of causes. Data on medically certified CoD are available only for less than one third of over 57 million deaths occurring worldwide annually (Naida Soleman, 2006). Moreover, information on how many people die and which cause is critical for public health decision-making, resource allocation, and programme planning is lacking.

Mortality statistics and CoD data provides essential epidemiological intelligence to guide policy reforms aimed at reducing premature mortality and improving the efficiency and effectiveness of health systems. The timely recording of deaths by cause can provide early insights into trends in disease prevalence, thus helping to design prevention or intervention strategies from public health standpoint (Philip W Setel S. B., 2007; Chalapati Rio, 2004).

In almost every culture and societies, there is association with each event, a religious ritual associated to it birth and baptism marriage and wedding, death and burial service etc. If these events are properly captured by way of recording them on continuous bases, they will provide adequate demographic record or data on which planning can be based. Therefore, vital events registration and VS systems are important for registering of vital events; providing certificates of the occurrences of vital events to individuals; and compiling, analyzing and disseminating VS resulting from the registration process. No other data collection vehicle can generate this essential health intelligence on a continuous basis and in a comparable and disaggregated fashion for the entire population except CRVS (Setel, 2015).

According to the UN recommendation CRVS comprise the process of collecting information on the occurrence and characteristics of vital population events (primarily birth, death, marriage and divorce, but also adoption, legitimation, recognition of parenthood, annulment of marriage, and legal separation); and generating VS through the compilation, analysis, evaluation, presentation and dissemination of data these data in statistical form (Nations, 1998). Strengthening the CRVS system has increasingly become a priority for many countries and the global development community. The formal registration of vital events reinforces the realization of civil, social and political rights by providing confirmation of individual identity and family relationships. CRVS is associated with numerous administrative and statistical benefits for public and private entities and is considered the foundation of modern administrative systems and governance (World Health Organization, 2014).

According to UNSD (UNSD, 2014, p.4) “Vital statistics constitute the collection of statistics on vital events in a lifetime of a person as well as relevant characteristics of the events themselves and of the person and persons concerned”. VS provides crucial and critical information on the population in a country. While, VS is the total process of a collecting information by CR or enumeration on the frequency or occurrence of specified and defined vital events. VS analysis are also helpful for setting targets and evaluating socio-economic plans for informed decision making, monitoring of health and population intervention programmers, and the measurement of important demographic indicators of levels of living or quality of life (UNSD, 2014).

Data for births, deaths, and CoD are essential for planning of services for populations. Data for mortality, particularly for CoD, are needed to set priorities, formulate policies, and monitor and assess such policies nationally and, increasingly, at lower administrative levels. Under sectoral reform programs in many low-income countries, planning, budgeting, and monitoring responsibilities have been decentralized to the regions, provinces, or districts. Yet few data exist at these levels even from survey and the demand for such information is rapidly increasing. International commitments to fight specific diseases are now funded at levels never seen before, and their success is often intended to be assessed on the reduction of deaths due to specific causes. CoD information is essential to guide and inform health policy and priority debates. Ideally, CoD data would be based on accurate medical certification and registration of all deaths (Philip W Setel S. B., 2007).

However, VR systems still function poorly in many countries, particularly in resource poor settings where mortality rates are higher and accurate CoD information is most crucial (Peter Serina, 2015). There continues to be an enormous gap in reliable CoD statistics for the vast majority of low income countries, which experience the highest burden of disease. Neither health facility based information systems nor VR provide adequate and representative data on levels and causes of mortality. The application of VA methods, as part of emerging techniques of community based demographic and mortality surveillance and sample VR, offer the most practical interim solution to this data short fall. The development and validation of core VA forms for pre- and neonatal, child, and adult deaths, and suitable ICD -10 coding and tabulation procedures are an essential first step to extending the benefits of these methods (Philip W. Setel, 2006; Philip W. Setel, 2005)

According to many scholars and development partners' (Health) finding and recommendation, VA is now being recognized as the only feasible alternative to comprehensive medical certification of deaths in such settings (medical certification is incomplete), whereby family members of an identified deceased person provide information about the circumstances surrounding their death. This information can consist of a checklist of symptoms, a narrative description of the process leading up to death, CoD as indicated at a health facility, or any combination of these methods. The WHO has now called for wider use of VA to improve understanding of the causes of mortality and the nature of mortality change in national

populations (Sheila S Mudenda S. K., 2011). Solid CoD data are absolutely essential to well-functioning public health systems. Thus, continuous monitoring of vital events with medical certification of deaths through a CRS is the only satisfactory mechanism. Similarly, monitoring the spread and distribution of non-communicable diseases a growing epidemic in Asia and the Pacific, and other developing regions can only be achieved with reliable VR a system that counts all deaths and reliably certify their causes. However, overburdened health-care providers are not necessarily able to deliver reliable CoD data consistently, and many deaths do not occur in healthcare facilities in low and middle income countries in the first place (WHO, 2013).

Interest in strengthening CRVS has recently augmented, with a number of global and regional initiatives being led by development institutions in partnership with non-governmental organizations, academia and the donor community. Several regions have established effective regional coalitions led by the United Nations Economic Commissions (Africa, Asia-Pacific) or by a WHO Regional Office (Eastern Mediterranean) that have enlisted ministerial support to strengthen CRVS systems (UNESA,2012).

2.2 Civil Registration System in different countries

Analysis, design and implementation CR and VS system have been studied extensively since technology is considered as one part for the advancement of CRS. The following section discusses the use of CR system and reporting systems of mortality statics in the CRVS system of different countries. According to PHMNC and UNSD the best CRVS is mandatory. In addition, it should be complete, in that it registers all vital events and it must provide high quality data in a timely manner. Completeness can be measured by comparing the percentage of recorded vital events with an estimate that has been established independently for that population. Some of the best CRVSs can be found in developed countries and middle income countries of which some of the studies are selected and discussed below based on the above mentioned qualities of CRVS.

2.2.1 The Danish Civil Registration system

Several studies have revealed that there is a long tradition for registration of vital events and for population statistics in Denmark. According to, Pedersen (2011), national registration of Danish residents was first established in Denmark in 1924, where individual information concerning members of each Danish family was registered and updated manually on index cards that area

file containing information on all persons living in the municipality. Electronic data processing was introduced in 1968, with CRS. During the 1970's the register based computerized vital statistics were established and developed by Statistics Denmark. Since, 1871 it has been mandatory by law to complete a death certificate in any CoD and it has been fully computerized and includes individual based data of all deaths among Danish residents dying in Denmark. Moreover, since the start of Danish mortality statistics, all data have been coded in accordance with WHO centrally in the National Board of Health (NBoH). It has been the source for annual death statistics. The coding was not performed by the physicians, who had completed the information when issuing the death certificate. It used to be performed by a limited number of specially trained coders under the supervision of the medical staff of the NBoH. The coding was based on the medical information on the death certificates that were sent to the NBoH after having been inspected by the regional medical officer. By 2002 new principles for coding of causes of death were introduced. It meant that scanned information could be prepared for coding of CoD by an international standard for coding, Automated Classification of Medical Entities (ACME) (Larsen, 2011).

2.2.2 Sri Lankan Civil Registration System

According to Rampatige et.al (2013), registration of deaths in Sri Lanka has been assessed as relatively complete. Currently, around 48% of all deaths in Sri Lanka occur in hospitals. The CR system of Sri Lanka was established in 1867 and maintained by the Registrar General's Department. The registration of both births and deaths was compulsory in since 1897. The death declaration form for Sri Lanka can be considered equivalent to the medical certificate of CoD. This death declaration form is used by the VR office to compile CoD statistics. However, this death declaration form does not use the format of the International Standard Death Certificate recommended by the WHO. Instead, it has three lines to document causes of death: line (a) is for recording immediate cause of death; line (b) is for reporting antecedent and/or underlying cause of death; and line (c) is for reporting other contributory causes.

2.2.3 Mauritius Civil Registration System

Division (2010) points out that, Mauritius CR were started in 1800. Births, deaths and marriages have been registered since then and registration records are available. Starting from November 2001, the registration system has been functioning electronically. A unique identification number for each citizen of Mauritius is assigned automatically at the time of birth registration. Electronic

registration records are transmitted from the Central Civil Status Office to Civil Status Office CSO for coding and dissemination. Moreover, death registration may be made at the CSO within the district where the death occurred or where the deceased last resided. After registration a permit is issued authorizing burial/cremation. Documents needed for the registration include medical certificate on the CoD; birth certificate and marriage certificate of the deceased; and national identity card of the deceased.

2.3 Verbal Autopsy to assert cause of death

The interest of WHO in VA (formerly “lay reporting”) of health data was first demonstrated in a publication by Dr. Yves Biraud in 1956. According to WHO VA Standards (2012), in Europe, before the 19th century, when modern systems of death registration were implemented, designated death searchers visited the households of deceased people to assess the nature of deaths.

The need for untrained reporting of CoD remained in developing countries where there was a lack of medical capacity to produce death certificates for the population. As an alternative, in the 1950s and 60s in Asia and Africa, systematic interviews by physicians were used to determine CoD. Workers at the Narangwal project in India labeled this new technique “verbal autopsy.” During the 1970s, WHO encouraged the use of lay reporting of health information by people with no medical information, leading to development in 1975 of lay reporting forms (Barnaby C Reeves, 1997). Since the late 1970s and early 80s when the introduction to VA Reproductive Age Mortality Studies (RAMOS), Matlab (Bangladesh), and Niakhar (Senegal) questionnaires first emerged, several other questionnaires have been developed for use in research settings and in national or large-scale regional surveys (Byass E. F., 2010).

Many studies revealed that understanding of global health and changing morbidity and mortality is limited by inadequate measurement of population health. With less than one third of deaths worldwide being assigned a cause, this long standing lack of information, almost exclusively in the world’s poorest countries, slowdown understanding of population health and limits opportunities for planning, monitoring, and evaluating interventions.

Furthermore, death registration and cause documentation strongly depend on the socio-economic status of the setting in which death occurs (Edward Fottrell and Peter Byass, 2010; Byass P. ,

2007). In less developed countries, most deaths are neither attended by physicians nor certified medically, so two thirds to three-quarters of the world's information remains outside of any systematic mortality surveillance (Byass E. F., 2010; Philip W Setel S. B., 2007; Naida Soleman, 2006; O. J. Gadabu, 2014).

According to Carla Abou Zahr et al. (2005) a basic prerequisite of any health programme is its ability to state explicitly how many deaths it will prevent and what proportion of the global burden of disease it will address. To fill these missing data gaps, there has been a proliferation of model based approaches to generating global, regional and national estimates of mortality, morbidity and burden of disease. Some of these models are relatively simple; others are complex and based on debatable assumptions and underlying philosophical frameworks.

As UNSD Principles and Recommendations for a VS System (UNSD, 2014) VS are obtained preferably through a CR system, as this is the ideal source from which to derive accurate, complete, timely and continuous information on vital events. In addition, VS derived from the CRS (and the population registers) can include annual flow statistics from the smallest civil divisions, which no other data collection system can provide.

However, in establishing or improving a VS system, first priority should be given to setting up procedures for the registration of live births and deaths. Data on births and deaths are fundamental to the understanding of population dynamics and are directly related to the measurement of key health indicators, such as infant and childhood mortality, maternal mortality and life expectancy (Chalapati Rio, 2004; Corinne L Fligner, 2011).

In the absence of routine death registration, VA method can be used to derive probable CoD. However, CoD data derive from VA are increasingly used for health planning, priority setting, monitoring and evaluation in countries with incomplete or no VS systems (Philip W. Setel, 2005). In some region of the world, it is the only method available to obtain estimates on the distribution of CoD. Currently, the VA method is used at over 35 sites mainly in Africa and Asia (Lu, 2008). Moreover, VA has been used not only to gather data on the CoD structure of certain population, but also in investigation of infectious disease outbreaks and risk factors for certain disease, and in measuring the effect of public health interventions (Naida Soleman, 2006).

Thus, VA is recognized as the only feasible alternative to comprehensive medical certification of deaths in settings with no or unreliable VR systems and non-negligible proportion of the population dies outside of the hospital system (Abraham D Flaxman A. V., 2011). The technique of VA is becoming an increasingly popular and reliable method for the community diagnoses of major CoD in developing countries where VS is lacking completeness. VA has applications in both community based mortality surveillance and in field research. It has been demonstrated to produce valid estimates of cause-specific mortality fractions (CSMFs) in many settings, and has also been integrated into the routine functions of local health authorities (Naida Soleman, 2006).

Methods for analyzing VA seek to predict CoD and/or CSMFs based solely on a decedent's about the circumstances, signs and symptoms leading up to death. The VA is used to collect information on cause specific mortality from bereaved relatives. A VA is a questionnaire administered to the caregivers or family members of deceased persons to elicit signs and symptoms and their durations, and other pertinent information about the decedent in the period before death. The family member's responses can then be analyzed to deduce the true CoD through either Physician Certified Verbal Autopsy (PCVA) or Computer Coded Verbal Autopsy (CCVA) (Christopher JL Murray S. L., 2011; Barnaby C Reeves, 1997).

PCVA typically involves at least two physicians examining each record with adjudication done by a consensus review or by a third physician examining. In recent years, there has been interest in using CCVA to improve inter-observer agreement, consistently and comparatively, and to make the code faster cheaper. A range of methods exists to classification rules from Data. Such rules are quick and simple to apply and many situations perform as well as experts. There are different five types of CCVA method used to automate structured questionnaire: two data driven algorithms, Random Forest (RF) and Tariff; InterVA, an expert-based probabilistic method, King and Lul (KL) and Simplified Symptom Pattern (SSP) (Jordana Leitao, 2014).

Hence, Physician Review (PR), which assigns CoD on the basis of specialist medical expertise, has face validity because of the similarities to medical history taking. It is unlikely to be feasible if VA is widely adopted because it time consuming and requires doctors, who are scarce and expensive resource in most middle income and developing countries. In addition PR is time consuming and has to be carried out by doctors. Furthermore, PR may not be the most valid methods of assigning CoD for population based assignments (Barnaby C Reeves, 1997).

Nevertheless, several VA validation studies reported that the validity of CoD ascertained using VA is affected by various methodological and conceptual factors. Besides, the validity of VA is dependent on its many components and there is a high degree of variability between studies in terms of field procedures, questioners used, CoDs assessed, recall by respondents and metrics performance. Some of the most commonly reported metrics are: sensitivity, specificity, and the CSMF error (the relative difference between the VA and the reference standard CSMFs). Despite the fact that there is no international consensus on benchmark values of validity, a working rule of thumb is to seek a sensitivity and specificity of at least 80% at the individual level, and minimum sensitivity of 50% and specificity of 90% at the population level. Low individual agreement may still produce accurate CSMFs at the population level as long as false positives and false negatives balance each other out. Hence, sensitivity thresholds are set lower than those for specificity. CSMFs were determined as the proportion of all deaths that were attributable to a specific COD (Jordana Leitao, 2014).

A variety of methods have been proposed for VA assignments ranging from PCVA to data-derived algorithms, various application of Bayes' theorem and direct statistical estimation of cause of fractions. Hence, several validation studies on VA cause assignment methods have been published. Results of validation studies to date, however, has been challenged on several grounds as mentioned below:

- First, previously published validation studies compare the CoD for individuals derived from VA to the CoD recorded in hospital records because, quality of record keeping and the laboratory, medical imaging, and pathological services available in many developing country hospitals can be extremely poor.
- Second, many studies start with a community sample and then trace back as many deaths to hospital records as possible. The resulting studies often yield small numbers for many causes, so that published results only cover the convergent validity of VA with hospital assigned (or derived) causes of death for a limited number of causes of death. For example no published information on performance of VA on chronic obstructive pulmonary disease (COPD).
- Third, validation studies often do not provide details on the exact items in the VA instrument, the training of interviewers, the training of physicians for PCVA, the coding

of death certificates completed by physicians for PCVA, or the protocol used to extract a CoD from the hospital records (Christopher JL Murray A. D., 2011,p.3).

2.4 Civil Registration and Vital Statistics in Ethiopia

As mentioned under introduction, conventional CR has never existed in Ethiopia (Ayalew, 2008). The main reason for this was the absence of a comprehensive law that made registration of vital events compulsory. This has changed with the 2012 law on the establishment of a conventional vital events registration. The law paved the way for an accessible, comprehensive and compulsory registration system which would provide citizens with legal documents and accommodate to the needs of the government for a proper and timely statistics from the records of vital events.

Ethiopia is a federated state with nine autonomous regional states and two city administrations the enactment of the 2012 law has given the basic structure to the various vital events registration organs at different administrative levels. Moreover, the enactment of the 2012 law has given the basic structure to the various vital events registration organs at different administrative levels. Accordingly, organs for registration of vital events: VERA(Federal Organ), RVERA (Regional Organ), Officers of Civil Status, Ethiopian Embassies and Consulates, Vital Events on Board Ethiopian Ships and Members of Defense Forces on Active Duty(Federal Negarit Gazeta,2012).

Moreover, with respect to the VS, the existing national office the Central Statistical Agency (CSA) has been the main agency for collection and compilation of official statistics, including VS from population and housing census and household surveys. It is also charged by law to coordinate the country's statistical activities to ensure use of uniform statistical concepts, definitions and classifications nationwide (Federal Negarit Gazeta, 2005). However, the 2012 law (Article 41/3) mentions that CoD and other information should be recorded for deaths occurring in a health institution or if a corpse is brought to it for examination and a certificate be issued to the person having the responsibility of declaring the death for registration. But, there is no provision in the 2012 law for deaths occurring at home it has only mentioned death at prison and boarding school. Even though, most of the events expected to occur at home.

The 2012 law does not provide clear and unambiguous definitions of the vital events. It repealed from Article 47 to Article 153 most of the articles in the 1960 Civil Code relating to civil registration. Moreover the 1960 Civil Code and the 2012 law do not define death. The international definitions given for marriage and divorce are not inconsistent with the provisions in the Revised Family Law enacted in 2001. Besides, definition of death was not included in the 1960 Civil Code or in the Revised Family Law of 2000. The 2012 law only specifies the particulars of the vital events to be recorded (births, Articles 24 and 25; marriages, Article 30; divorce, Article 34; and deaths, Article 38) (Zewoldi, 2013).

2.5 Integration of CRVS with VA

Effective public health practice requires timely, accurate, and authoritative information from a wide variety of sources. The need for rapid access to information to support critical decisions in public health cannot be uncertain (Carla AbouZahr & Ties Boerma, 2005). However, development of such systems requires an understanding of the actual information needs of public health professionals.

Development of effective public health information systems requires understanding public health informatics (PHI), the systematic application of information and computer science and technology to public health practice, research, and learning. PHI is distinguished from other informatics specialties by its focus on prevention in populations, use of a wide range of interventions to achieve its goals, and the constraints of operating in a governmental context. The current need for PHI must focus on speeding and simplifying the conversion of hypotheses about the distribution and determinants of diseases in populations into usable information, and help to disseminate new knowledge in ways that will support public health practices (William A. Yasnoff, 2000). Public health organizations require well-designed information systems in order to make optimal use of the mounting supply of health related data. Organizations rely on these systems to inform managerial decision making and improve operation in areas such as epidemiologic surveillance, health outcomes assessment, program and clinic administration, program evaluation and performance measurement, public health planning and policy analysis. Key design considerations in developing integrated information systems include service based and population based application objectives, units of analysis, data sources, data linkage methods, technology selection and integrated strategies, and information privacy protection.

In addition, the HIS is part of both the health system and the wider statistical system (Carla AbouZahr & Ties Boerma, 2005). However, the range of stakeholders with an interest in CRVS is much broader different government ministries, including justice, education, employment, social insurance and security, contribute to and draw upon integrated CRVS systems. Getting the civil registry, health systems, and VS systems to interact efficiently is difficult especially where there is a lack of effective and comprehensive national CR and VS or system administrative capacity. Integrating the different components is also a technical challenge related to standards, protocols, and data exchange, often requiring institutional agreements across many government departments. For example technically, integration refers to the degree of interoperability and interconnectivity among technical components, and relies on standardization at a certain level. Over the last decades there has been proposed a rich and expanding list of technical mechanisms for integration, from low-level (e.g. database schema integration), middle-level (e.g. middle-ware like CORBA, Web services), to high-level (e.g. Service Oriented Architectures (SOA)) solution.

Furthermore, the integration of healthcare software systems has remained one of the most prominent issues in healthcare software development. Integration is the ability to, share information across systems and organizations automatically to progress toward shared vision. So far there is limited research available examining integration from inter-intuitional perspective. CRVS systems in low and middle income countries are disparate, typically not designed to be integrated, and focusing on one aspect of the overall CRVS process. This is a key challenge undermining both the coverage and quality of CRVS data.

Integrating the different components is a technical challenge related to standards, protocols and infrastructure data interexchange. At the same time, the multi-sectoral nature of CRVS implies that integration is also an equally significant institutional challenge requiring institutional agreements achieved at the level of departments and ministries, and the establishment of governance and coordination mechanisms. Accordingly, the enactment of the 2012 law has given the basic structure to the various vital events registration organs at different administrative levels. Organs for registration of vital events: VERA, RVERA , Officers of Civil Status, Ethiopian Embassies and Consulates, Vital Events on Board Ethiopian Ships and Members of Defense

Forces on active duty. Moreover, there are many different organizations involved in public health. These are organizations not only from the health sector but also from the other sector of the society.

As mentioned in chapter one, in most African and many Asian countries, CR coverage is inadequate and the availability and quality of VS are poor particularly for mortality and CoD. When CR coverage is low, vital events are more likely to be missed in poor, rural and marginalized populations, which tend to have different birth and death rates and patterns of CoD compared with better-off, urban populations. Moreover, in low and middle income countries, integration tends to fail at two levels. First, CR and VS systems are typically separate, hindering the ability to generate VS reports or to carry out data analysis such as profiling of deaths by causes and geography. Second, CRVS systems (separate or not) are typically not integrated with other systems generating relevant data, for example information related to death emanating from hospitals, funeral homes and burial grounds.

However, when CR systems are weak or dysfunctional, alternative methods of data collection on births, deaths and causes of death should be available and can be used on an interim basis to generate national and sub-national estimates of fertility and cause-specific mortality to support decision-making. After going through some developed and developing countries experience on CR and vital events registration and VS system, the following lessons are learned by the researcher of this study as integration methods that can address the bottlenecks:

- Making one central repository of data to ensure quality and integrity, while enabling access to different institutional data owners to ensure data will be updated by different key stakeholder
- The use of proprietary systems in many countries acts as a severe impediment to integration for this reason the study suggests to use open source tools for the implantations
- Internet backbones and connectivity are continuously improving in low and middle income countries, enabling the use of web-based and client-server architecture which, by design, allows for integration in single repositories.

- CRVS systems are composed of various business processes such as recording, notification, registration and the generation of VS. These business processes each have their particular information flows, artifacts in use and applications. The designed information systems interventions must carefully support the flow of information both within the process and also between different entities and information systems that comprise the CRVS IS architecture.
- Linking systems which are naturally distributed, such as a VA carried out in a community within the death certification processes.

As far as the researcher's knowledge and the results of the survey, no resources presently provide comprehensive or exhaustive answers to these questions in Ethiopian context. Many problems appear to be visible hindrances for managing the public health care information system and others administration system. Existing fundamental problems being the motivation for this study there is poor and fragmented data quality which will be solved by designing an Integrated Vital Event Registration System in the case of federal VERA.

2.6 Related works on Vital Registration and Verbal Autopsy

In recent years, there has been interest in CCVA to improve inter observer agreement consistency and comparability and to make the coding of VAs faster and cheaper. Despite its being costly, slow and a non-reproducible, PR is a commonly used method to interpret VA data. However, there is a growing interest to adapt new automated and internally consistent methods. The following studies are done in relation to the VA and VR system.

A study was conducted in Ethiopia in 2008 to launch web based Electronic (Automated) Vital Event Registration System. The study followed Object-Oriented Software Engineering approach to automate vital registration business processes. The electronic vital events registration system is decomposed in to six subsystems in order to reduce complexity in the solution domain of the overall system: 1) Registration interface: enables the users to register vital events, 2) Update interface: enables the users to update personal information, 3.) Report Interface: enables the system to show the report generated by the system, 4) Login interface: enables the system to be accessed by system users. 5) Manage Account interface: enables the administrators of the system to interact with the system in order to administer it, 6) Verification interface: enables the users to

verify birth and death certificates. Furthermore, several tools were used to achieve the desired results of the project. The following are the main software/hardware tools Java 2 Enterprise Edition J2EE platform was used to develop the application, Sun ONE Studio 4 CE Integrated Development Environment (IDE), Java JDK 1.4.1 and MySQL Server 5.0.22 (Ayalew, 2008).

Moreover, another project was initiated to utilize the possible opportunities of automated civil improvement (Kamu, 2011). The general objective of the project was to design and implement enhanced electronic vital events registration system for Ethiopia with specific purposes of: including events like marriage and divorce; designing the system in such a way that it can be accessible through the internet; and designing it to support both Amharic and English languages. Automation of vital events registration systems was done by studies conducted by (Ayalew, 2008) and (Kamu, 2011) including birth, divorce, marriage, adoption and death registration system for Ethiopia.

However, these studies lacks features like appreciation of the public health value of CoD statistics to meet the goal in the Ethiopian context and to the standard of CR systems. To utilize the possible opportunities of automated CR and have a robust and standard CR in Ethiopia, a project to integrate them all is needed. This is mainly due to the lack of both studies to address issues like integrating the whole CRVS information with concerned stakeholder (the establishing of collaborative mechanisms between the ministry of health, national statistics office and local registrars to ensure the collection of better-quality data) ,implementing VA techniques for deaths that occurred at home and were not medically certified, the importance of CoD information, common problems with death certification and CoD data , notification of death and birth form health facility or community and available approaches to improve CoD statistics. Death records are of particular importance in public health, for identifying the magnitude and distribution of major disease problems. Data from these records can be used for epidemiological studies. Since it is unreasonable to expect an immediate implementation of nationwide population-based registration systems in low-income countries, considering other interim options is important. Hence, access and completeness are closely related concepts as events cannot be registered if people do not have access to registration points. As accessibility increases, it is likely that the degree of completeness will also increase. The production of good quality mortality data requires a system in which all deaths are registered (with an assigned CoD) by either the CR or the VS

systems, and that these two systems are integrated; which in turn all deaths are certified using the WHO International Form of Medical Certificate of CoD, and the underlying CoD is correctly coded according to the rules and principles of the ICD-10. Mortality statistics are based upon determining the single underlying cause of death, which is the disease or injury that initiated the sequence of events that led directly to death. It is this underlying CoD that is amenable to preventative public health intervention.

This provided a unique opportunity exploited in this study to investigate the mortality data coverage, patterns and the predictors of mortality in a predominantly rural low-income population to strengthening CR and VS for births, deaths and CoD. In addition, it helps us ensure that all information essential for public health purposes is collected at the time of registration, especially administrative information and information on the important characteristics and circumstances of births and deaths (including CoD) and that such information is compiled and shared with users(key stakeholders). Despite data limitations, it is feasible to link national vital registration and VA data. Data linkage proved a promising method to provide empirical evidence about the quality and utility of rural and urban CRVS mortality data.

Reliable and valid mortality data are key inputs for appropriately aligning a population's health care delivery with its health care needs. Countries need to know how many people are born and die each year and the main causes of their deaths in order to have well-functioning health systems. However, there is a lack of such information in many low and middle income countries, with particular limitations in SSA. In the absence of comprehensive medical certification of deaths, the only feasible way to collect essential mortality data is VA. VA are increasingly used in low- and middle-income countries where most causes of death occur at home without medical attention, and home deaths differ substantially from hospital deaths. The proposed IVERS focus primarily on understanding the leading CoD to certify death at institution level by using Verbal Autopsy Interviews (VAIs).The WHO short-form VA 2014 questionnaire and CR will be integrated for diagnosing out-of-hospital deaths. The study will use Tariff method which was developed by the PHMRC to ascertain COD from VA information. The premise behind the Tariff Method is to identify signs or symptoms collected in a VA instrument that are highly indicative of a particular CoD. Therefore, unlike the former two studies conducted in Ethiopia on CR automation, this study mainly focused on integrating the CRVS and use VA as a means of

identifying the individual CoD in rural areas where majority of deaths occur without medical attention at community level.

Furthermore, a feasibility study conducted in Zambia in 2010 to determine the feasibility of using SAVVY and to pilot implementation of a standardized process for collecting vital events data. A dedicated census was conducted in regions of four provinces chosen by cluster-sampling methods in January 2010. Nearly half (49%) of all reported deaths occurred at home. Subsequently, trained field staff conducted VAI with caregivers or close relatives of the deceased using structured and unstructured questionnaires conducted in the selected provinces. After the interviews, two physicians independently reviewed each VA questionnaire to determine a probable CoD and coded by using the 10th revision of the ICD-10. Results from this pilot study indicate that collection of verbal autopsies to estimate causes of mortality using SAVVY methods is feasible in Zambia (Sheila S Mudenda S. K., 2011).

A VA validation study was conducted in Ethiopia in 2015 by Weldearegawi et al (2015). The study was undertaken in the Kilite Awlalo Health and Demographic Surveillance System (KA-HDSS), which is a longitudinal population-based surveillance system established in 2009. The KA-HDSS, located in northern Ethiopia, has been using PR method to determine CoD and corresponding ICD-10. The investigators used data from the KA-HDSS to measure the agreement in diagnosis between PR and the computer-based InterVA-4 model. The InterVA-4 model (version 4.02) was used to interpret VA data into probable cause(s) of death. The study concluded that, the level of agreement varies across different categories of causes of death, and age of the deceased. Therefore, if the InterVA were used in place of the PR process, the overall diagnosis would be fairly similar. In addition, a study was carried out in Ethiopia in 2012, on Addis Ababa Mortality Surveillance Program Ethiopia (AAMSP) that revolves around four major independent but interrelated activities: death registration at burial sites, sample VAI among bereaved families or deceased's caregivers, hospital patients surveillance, and the community based surveillance of deaths, the Iddir (traditional organization for burial service) surveillance. The investigator explained that the goal of the project was to use a surveillance of burials as a partial substitute for a true vital registration system for monitoring AIDS mortality and the population-level impact of antiretroviral treatment on AIDS mortality via analyses of age and sex specific trends in AIDS mortality with the specific objectives to estimate AIDS mortality

trends in Addis Ababa. Similarly, the investigator conducted this study to ascertain whether physician VA reviewers can accurately diagnose HIV/AIDS-related deaths by routinely reviewing completed VA questionnaires. Also, the study revealed that the data obtained from burial sites in Addis Ababa are fundamentally useful in estimating the causes of death at population-level. The paper concludes that the InterVA model is an easy to use and cheap alternative to physician VA reviews for assessing AIDS-related mortality in countries without VR and medical certification of causes of death (Araya, 2012).

In most African resource-constrained countries, vital registration systems are either absent or dysfunctional (Yazoume Ye, 2012).Ethiopia is no exception. Major sectors and services affected by the incomplete or inadequate nature of civil registration systems include:

- I. Public administration services
- II. Protection of children and women from abuses and exploitation
- III. Administering civil matters and associated criminal cases in courts
- IV. Provision of public health and education services
- V. Provision of current and continuous health and demographic statistics:
- VI. Measurement and monitoring of Millennium Development Goal/Sustainable Development Goal MDG/SDGs
- VII. Provision of epidemiological and other research data inputs (UNECA, 2012)

Improving the monitoring of vital events, and generating representative mortality statistics in low-income countries in particular, will require new techniques, new technologies, and new thinking about sustainable, representative, and reliable systems for registering deaths and determining their causes. SAVVY, by using standardized "verbal autopsy" VA procedures represents a viable mid- or long-term strategy for improving mortality information. Moreover CCVA methods to assign causes of death (CoDs) for medically unattended deaths have been proposed as an alternative to PCVA. In this study, a new approach to death registration, and a set of VA procedures, will be designed and integrated and by adapting WHO 2014 VA questioner (WHO, 2015). The investigator hopes to demonstrate that by automating CRVS data in combination with VA methods to provide evidence based mortality data that will better inform public health.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter outlines the research paradigm, research methodologies, strategies and design used in the study, including procedures for data collection, population and sample selection, data collection tools, data collection and analysis methods, and the design sciences strategies underpinning this project. The chapter also discusses ethical considerations to be considered while executing the project.

3.2 Study setting and area

The study was carried out at FDRE VERA which is found at Addis Ababa. FDRE VERA was established in 2012 with the objective of establishing a system of registration of vital events and issuance of national identity cards to citizens. Currently VERA has a total of 60 employees working under fourteen different core work processes including research and development and information gathering, business process improvement, education and training and technology administration. The study period was from December 2015 to June 2016.

3.3 Study Design

This study employed mixed qualitative cross sectional case study design and OO methodology to design an integrated vital event registration system for VERA. Object-orientation, as the name implies, makes objects the centerpiece of software design while the qualitative design help in collecting primary data from users (employees). It is an appropriate method for designing, and developing application systems, especially large ones in which objects often reflect entities in application systems. The OO methodology is a perspective that views the elements of a given situation by decomposing them into objects and object relationships in the system (Booch, 1994).

Moreover, case study method is a very popular form of qualitative analysis and involves a careful and complete observation of a social unit, be that unit a person, a family, an institution, a cultural group or even the entire community. Case study research is the most widely used in information research and is well suited to understanding the interaction between information technology related innovation and organizational context (Peta Darke, 1998). It is a method of

study in depth rather than breadth (Kothari, 2004). The particular features associated with case studies are variously seen as (Lewis, 2003):

- the fact that only one case is selected, although it is also accepted that several may be
- the fact that the study is detailed and intensive
- the fact that the phenomenon is studied in context
- the use of multiple data collection methods.

Philosophical Foundation

Since the purpose of this study is to identify facts, taught, ideas, and feelings about the current practices of integration of VR System in the case of Federal VERA, this project is based on the philosophy of interpretivism paradigm that adopts the position that our knowledge of reality is a social construction by human actors (Lewis, 2003). Similarly, interpretive research can help computer scientists to understand human thought and action in social and organizational contexts; it has the potential to produce deep insights into computer science including the management of information systems, information systems development and software engineering (Kirsti E. Berntsen, 2004). For instance interpretive software engineering is that the entire research effort focuses on the researcher continuously interpreting data, sources, and results produced by different methods for gathering data and analysis of these requirements. It is the investigator belief that systems development and other research methodologies are complementary and that an integrated multi-dimensional and multi-methodological approach will generate fruitful Information System research results. Therefore, this study applied qualitative cross sectional case study with OO system development approach.

3.4 Sampling Method

The reference population of this project were all organizations ;RVERA (Regional and City administration organ), Officers of Civil Status Ethiopian Embassies and Consulates, Vital Events on Board Ethiopian Ships and Members of Defense Forces on Active Duty having mandate on registration of vital events. The study population was the Federal Vital Events Registration Agency.

3.4.1 Source and Study Population

The source of study population for this project includes all institutions having mandate on vital event registration of Ethiopian population. Since the unit of analysis for the study is the individual level, the study population of this project is employees working at the Federal VERA.

3.5 Study Unit

The study units were all employees/professionals working in the VERA who was participated as respondents.

3.5.1 Sample size

Qualitative research uses non-probability samples for selecting the population for study. In a non-probability sample, units are deliberately selected to reflect particular features of or groups within the sampled population (Lewis, 2003). The main sampling approaches that were used in this study was purposive sampling method: the investigator picks an initial sample, analyses the data and then selects a further sample in order to refine the emerging categories and concepts. Consistently, purposeful sampling takes place when the researcher selects a sample from which the most can be learned (Merriam, 1998). The study is qualitative and applies purposive sampling method, which does not be concerned about the representativeness.

3.6 Method of Data collection

To achieve the objective of this study the investigator performs requirements identification by applying in depth interview and relevant document review techniques. The data were collected by the researcher. To maintain the validity, the data collection of VA interview and observation guiding questions were adopted from the WHO standard 2014 VA questionnaire. According WHO the 2014 WHO VA instrument is designed to be compatible with electronic data collection platforms and automated analytical software to assign CoD. The 2014 version of the WHO VA instrument is suitable for routine use such as vital registration system. The instrument is designed for all age groups, including maternal and perinatal deaths, and also deaths caused by injuries (WHO, 2015).

3.6.1 Interview

The interview is the most commonly used requirements elicitation technique in the qualitative approach (Alan Dennis, 2012). Likewise, many of the methods used in qualitative research were developed to allow investigation of phenomena in their natural settings. Interviews are a part of

most interpretive studies as a key way of accessing the interpretations of informants in the field (Geoff Walsham, 2006). Individual interviews are probably the most widely used method in qualitative research. They provide an opportunity for detailed investigation of people's personal perspectives, for in-depth understanding of the personal context within which the research phenomena are located, and for very detailed subject coverage (Lewis, 2003). It is common to begin by interviewing one or two senior managers to get a strategic view and then move to mid-level managers who can provide broad, overarching information about the business process and the expected role of the system being developed.

The main advantages of interview method of data collection are that direct contact with the users often leads to specific, constructive suggestions, they are good at obtaining detailed information, and few participants are needed to gather rich and detailed data. There is greater flexibility under this method as the opportunity to restructure questions is always there, especially in case of unstructured interviews. Depending on the need and design, interviews will be unstructured, and semi-structured. The unstructured type of interviews allows the investigator to pose some open-ended questions and the interviewee to express his/her own opinion freely. Procedurally, a questionnaire was developed with the primary focus on study of the current system (called the as-is system) and its problems, and envisioning ways to design a new system (called the to-be system) (ANNEXURE.A).

3.6.2 Document Review

There are many helpful documents that do exist in the organization paper reports, policy manuals, user training manuals, organization charts, and forms. They represent the formal system that the organization uses and helps to understand the as-is system. Thus, it is useful to review from each department included in the study with regard to routine data recording forms, compilation forms, processing and reporting form.

3.6.3 Instrument Development

As common with quantitative analyses, there are various forms of interview design that can be developed to obtain thick, rich data utilizing a qualitative investigational perspective (Creswell, 2007). A requirements elicitation questionnaire is a list of questions about the project functional and non-requirements. Typically the questions are organized by feature (business requirement or project objective). Essentially each high-level requirement from the project scope document

should have a list of questions to further refine the business process understanding. The project uses VA questionnaire from WHO 2014 version and self-developed and standardized (as if it address the objective) questionnaire for the qualitative in depth interview guide. The WHO standard questionnaire is selected based on its recent edition and the qualitative interview guide is developed and pretested so that it can address the objective of the study with greater validity and reliability.

3.7 Methods of Data Analysis

Analysis of the interview and document review were done hand in hand in an iterative manner in that the results of the analysis will help to guide the subsequent collection of data as user requirements. An important aspect of data analysis in qualitative case study is the search for meaning through direct interpretation of what is observed by investigator as well as what is experienced and reported by the participant (Creswell, 2003). Likewise, Object-oriented analysis is a method of analysis that examines requirements from the perspective of the classes and objects found in the vocabulary of the problem domain (Booch, 1994).

After the interviews were made with different respondents from different departments, the process of coding and analyzing the qualitative data were made using general inductive approach. The process of data analysis begins manually by using inductive method with the categorization and organization of data in search of patterns, critical themes and meanings that emerge from user (respondent) concepts and insights in addition to reviewed document. The primary purpose of the inductive approach is to allow research findings to emerge from the frequent, dominant or significant themes inherent in raw data (Lewis, 2003). The aim of system analysis and requirement in software development life cycle with qualitative data is to discover patterns, concepts, themes and meanings to look for the relationship they have. After collecting the functional and nonfunctional business requirements, the collected requirements were depicted using Object-oriented design by using Unifying Modeling Language (UML) language.

3.7.1 Thematic analysis

Thematic analysis is a search for themes that emerge as being important to the description of the phenomenon (Dawson, 2002). It is a form of pattern recognition within the data, where emerging themes become the categories for analysis.

3.7.2 Object-oriented design

Each model within a design describes a specific aspect of the system under consideration. The design phase decides how the system will operate in terms of the hardware, software, and network infrastructure that will be in place; the user interface, forms, and reports that will be used; and the specific programs, databases, and files that will be needed. Thus modeling is the central part of the system of all the activities that lead up to the development of good software. The contemporary view of software development takes an OO perspective. OO design is a method of design encompassing the process of OO decomposition and a notation for depicting logical and physical as well as static and dynamic models of the system under design (Booch, 1994). UML is a standard language to specify, visualize, construct, and document the artifacts of software systems, as well as other non-software systems for describing the end products of the design activities. The documents generated in this language can be universally understood and are thus analogous to the 'blueprints' used in other engineering disciplines.

3.7.3 Analysis and Design tools

Front end: HTML5 and PHP will enable the construction of easy and intuitive user interface for accessing the database.

Back end: My SQL it's easy to use, inexpensive database language it can run on a variety of operating system such as window, Linux, and others. It is secure and technical support is widely available on the internet but most of all it supports large databases.

3.7.4 Method for determining Causes of Death

In the past decade, methodological developments in automated methods for assigning CoD for VA have emerged with significant potential for future application in routine national and research data collection platforms. These methods create new opportunities for reliable, timely, and useful cause-specific mortality measurement. VA is used to estimate the causes of death in areas with incomplete vital registration systems. The application of VA methods, as part of emerging techniques of community-based demographic and mortality surveillance and sample VR, offer the most practical interim solution to this data shortfall. Methods for analyzing VAs seek to predicate CoD and /or CSMFs based on a descendant's signs and symptom leading up to death. The signs and symptom for a given death are recorded in an interview with a member of descendant family.

A range of methods exists for deriving classification rules from data. A classification method refers to classes and attributes; in context of VA, classes are validated CoD and attributes are signs, symptoms and data about the deceased which are collected using the VA questionnaire. Such rules are quick and simple to apply and in many situations perform as well as experts. The application of various analytical techniques to derive CoD based on linear and other discriminatory techniques (logistic regression) probability density estimation and decision tree and rule based method (including artificial neural network) depends on the intended use. Moreover, the use of automated VA CoD assignment methods also ensures that CoD are determined in a standard fashion, removing the variability inherent with physician coding of VA. In brief, four main factors influence the choice of the classification method (analytical techniques);

- 1) The purpose of the CoD analysis is the outcome needed to;
 - 1.1 Compare patterns of mortality to inform health policy (multiple causes of death are compared);
 - 1.2 To compare patterns over time or between geographical areas or intervention groups (single or multiple CoD are Compared); or
 - 1.3 Formulate intervention to lower mortality and to allocate resources
- 2) The number validated CoD which can be assigned to each case
- 3) Characteristics of VA data used for analysis (categorical, ordinal and continues)
- 4) Need for a particular classifier rule for analytical technique to be comprehensible (WHO, 2004)

Here with respect to choice of classification method, the key distinction is whether a classifier is required to estimate mortality for several causes or single CoD. When the objective is to estimate mortality from a single CoD, logistic regression should be used. When the objective is to determine patterns of mortality, the choice of the method will depend on the above factors. The classification methods described above are only applicable in a straightforward way when a case is validated as having a single CoD. Using the method on VAs to determine both individual-level cause assignment and CSMFs will greatly increase the availability and utility of CoD. Information for populations in which comprehensive and reliable medical certification of deaths is unlikely to be achieved for many years to come. Since vital event registration system is new in

our country and access to health services is limited and most deaths occur at home. But it is urgently needed for health policies, programs, and monitoring progress with development goals. The proposed project will use Tariff method in order to predict CoD. The Tariff method was developed by the PHMRC to ascertain CoD from VA information. The premise behind the Tariff Method is to identify signs or symptoms collected in a VA instrument that are highly indicative of a particular CoD. The general approach is as follows. A tariff is developed for each sign and symptom for each CoD to reflect how informative that sign and symptom is for that cause. For a given death, based on the response pattern in the VA instrument, the tariffs are then summed yielding an item-specific tariff score for each death for each cause. The cause that claims the highest tariff score for a particular death is assigned as the predicted CoD for that individual. The tariffs, tariff scores, and ranks are easily observable at each step, and users can readily inspect the basis for any cause decision. The tariff for a given cause-feature combination quantifies how uniquely and strongly predictive a given data feature is for a given cause. The tariff for cause i and feature j is calculated as:

$$\text{Tariff}_{ij} = \frac{X_{ij} - \text{Median}(x_{ij})}{\text{Interquartil Range } X_{ij}}$$

where tariff $_{ij}$ is the tariff for cause i , feature j , x_{ij} is the fraction of subjects with cause i for which there is a positive response for item j , median (x_j) is the median fraction with a positive response for feature j across all causes, interquartile range x_{ij} is the interquartile range of positive response rates for feature j averaged across causes. Note that as defined tariffs can be positive or negative in value. As a final step, tariffs are rounded to the nearest 0.5 to avoid over fitting and to improve predictive validity. For each death, we compute summed tariff scores for each cause:

$$\text{Tariff Score}_{kj} = \sum_{j=1}^w \text{Tariff}_{ij} x_{jk}$$

where x_{jk} is the response for death k on item j , taking on a value of 1 when the response is positive and 0 when the response is negative, and w is the number of items used for the cause prediction. It is key to note that for each death, a different tariff score is computed for each of the possible causes.

At present, methods for evaluating VAs have either been expensive or time consuming, as is the case with PCVA, or they have been computationally complex and difficult for users to implement in different settings. This has inhibited the widespread implementation of VA as a tool for policymakers and health researchers. Tariff overcomes both of these challenges. The researcher have chosen Tariff method because the method is transparent, intuitive, and flexible, and, importantly, has undergone rigorous testing to ensure its validity in various settings through the use of the PHMRC gold standard VA training dataset (Spencer L James, 2011).

3.8 Dissemination of the result

Aat the end of the project, user test was done on different aspects of the integrated vital registration system so as to ensure the user friendliness of the system andthe result of the study was communicated to Addis Ababa University and Ethiopian Vital Events Registration Agency.

3.9 Ethical Consideration

Ethical clearance was obtained from Addis Ababa University ethical clearance committee and the VERA management board to conduct the study and to seek support of professionals of the selected institution where the study will be conducted.

The Belmont Report articulated three main ethical principles on which standards of ethical conduct in a study are based: beneficence, respect for human dignity, and justice (Polit& Beck 2008: 170).

In relation to the project topic (Vital registration information system, methodology and the design), the ethical issues addressed in this study are presented as follows.

Autonomy: Is negotiating and acting under the direction of the negotiation (Ehrlich, 2007). Individuals have the right to choose and thus the right to know about the personal consequences of joining a study. In this study, participants were informed about the right to decide voluntarily whether to participate in a study or not and were also informed that there will not be any risk or penalty prior to the data collection.

Informed consent: Involves giving participants adequate information regarding the research to enable them to comprehend the information, and have the power of free choice, enabling them to voluntarily consent to or decline participation (Polit, 2008). Both verbal and written informed consent will be obtained from the study participants before they were interviewed by the data collectors.

Beneficence: Is the ethical obligation to maximize benefits of the study participants and to prevent harm (Polit, 2008) Participants in this project were treated well. The research is aimed at producing results beneficial to the population and different sectors; in this case VERA, Ministry of Health and Statistical Agency.

Confidentiality: Confidentiality is a pledge that any information obtained from participants will not be publicly reported in a manner that identifies them and will not be made accessible to others (Polit, 2008). Confidentiality and anonymity of the participants and their information will be secured by using codes and not the respondent's names throughout the study, so that the respondents would not be identifiable. The questionnaires were also kept in a secure place where only the principal investigator could access them.

Justice: Is the right to fair treatment and the right to privacy (Polit, 2008). Any benefit, if there are, should be fairly distributed among the study participants. Participant's privacy was ensured throughout the study by conducting the interview in a private room.

CHAPTER FOUR

DISCUSSION OF RESULTS

4.1 Introduction

This chapter will outline the proposed system, the business process, the functional and non-functional requirements definition; use cases and system architecture are presented.

4.2 Requirement Analysis

As already stated, the resulting solution was required to automate the manual existing record system of VERA with additional functionalities. So providing integrated, timely, reliable, relevant and accessible information to VERA and key stakeholders were the aim of this requirement analysis. After the interviews were made with different respondents from different directorates and external consultant (VERA), departments, the process of coding and analyzing the qualitative data was made using general inductive approach (See interview questions under Annex B). The primary purpose of the inductive approach is to allow research findings to emerge from the frequent, dominant or significant themes inherent in raw data (Dawson, 2002). Microsoft office excel tool is used to organize in a table that can be sorted by respondent id, question number, response and code. Initially, respondent identification number is given at the top of the first page of the interview questioners or question responses. After giving respondent ID, a three column table was created. The first column is for the respondent ID number, column two is for the question number, and column three is for the response. The next task done was coding and analyzing the data question by question. Coding is a process for categorizing the data which involves the production of initial codes manually. To categorize is to arrange things in a systematic order. Within each category, search for subtopics was made. Appropriate contexts that convey the core theme of the category was selected. The categories may be combined together when the meanings are similar. The researcher went through the data looking for things relevant to answering the research questions. The raw data were read and in detail so the researcher is familiar with the content and gains an understanding of the themes and details in the data. Coding was made by using priori and inductive coding approaches. A priori codes are

codes that are developed before examining the current data and inductive codes are codes that are developed by the researcher by directly examining the data.

There were also emergent codes that are becoming apparent while review is made. These were identified and added to the table, and codes are given for each. The step followed from this is finding themes, patterns, and relationships across the categories and summarizing them question-by-question to illustrate key themes in each question. Based on the data coded and summarized, the various summaries and findings across multiple data sources are synthesized. Some response segments are unrelated with any category and these data were not assigned to any category, in other way there were responses which were not relevant to the research objectives.

After passing such steps using inductive analysis approaches, the findings of the interviews are discussed, analyzed and interpreted in the following manner. The leading categories developed are presented in each topic before the data is analyzed. The main categories derived from analysis that are linked with the problem at hand are:

Main function for each department

The current organizational structure of VERA has fourteen different departments that the director-general which shall be supported by two deputies. Operational directorate deputies will be responsible for core activities, while the other will cover administrative responsibilities. Among the core business activities are directorate of data capturing and supplies, directorate of ICT, directorates of research and system development and directorates of education and training are under deputy general director of VERA Operation Directorate. The proclamation also provides VERA to ensure effective implementation, coordinate and support the registration of vital events at national level, and to centrally organize and keep records of vital events.

Readiness on integrated Vital Information System VERIS

As per the interviewees mentioned there is no integrated information system in the agency. A frequent comment made by senior director and experts that the vital event registration system should be interoperable with other government systems such as the national identity databases card, FMOH and CSA to generate legal, administrative and statistical information. The proclamation has also clearly defined the responsibility of FMOH in notifying institutional death

and birth. In addition other aspects raised in this category, the new system should be accessible from woredas, regions and federal institutions through internet for example to notify birth and death in community and health facility. Where internet access is available, should be able to access data directly, once it has been aggregated and individual identifiers removed. When data are brought together in an integrated data repository (database), key stakeholders can query the data online, download and manipulate the data, and produce outputs that are most relevant to their needs.

Inputs and outputs of the current information system VERA

As per the respondents, the 2012 law specifies the particulars of the vital events to be recorded in the occurrence of key (or vital) events are births, marriages, divorce, and deaths. After a birth, death, marriage and divorce has been registered, the information must be processed and forwarded to the agency responsible for compiling data from the individual records and for analyzing the statistics (aggregated data). Regarding at document flow and documentation, kebele civil status officers have to transmit vital events records to regional and federal VERA, through wereda and/or zone offices, and then a copy is transmitted to CSA for compilation of the data. As the law requires that the three detachable copies of the registration forms have to reach the RVERAs within 30 days of following the date of registration. It is a requirement that the vital events registration agencies at federal, regional and kebele offices should keep the registers indefinitely.

It is in consideration that there will be a permanent and secure archiving system for the paper-based records at VERA, RVERA and kebele civil status office; until such time that an acceptable, safe and efficient digital archiving is implemented. All possible measures will be put in place to keep records containing personal information, whether they are paper-based or digital, safe and secure.

Availability of Information Communication Technology (ICT) infrastructures in VERA

Regarding this topic, most interviewees mentioned, that information communication technology, ICT infrastructure refers to the physical hardware used to interconnect computers and users. According to most participants currently there is no ICT infrastructure that can support computer network and application software's between VERA and RVERA. In order to establish the

electronic system, VERA need to introduce ICT infrastructures; communication equipment that would help to build a network. The network will support vital events operations converted into automated functions and links woredas, regions and federal governmental institutions.

Problems on the existing vital event registration forms

As per VERA directors, senior experts and external consultant there is no problem on the existing registration and certification form in terms of content or variable capturing. From the respondents' perspective, forms are critical aspects of ensuring coherence at all administrative levels and standard forms allow the aggregation of data from the kebele to the national level, and for comparisons to be made over time and across administrative areas. However, most of the respondent raised their concern on manual recording that is recording data on the formats are very time consuming, subject to error, difficult to amend since civil status officers have to transmit vital events records to regional and federal registration organ. Consequently, manual information recording format sample are taken to identify data items included in each type of registration form to include in IVERS automation.

Method for identifying CoD for a given Client and Community

As per the respondents medical certificate were chosen to ascertain CoD for a given client with their respective reasons. Hence, most of the senior experts have agreed on VA with its respected interim solutions to certify death at community level. In this category linkages were made between lack of mortality data and VA. These shows how certain vital events may fail to be registered and medically certified. All participants agreed there is lack of mortality data and CoD for deaths that have occurred at home or at community and which were not medically certified.

Additional information or features that the new system incorporates

The most commonly requested services that should be added with the IVERS are report system and CoD ascertainment. There is no system or supporting ways for data analysis in the existing manual system.

4.3. The existing system and problems with the current recording System

The straightest forward and the most commonly used requirements analysis strategy is problem analysis. Problem analysis means asking the users and managers to identify problems with the as-is system and to describe how to solve them in the to-be system. According to the users in VERA, birth, death, marriage and divorce, are to be mandatory, which serve the minimum requirements to start civil registration.

The declarant or register should report immediately to the office /local registrar/ and the registrar request the register ID card, evidence for the occurrence of the event for instance a medical certificate or personal evidence. After the event is registered according to the evidence and additional information collected from the register, the registrar issues the certificates. In addition the task of registering vital events will be the duties of the lowest administrative levels (kebele/woreda). According Article 2/8 of the 2012 law requires the registration of vital events to be carried out at the kebele level which is the lowest administrative government structure unit in both urban and rural.

The kebele office managers are responsible to register manually the vital events on paper based forms. In all organizational concepts described above local registration units are responsible for registration task. One of the key features of the kebele offices is that they are easily accessible to the population living within their boundaries in terms of distance. Most of these offices are located at walking-distances to the households living within their boundaries. VERA will use two types of registration methods to register vital events active and passive registration methods. Registers of civil status to be used by a region are already prepared by the VERA in collaboration with the regional VERA; it will be distributed to all administrative offices as soon as possible to start registration nationally in July at national level simultaneously. The RVERAs have already incorporated vital events functions in existing structures of kebele and wereda offices (lower district level governance or structure).

Each registration form will be accompanied by three detachable hard copies bearing identical particulars attached to a counterfoil. In addition Wereda offices could also play an important role in the vital registration process, in particular by providing document movement logistics support,

and monitoring and evaluation of the operation. Hard Copies of the record will be detached from the main form and will be sent to the concerned organs as follows;

- I. Where the registration of a vital event is completed, the officer of civil status shall send three copies of the registration form to RVERA within 30 days following the date of registration.
- II. The RVERA will send two of the copies of the registration form it has received in accordance with sub-article proclamation to VERA (Federal) within 30 days following the date of receipt and
- III. VERA shall send one of the copies of a registration form it has received in accordance with Article 45(7) to the CSA within 30 days following the date of receipt. Where the remaining hard copy of registration form will be kept at VERA (Addis Ababa) the department responsible to organize data entry will be Directorate of data capturing and supplies. Critical analysis of this system reveals that it is a system prone to a lot of errors and it is not effective. As reported by the different directorate directors, external consultant and experts of the VERA the problems faced by existing system are described as below:
 - Difficulty in maintenance of records when mistakes are made or changes or corrections are needed, often a manual transaction must be completely redone rather than just updated.
 - Editing of data becomes a tedious job as information is stored in different places and may even require additional resource. Where the correction affects all copies of the registration form, the officer of civil status shall give notice of same to all bodies which have already received such copies.
 - Recording vital event data on the formats are very time consuming.
 - Sending the copy of the record from local registrar to the concerned organ (structure) manually/through traditional approaches is subject to loss and delay of records.
 - Lack of mortality data and CoD for deaths that have occurred at home and which were not medically certified
 - Difficulty in data recording, corrections in particulars entered in a register of civil status, other than those involving clerical mistakes, may not be corrected except by virtue of a judgment given by a court.

- Federal and regional governments regularly encounter problems accessing reliable data quickly at national and local levels, reduction in sharing information (demands for reliable local area statistical data) and citizens' services.
- No security of data.
- There is no notification system to notify the occurrence of the birth and death at the community and health facility to ensure that all information is captured into the civil registration process.
- Lack of efficiency and manpower.
- Lack of creating demand for vital event records.
- Uneasy channel for monitoring and evaluation.
- High data redundancy.
- Data inconsistency (accidentally switches details and end up with inconsistency in data entry or in hand written orders).
- Duplication of data entry, room for errors, miskeying information.
- There is no central repository of data
- Large ongoing staff training cost.
- System is dependent on capacity or skills of individuals.
- Time consuming and costly to produce reports.
- Duplication of data entry
- Generating comprehensive statistical report is difficult;
- Manually producing the certificate is subjected to errors and forgery

4.3.1 The Proposed System

The literature review conducted provided a base to consider the possible opportunities, limitations, principles, and current status of vital registration generally. To identify the requirements, interview and document review has been conducted. The agency has recently established directorates which are delegated for establishment of vital events registration system according to 2012 proclamation on vital events and national identity card. According to the 2012 proclamation, seven vital events (birth, marriage, divorce or death, and includes adoption, and acknowledgement and judicial declaration of paternity) are to be registered mandatory, which serve as initial requirements to have continuous, permanent and compulsory civil registration.

According to VERA officials national vital registrations will be launched in July 2016 manually at a national level. In addition, the task of registering vital events will be the duties of the lowest administrative levels (kebele/woreda). The requirement elicitation has also showed that VERA doesn't have as such well-studied anticipated output from vital registration.

Considering the result of requirement elicitation, integrated of vital events registration systems, in the context of the country, and anticipation of experts, requirements of the proposed system are set. To understand their needs from the new system the basic process of analysis involves three steps:

1. Understand the existing situation (the as-is system)
2. Identify improvements
3. Define requirements for the new system (the to-be system)

The introduction of the proposed system is to design an integrated VRVS information system which in the case of VERA is a web based system adding the following functionalities to the already present/old system.

- Add, change, correct and update data and events relating to individuals and check entered data for errors and correctness;
- Capture live birth, and death events in settings where many births and deaths take place in health facilities, The health facility notifies for both events occurred within the health facility by using notification system integrated in the new system
- Provide data for external institutions, health(epidemiological), legal administrative and statistical purpose, i.e., for verification of a child's birth date and someone's death;
- Automated issuance of certificate, the system issues a certificate electronically at a time of registration quickly;
- Generate vital statistical report as per stakeholders needs;
- Provide reliable mortality statistics and predict CoD at individual level by identifying signs or symptoms from a VA instrument. Information on adult mortality is essentially non-existent in Ethiopia particularly from rural areas where access to health services is limited and most deaths occur at home the system will provide mortality patterns information.

Data were collected and analyzed to obtain representative input requirements to design the new system. Based on the results of the analysis main themes functions for each department, integration existing inputs and outputs of the current information system ICT infrastructures, CoD for a given client, and additional features that the new system incorporates are assessed, interpreted and devised. This system will be used to record birth, marriage, divorce, death, CoD management system, notification, certification system, and report generating system. The new proposed system reduces errors and help proper documentation for each and every step of vital registration and certification process. This means that, it has to ensure that vital event records are correctly maintained, that report is correctly given at the local district and national, and generate aggregate report. Moreover, the system is used to ensure a national birth and death registration and thereby obtaining certificates for all the citizens throughout the country. It is as well imperative for the government for a sensible operation of local self- governance.

4.4 Requirement Specification

The functional requirement of the system is concerned with the functionality that the system should provide to users. This functional requirement specification for the IVERS has been identified from VERA's officials and senior experts and external consultant (managing director) point of view. It helps that IVERS, perform correctly and reliably its intended functionality and most of them had a very good idea of the changes they would like to see. The investigator has used questionnaires and document analysis; both are easily capable of soliciting a wide range of information from a small number of respondents. Functional requirements were identified from the following thematic categories;

- Descriptions of data to be entered into the system
- Descriptions of operations performed by each screen
- Descriptions of work-flows performed by the system
- Descriptions of system reports or other outputs
- Who can enter the data into the system
- How the system meet applicable regulatory requirements

4.4.1 Functional Requirements definition

This system is designed to enable users to collect vital event records such as birth, marriage, divorce, death, predict CoD, notification of death and birth form facility and community and printed certificate can be issued during the registration time. The functional requirements definitions are listed as follows.

Table 4.1: Functional Requirements list

Requirement ID	Requirement	Mapping to IVERS system Component	Use case
RQ_1	The system shall support the management of system, actors' relationship, authenticate and authorize users to provide different levels of privileges to actors and key stakeholders to share records and the database.	Application Layer: Admin UI Presentation Layer: Admin UI	UC_1
RQ_2	The system shall enable the identification of different users and their roles authenticate and authorize users.	Application Layer: n UI Presentation Layer: Admin UI	UC_2
RQ_3	The system enables recording of vital event registrations via the web-based and transfer information to central cites or agencies.	Application Layer: Admin UI Presentation Layer: IVERS UI	UC_3
RQ_4	The system shall enable notification of birth and death that have occurred in settings where many births and deaths take place in health facilities, via the web-based and transfer information to central cites or agencies.	Application Layer: Admin UI Presentation Layer: IVERS UI	UC_4
RQ_5	The system shall support update amendment of registration records and change vital event records via the web-based as well as enables corrections in particulars entered in a register of civil status, other than those involving	Application Layer: Admin UI Presentation Layer: Admin UI and IVERS UI	UC-5

	clerical mistakes, may not be corrected except by virtue of a judgment given by a court or details which type of errors registrars can correct and which can only be amended following a court ruling.		
RQ_6	The system shall give registrar, health extension worker professionals the ability to assign COD by conducting WHO verbal autopsy instrument to care givers to assess or gather information on cause of death. And should be linked to routine use (Vital registration system where routine information system). The form has to be designed for all age groups, including maternal and perinatal deaths, and also deaths caused by injuries.	Application Layer: Admin UI Presentation Layer: IVERS UI	UC_6
RQ_7	The system shall predict CoD by using verbal autopsy information, to measure causes of death that have occurred at home without any medical attention. As well the system shall provide information on a mortality statistics which is essentially non-existent in Ethiopia particularly from rural areas where access to health services is limited and most deaths occur at home.	Application Layer: Admin UI Presentation Layer: IVERS UI Database Layer: IVERS UI	UC_7
RQ_8 -	The system shall provide or issue certificates for registered events, up on request.	Application Layer: Admin UI Presentation Layer: IVERS UI	UC_8
RQ_9	The system shall provide verification and authentication of vital event certificates or records	Application Layer: Admin UI Presentation Layer: IVERS UI	UC_9

		Database Layer: IVERS UI	
RQ_10	The system should enable system users to generate daily, weekly, monthly, yearly report based on the collected data and information ports based on users query	Application Layer: Admin UI Presentation Layer: IVERS UI Database Layer: IVERS UI	UC_10
RQ-11	Data requirements of the system The system has a database with search capabilities.	Application Layer: Admin UI Database Layer: IVERS UI	UC-11
RQ-12	Business Rule and logic Only users and key stakeholders allowed in a system can have user name and password to access the database	Application Layer: Admin UI Database Layer: IVERS UI	UC-12

4.4.2. Non-functional requirement

The non-functional requirements describe user visible aspects of the system that are not designated to the functional behavior of the system. They span on a number of issues from user interface to security issues, operational, performance and cultural and political factors and legal requirements that affect the system. In a nutshell the basic non-functional requirements for the VERA IVERS can be viewed as follows:

Security

Since the system is going to handle personal information which is confidential, it should be protected from an unauthorized users and intruders. On this point, it should be noted that it is generally considered that although identification data is shared between the citizen concerned and the government bodies, the civil register data is however generally viewed as representing private data. No one can log into the system without a registered user name and corresponding password. Moreover the system adopts encryption techniques to avoid the tapping of the data while in transfer. Personal data, in particular name, geographical information and contact

information about the respondent, should be kept separate from the epidemiological data and ideally be encrypted to protect privacy and ensure confidentiality. Additional measures to anonymity the individual record may be subject to the legislation in force. A common case-ID in the person identifiable VA dataset and the diagnostic VA dataset will allow data linkage between personal and diagnostic data upon formal request in line with national and international regulations.

Organization and Human Resource

In order to support the automation process, the manual procedures may need to be changed partially or completely. The consequence of this may be the disappearance of some manual functions and the introduction of new ways of working. But doing this may need to conduct business process re-engineering; for instance, restructuring the organizational structures of the agencies that have been responsible for hardcopies transfer and archiving department.

4.4.3 Hardware System Requirement

This section describes the hardware components and software requirements needed for effective and efficient running of the system.

Table 4.2: Server Side Hardware Requirements

COMPONENT	RECOMMENDED
CPU	2Quad Core Intel® / Core i(X) or Xeon processors at 2.33 GHz – 3.5 GHz Series Processor (implementing 64 bits architecture)
Hard	TB SAS disk array at 10k rpm (3 TB).
DVD-ROM	48 DVD+/-RW
Memory	From 12 GB up to 64 GB
Screen/Video adapter	17" Flat Panel
Backup streamer	Digital tape streamer with the same capacity as the total disk space
Network Interface Card (NIC)	1GB, Network card supported by the network installed 100 Mbps for best performance
Number of users	15000 to 17000 users available access the system. Database Engine with 2,200 to 3,600 users easily to manage.

Table 4.3: Client Side Hardware Requirements

COMPONENT	RECOMMENDED
CPU	Intel Pentium (R) Dual Core CPU ES400 2.33 GHz / 2.49 GHz processor
Hard disk	160 GB SATA
RAM	2 GB or more of RAM
Screen/Video adapter	A monitor with a resolution of 1024 × 768
Network Interface Card (NIC)	Network card supported by the network installed 100 Mbps for best performance
Printer	Windows compatible printer

Table 4.4: Client Side Software Requirements

COMPONENT	COMPONENT
Operating System (OS)	Windows Server 2003/2008 64bit (Server edition is required for networks with > 10 workstations)
Microsoft.NET Framework	NET 3.5 SP1 is a requirement for SQL Server 2008 when you select Database Engine, Reporting Services, Master Data Services, Data Quality Services, Replication, or SQL Server Management Studio

Table 4.5: Server Side Software Requirements

COMPONENT	COMPONENT
Operating System (OS)	Window XP /Vista/7 Anti-virus program Licensed (updated)
virus program	Licensed (updated)

4.4.4 System Architecture

Architecture is an artifact for early analysis to make sure that the design approach will yield an acceptable system. Architecture holds the key to post deployment system understanding,

maintenance, and mining efforts. In short, architecture is the conceptual glue that holds every phase of the project together for all its many stakeholders. The architecture chosen for the system is three tiers. The first layer runs on the client side, the second layer at the middle layer and the third layer will be the database system. The system will run using web applications technologies. This architecture provides greater application scalability, high flexibility, high efficiency, lower maintenance, and reusability of components. Since each tier runs on a separate machine, it improves systems performance. According to Ayale(2008) distributed client-server architecture is a software architecture designed around the concept of distributed processing and data storage. In each region, a task is divided between a back-end (database management system), which is responsible for data manipulation, and a front-end subsystem, which accesses specific data from the database. By allocating subsystems to hardware nodes enables to distribute functionality and processing. It also helps to solve issues related to storing, transferring, replicating, and synchronizing data among subsystems.

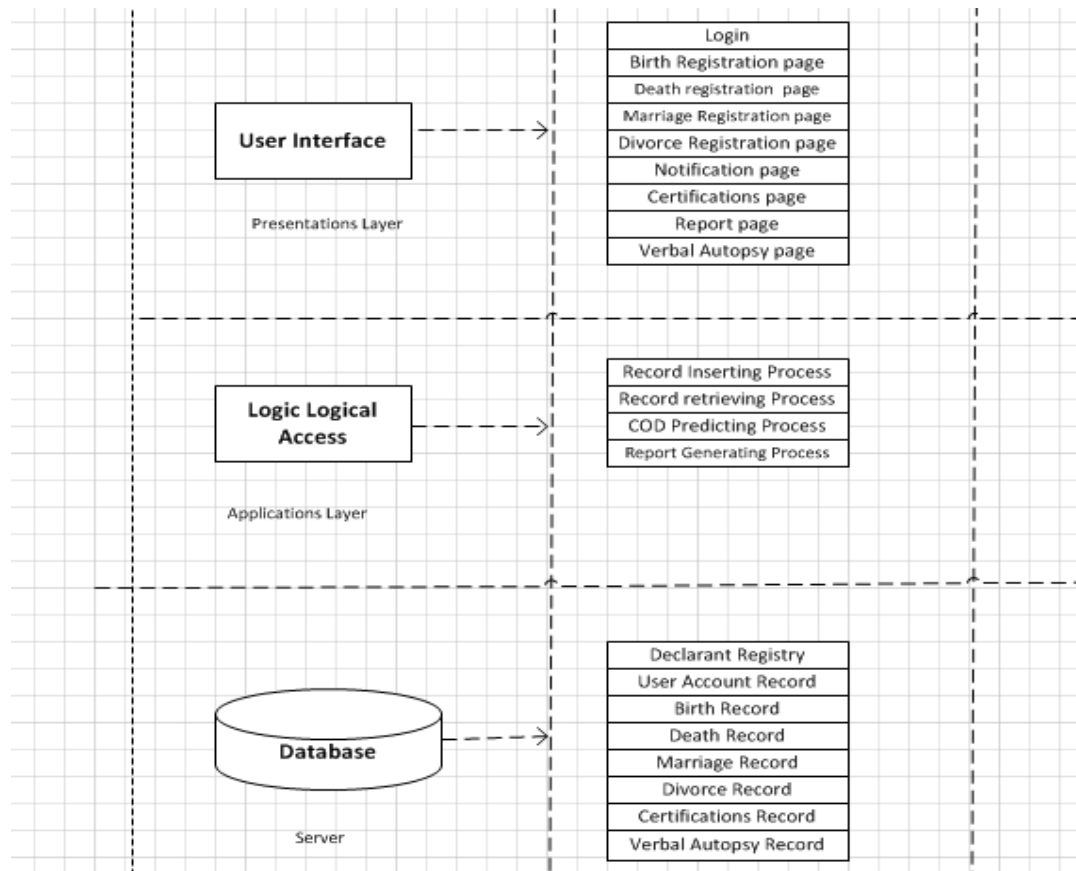


Figure 4.1: System Architecture

4.4.5 Use Case detail description

Use Case model is used to specify the functionality of a system from the point of view of the business users. A use case describes a sequence of actions that provide something of measurable value to an actor and is drawn as a horizontal ellipse. Each Use Cases describes a logical task that may be performed by the system. The Use Case description describes the interaction between the system and the outside world. That interaction may be an online transaction where the Actor is a human user. An Actor is a person, organization, or external system that plays a role in one or more interactions with system. Actors are drawn as stick figures. Associations between actors and use cases are indicated in use case diagrams by solid lines. An association exists whenever an actor is involved with an interaction described by a use case. Associations are modeled as lines connecting use cases and actors to one another, with an optional arrowhead on one end of the line. The arrowhead is often used to indicating the direction of the initial invocation of the relationship or to indicate the primary actor within the use case. System boundary boxes (optional). A rectangle around the use cases, called the system boundary box, to indicate the scope of a given system. Anything within the box represents functionality that is in scope and anything outside the box is not. Finally the Use Case may describe a piece of background or batch processing, when the Actor is often depicted as a time event; in this case, the dialogue with the outside world tends to be minimal, perhaps just one or two steps. The study will focus on online Use Cases with a human Actor, since they are usually more common and contain more complex conditional flows. In the proposed system, the following use cases were identified:

- Manage Account
- Login
- Register Event
- Notify Birth and Death
- Update client vital status information
- Conduct Verbal Autopsy interview
- Predict CoD
- Issue Certificate
- Verify Certificate
- Generate reports

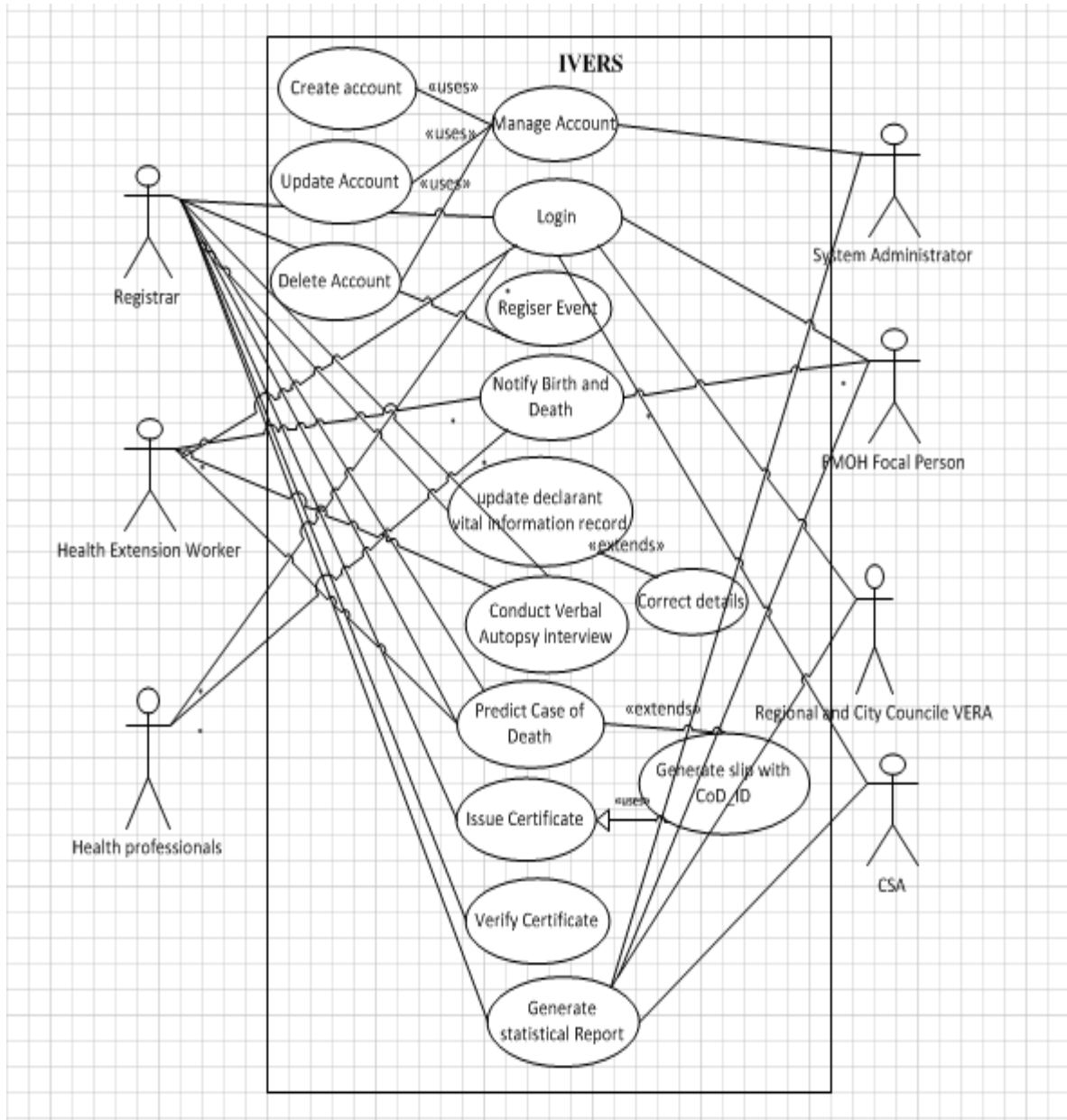


Figure 4.2: System Use Case Diagram

System Use Case 1: Manage User Account

Use Case ID	UC_1
Use Case Title	Manage User Account
Use Case Description	This use case describes how to create, manage or remove a user account information process.
Participating Use Case Actor	System Administrator
Trigger	Administrator login into the system
Pre-conditions	The user must be authenticated and authorized.
Post conditions	User account information is managed.
Process of Scenario	<ol style="list-style-type: none"> 1. The system displays main menu user interface 2. Open account management window. 3. The system display present list of staff user account list. 4. Search/ check registrar and key stakeholder actors have a user account by using staff ID. 5. If the staff didn't have an account, then the user click on create new account button. 6. The system displays a window/ form to create new account. 7. The user fills the required filed in the form. And click submit button. 8. The system validates and confirms the inserted data 9.The system is saved new account information in to the system.
Alternative Course	<p>4A: If the staff has an account before:</p> <p>4a.1. If the user wants to update the staff's account information.</p> <ol style="list-style-type: none"> a) Click on update/ edit account button b) The system displays a form to update the user account.

	<p>c) The user fills the required information and click on save button.</p> <p>d) The system validates the inserted data.</p> <p>e) The updated account information is saved.</p> <p>4a.2. If the user wants to delete the staff's account.</p> <p>a) Select and click the staffs account.</p> <p>b) The system displays a message to confirm account deletion.</p> <p>c) The user confirms the deletion process by clicking delete button.</p> <p>d) The system deletes the account information from the database.</p> <p>8A: If the password mismatch with confirm password field</p> <p>a) The system notifies the user entered wrong data.</p> <p>b) The system let the user to enter password and to confirm it.</p>
Frequency of use	10 per month

System Use Case 2: Notify birth and death

Use Case ID	UC_2
Use Case Title	Notify birth and death
Use Case Description	This use case describes how to notify birth and death user account information process.
Participating Use Case Actor	Health professionals
Trigger	Health extension Worker and Health professionals login into the system
Pre-conditions	The user must be authenticated and authorized.
Post conditions	User account information is managed.
Process of Scenario	<ol style="list-style-type: none"> 1. The system displays main menu user interface 2. Open Notification window.

	<p>3. The system display present list of Notification form .</p> <p>4. Inter notification serial no and ID and notify death and birth occurs either at the health facility or outside health facility</p> <p>5. The health provincial click on submit button</p> <p>6. The system acknowledges.</p> <p>7. Use case ends</p>
Alternative Course	<p>1a.If the health professional is already registered on the system</p> <p>1a.1 The health professional enters user ID number to the system and requests the system to retrieve from the central database to search the existing declarant pervious information.</p> <p>1a. 2 The system update details the required deceased information in the server</p> <p>3a.If the health provisional skips essential information unknowingly,</p> <p>3a.1The system display information to complete the skipped essential information</p> <p>3a.2 The system will display different warnings, sort out and display the skipped information box or give pop up message on the screen to delay his/ her</p>
Frequency of use	21per month

System Use Case 3: Login

Use Case ID	UC_3
Use Case Title	Login
Use Case Description	This use case describes the user login process.
Participating Use Case Actor	User (Registrar, Health extension worker, System Administrator, Regional and City Council VERA, CSA,FOMH focal person)
Trigger	Registration clerk open new client registration form

Pre-conditions	The users (Registrar, Health extension worker, System Administrator, Regional and City Council VERA, CSA. FOMH focal person) must have authorized user name and password given by Administrator.
Post conditions	The user logs into the in the IVERS system
Process of Scenario	<ol style="list-style-type: none"> 1. The system display main user interface, when the users click in the login screen. 2. The system displays login screen. 3. The user enters the username, password and select user type on login screen. 4. The system verifies account information and set access permission 5. The user logged in to the system then system will display the main screen. 6. Use case ends
Alternative Course	<p>4a. If the username or password is not correct, invalid login message is displayed.</p> <p>4a.1. The user is returned to login screen and re-enters user name and password.</p> <p>4a.2. The user try the password more than five the system make freeze.</p>
Frequency of use	15000 per month at kebele level

System Use Case 4: Register Event

Use Case ID	UC_4
Use Case Title	Register Event
Use Case Description	This use case describes vital event registration information system process.
Participating Use	Registrar (officer of civil status)

Case Actor	
Trigger	Registrar opens new client registration form.
Pre-conditions	The registrar is logged into the system and the actor must have an account with registrar privilege.
Post conditions	The individuals should be registered and certificate must be issued for registered event up on request.
Process of Scenario	<ol style="list-style-type: none"> 1. The system displays list of operations on vital events menu user interface (IVERS Home page) 2. The registrar selects registration operation menu and the system provides registration form, vital event (option) main menu option. 3. The registrar click on open new vital registration form 4. The system display vital event registration new form 5. The registrar fills the detail of declarant information on the vital event registration form 6. The registrar click on submit button 7. The system saves or stored registration information on the vital event database 8. The system acknowledges and prompts for print of certificate 9. The registrar asks confirmation from the declarant click on print button to print out vital event certificate form 10. The system acknowledges 11. Use case ends
Alternative Course	<ol style="list-style-type: none"> 1a.If the declarant is already registered on the system <ol style="list-style-type: none"> 1a.1 The registrar enters declarant national ID number to the system and requests the system to retrieve from the central database to search the existing declarant pervious information. 1a. 2 The system update details the required declarant information in the server 3a.If the registrar skips essential information unknowingly, <ol style="list-style-type: none"> 3a.1The system display information to complete the skipped

	essential information 3a.2 The system will display different warnings, sort out and display the skipped information box or give pop up message on the screen to delay his/ her work(the system displays an error message with registration form)
Frequency of use	50-60 per month at kebele level

System Use Case 5: Update declarant vital information record

Use Case ID	UC_5
Use Case Title	Update client vital information record
Use Case Description	This use case describes vital update client vital information process
Use Case Actor	Registrar (officer of civil status)
Trigger	Registrar opens existing client registration form.
Pre-conditions	The registrar is logged into the system and the actor must have an account with registrar privilege
Post conditions	The personal vital event record should be updated and the system should store updated vital events record and declarant detail information in to the database
Process of Scenario	<ol style="list-style-type: none"> 1. The system prompts the actor to enter Civil Registration Number of the person 2. The registrar fills and submits the Civil Registration Number 3. The system provides the declarant vital event record. 4. The registrar updates vital events record. 5. The registrar click on submit button 6. The system acknowledges. 7. Use case ends
Alternative Course	<ol style="list-style-type: none"> 1a.If the declarant is already registered on the system <ol style="list-style-type: none"> 1a.1 The registrar enters declarant Civil Registration Number

	<p>national ID number to the system and requests the system to retrieve from the central database to search the existing declarant pervious information.</p> <p>1a. 2 The system updated details the required declarant information in the server</p> <p>3a. If the user doesn't provide valid account information and if the registrar skips essential information unknowingly,</p> <p>3a.1The system display information to complete the skipped essential information</p> <p>3a.2 The system display different warnings, sort out and display the skipped information box or give pop up message on the screen to delay his/ her work the user do not continue his/her work.</p>
Frequency of use	10-20 per month at kebele level

System Use Case 6: inquiry family members or caregivers

Use Case ID	UC_6
Use Case Title	Conduct VA interview
Use Case Description	This use case describes VA interview to family members or caregivers for assessing probable causes of death from lay reporting of signs and symptoms information process.
Use Case Actor	Registrar (officer of civil status) and Health Extension Worker
Trigger	A death is reported to registrar by the declarant and the certification and interview are conducted at the same time (active registration) or a death has been reported and notified, and health extension worker is sent to query the CoD (passive registration). Both user will chose age categories for pre- and neonatal, child, and adult deaths from in VA registration menu

Pre-conditions	<ol style="list-style-type: none"> 1. A death registration unique number and birth registration unique will be required to ensure the vital registration linkage between the death registry and the VA questionnaire observable features that can be recalled during a verbal autopsy interview. 2. The respondent who provides information about the deceased and allows the interviewer to complete the VA questionnaire should be the primary caregiver (usually a family member) who was with the deceased in the period leading to death or a witness to a sudden death or accident.
Post conditions	<p>The VA interviews should be conducted as soon as practically possible after the report of the event is received. A common case-ID in the person identifiable VA dataset and the diagnostic VA dataset will allow data linkage between personal and diagnostic data upon formal request in line with national and international regulations.</p>
Process of Scenario	<ol style="list-style-type: none"> 1. the system prompts the actor to enter birth registration number of the person and death registration number 2. the registrar/ health extension worker fills information on the deceased and enter national identification number of deceased 3. The system provides pervious declarant birth record. 4 .The registrar/health Extension worker will collect information on diseases, signs and symptom 5. The registrar updates deceased information in the VA form 6. The registrar click on submit button 7. The system acknowledges. 9. Use case ends
Alternative Course	<ol style="list-style-type: none"> 1a.If the declarant is already registered on the system <ol style="list-style-type: none"> 1a.1 The registrar enters declarant birth registration number national ID number to the system and requests the system to retrieve from the central database to search the existing declarant pervious information.

	<p>1a. 2 The system updated details the required declarant information in the server</p> <p>3a. If the user doesn't provide valid account information and if the registrar skips essential information unknowingly,</p> <p>3a.1The system display information to complete the skipped essential information</p> <p>3a.2 The system display different warnings, sort out and display the skipped information box or give pop up message on the screen to delay his/ her work the user do not continue his/her work.</p>
Frequency of use	10-20 per month at kebele level

System Use Case 7: Predict CoD

Use Case ID	UC_7
Use Case Title	Predict CoD
Use Case Description	This use case describes prediction of CoDprocess
Use Case Actor	Registrar (officer of civil status)and Health extension worker
Trigger	The Registrar(officer of civil status) and health extension worker login into the system
Pre-conditions	<p>1.Data on the causes of death should be collected from close relatives of the deceased persons by registrar and health extension worker</p> <p>2.A death registration unique number and birth registration unique will be required to ensure the vital registration linkage between the death registry and the COD prediction</p> <p>3. The signs and symptom for a given death must be recorded in an interview with a member of descendant family</p>
Post conditions	<p>1.Causes of Death should be diagnosed using tariff algorithm for a given death, based on the response pattern in the VA instrument</p> <p>2. The system should ascertain individual CoD that may be</p>

	attributed with reasonable accuracy from a well administered verbal autopsy interview to certify death at kebele registrar office level.
Process of Scenario	<ol style="list-style-type: none"> 1. The system prompts the actor to enter birth registration number of the person and death registration number 2. The registrar/ Health extension worker fills and submits birth registration unique number. 3. The system provides CoD . 4 .The registrar/health Extension worker have to enter national identification number of deceased 4. The registrar updates deceased vital symptoms in the death registration and certify 5. The registrar click on submit button 6. The system acknowledges. 7. Use case ends
Frequency of use	10-20 per month at kebele level

System Use Case 8: Issue Certificate

Use Case ID	UC_8
Use Case Title	Issue Certificate
Use Case Description	This use case describes a certificate of registration of vital events shall be given to the person who has declared process
Use Case Actor	Registrar (officer of civil status)
Trigger	A certificate of registration of vital event shall be issued upon request of the service and the registrar will open new certification form

Pre-conditions	A death registration unique number and birth registration unique will be required to ensure the vital registration linkage between the death registry and the VA data.
Post conditions	The individual's CoD should be registered and certificate must be issued for registered event.
Process of Scenario	<ol style="list-style-type: none"> 1. The system prompts the actor to enter Civil Registration Number of the person 2. The registrar fills and submits the Civil Registration Number 3. The system provides the declarant vital event record. 4. The registrar updates vital events record. 5. The registrar click on submit button 6. The system acknowledges. 7. Use case ends
Alternative Course	<p>1a.If the declarant is already registered on the system</p> <p>1a.1 The registrar enters declarant Civil Registration Number national ID number to the system and requests the system to retrieve from the central database to search the existing declarant pervious information.</p> <p>1a. 2 The system updated details the required declarant information in the server</p> <p>3a. If the user doesn't provide valid account information and if the registrar skips essential information unknowingly,</p> <p>3a.1The system display information to complete the skipped essential information</p> <p>3a.2 The system display different warnings, sort out and display the skipped information box or give pop up message on the screen to delay his/ her work the user do not continue his/her work.</p>
Frequency of use	10-20 per month at kebele level

System Use Case-9: Verify Certificate

Use Case ID	UC_9
Use Case Title	Verify Certificate
Use Case Description	This use case describes verification certificates of vital events which has been given to citizens and allows actors to view individual vital events record
Use Case Actor	Registrar (officer of civil status)
Trigger	A certificate of registration of vital event shall be issued upon request of the service and the registrar will open new certification form
Pre-conditions	The record must exist in the database and the client should have valid required event ID details or Civil Registration Number
Post conditions	The registrar must be able to view the vital record
Process of Scenario	<ol style="list-style-type: none">1. The registrar initiates login2. The system prompts actors to enter account details or Civil Registration Number (CRN)3. The actor supply account detail or CRN4. The system displays the corresponding vital event record5. The actor closes the page
Alternative Course	<ol style="list-style-type: none">3: [if the supplied information is invalid]<ol style="list-style-type: none">3.1. The system displays error message with text box3.2. Go to 3
Frequency of use	10-20 per month at kebele level

System Use Case 10: Generate Report

Use Case ID	UC_10
Use Case Title	Generate report

Use Case Description	This use case describes report generating information process
Use Case Actor	Registrar (officer of civil status) and eligible actors
Trigger	<ol style="list-style-type: none"> 1. The system user request to generate report 2. The user login into the system
Pre-conditions	<ol style="list-style-type: none"> 1. All required data must be exists in the system database to generate report. 2. User has security access to the confidential data will be extracted with report 3. Data has been gathered
Post conditions	<ol style="list-style-type: none"> 1. Requested report is produced 2. The generated report information will be exported to Ms- excel , saved in different file formats and stored in database server.
Process of Scenario	<ol style="list-style-type: none"> 1. The actor click login link. 2. The system displays login form. 3. The actor fills username and password. 4. The actor click login 5. The system display the corresponding service page to the account details submitted. 6. The actor selects Report link. 7. The system displays a page which contains different type of variables and attributes 8. The actor selects variables and attributes type. 9. The system display corresponding report generation format 10. The actor select filter criteria. 11. The system displays the corresponding report to the filter criteria
Alternative Course	<ol style="list-style-type: none"> 5a. Configuration option available 8a. The system display the option available for the report 8a.1 The actor select one or more filtering criteria from the list 8a.1 If the actor confirms selection option on the system notifies the

	<p>user no matching data found,</p> <p>8a.1.1 The system shows a message to users that the data not available</p> <p>9A. If the user wants to get the report in different format then,</p> <p>9a.1 Click on export the report button.</p> <p>9a.2 Select the file type of the report.</p> <p>11a. If the actor want a soft copy report,</p> <p>11a.1 The system copy the report on the storage device inserted on the system</p>
Frequency of use	10-20 per month at kebele level

CHAPTER FIVE

SYSTEM DESIGN AND IMPLEMENTATION

5.1 Introduction

During requirement elicitation and analysis phase the services and features that are intended to be provided by the system are identified and modeled in such a way that can facilitate communication among clients, users and developers, but is not detailed at low level how the tasks will be performed. Likewise, by applying standard design strategies, the gap between specification of requirements and what the system really consists of in terms of functional components is filled. The goal of this phase is to manage complexity by dividing the system into smaller or manageable pieces. This is done by OO abstraction and divide-and-conquer approach, where the researcher recursively divide parts until they are simple enough to be handled by one person or one team. System design is the determination of the overall system architecture consisting of a set of physical processing components, hardware, software, people, and the communication among the users that will satisfy the system's essential requirements. Design goals of the proposed system are inferred from functional and nonfunctional requirements based on (performance, maintainability, reusability, and end user usability) and elicited from clients. It will help to make better decision when trade- offs are needed

5.2 Conceptual /Domain modeling

Conceptual modeling is the elicitation and the representation of the general knowledge that an Information System (IS) operating in a specific domain needs to know. Describing a domain of the real world through conceptual models means viewing it in a particular way, i.e. through the assumption that the world consists of concepts, e.g. entities, objects, events, processes. In particular, conceptual modeling aims at representing static (e.g., objects, entities) and dynamic phenomena (e.g., events and processes) in a particular domain. The importance of domain model in designing IVERS is that it helps the study to use real world domain in creating software class and fulfills the representational gap between how the system users in CRS conceive the domain and its representation in software, the researcher develops the conceptual model for designing IVERS as follows in figure 5.1.

structural diagram. Classes are abstractions that specify the common structure and behavior of a set of objects in Use Cases. Objects are instances of classes that are created, modified, and destroyed during the execution of the system. The proposed system consists of Person, Users, Account, Customer and Registrar classes. The object-oriented analysis was chosen as the methodology for creating the conceptual model for the IVERS of the VERA. The UML class diagram can depict all these things quite easily. Attributes are properties of the class about which we want to capture information and represent the actions or functions that a class can perform. This technique use domain classes which illustrates important concepts in a real world domain of the vital event registration handling system independent of software perspectives. The figure 5.2 shows a class diagram that was created to reflect the classes and relationships needed for IVERS system.

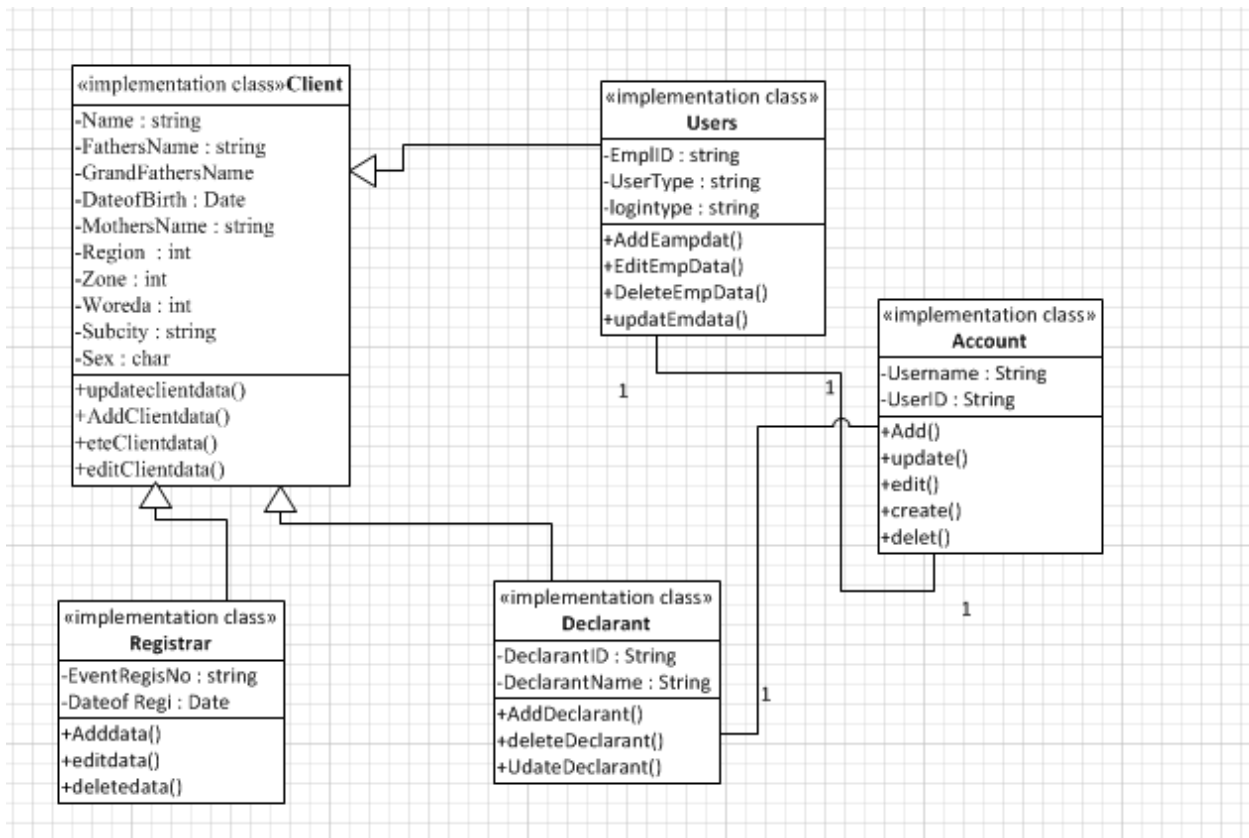


Fig.5.2 Class diagram

5.2.2 Data Modeling

Database management systems are central to any business because they capture and store the information required to support business operations. The database design process often begins with a statement of the user's requirements. According to senior VERA directors' requirements, *“VERA is centralized coordinating body, supports the registration of vital events at national level and to centrally organize and keep records of vital events. Similarly, uniform procedure to be followed by regional VERA which is designated by each region to direct, coordinate and support the registration of vital events at regional level and to transfer records of vital events to the appropriate federal organ. Finally VERA will send one copy to Central Statistical Agency (CSA)”*. Moreover, the existing proposal by (Ayalew, 2008) tried to implement the advantages of distributed information processing and storage, this study will also use distributed database management system (DDBMS).

A DDBMS is a set of multiple, logically interrelated databases distributed over a network. A DDBMS (distributed database management system) is a centralized application that manages a distributed database as if it were all stored on the same computer. They provide a mechanism that makes the distribution of data transparent to users. DDBMS is a centralized application that manages a distributed database. This database system synchronizes data periodically and ensures that any change in data made by users is universally updated in the database. One of the considerations in any distributed database management system is the latency in data consistency between the master and the slave. The DDBMS synchronizes all the data periodically, and in cases where multiple users must access the same data, ensures that updates and deletes performed on the data at one location will be automatically reflected in the data stored elsewhere. This consideration is important in assessing the trade-off between performance and the amount of data the application designer is willing to lose in the event of a catastrophic failure on the master database. Many distributed databases provide synchronous and asynchronous mirroring modes with the slave. In synchronous mode, the slave is part of the update transaction. In asynchronous mode the updates arrive at the slave in a delayed manner. In the latter mode if the master fails before the updates are shipped, the slave will still have the old values. This window of data inconsistency between the master and the slave depends on the periodicity and throughput speed of the update transfers between the master and the slave. DDBMS is widely used in data warehousing, where huge volumes of data are processed and accessed by numerous

users or database clients at the same time. This database system is used to manage data in networks, maintain confidentiality and handle data integrity. A distributed database management system has many advantage: reflects organizational structure, improved sharing and local autonomy, improved availability a failure does not make the entire system inoperable, improved reliability data may be replicated, improved performance data are local to the site of as per their demand, economic feasibility (many small workstation computers cost less than a server or supper computer) and modular growth easy to add new modules Besides, the system needs to permit different users to have different views of the system and to allow concurrent access to the system's information and other related issues..

5.2.3 Entity Relationship model

The entity relationship diagram E/R model uses the notions of entity, relationship informally, entities are objects that need to be represented in the database; relationships reflect interactions between entities; attributes are properties of entities and relationships .An entity relationship diagram is a picture which shows the information that is created, stored, and used by a business system. The following figure depicts the Relational Model for Integrated Vital Event Registration IVERS.

(sometimes known as system sequence diagrams). A sequence diagram is made up of a collection of participants (the system parts that interact each other during the sequence), Classes or Objects, each class (object) in the interaction is represented by its named icon along the top of the diagram. The sequence diagram for most use cases is shown in the upcoming diagrams. The label below the figures describes to which use case the sequence diagram belong to.

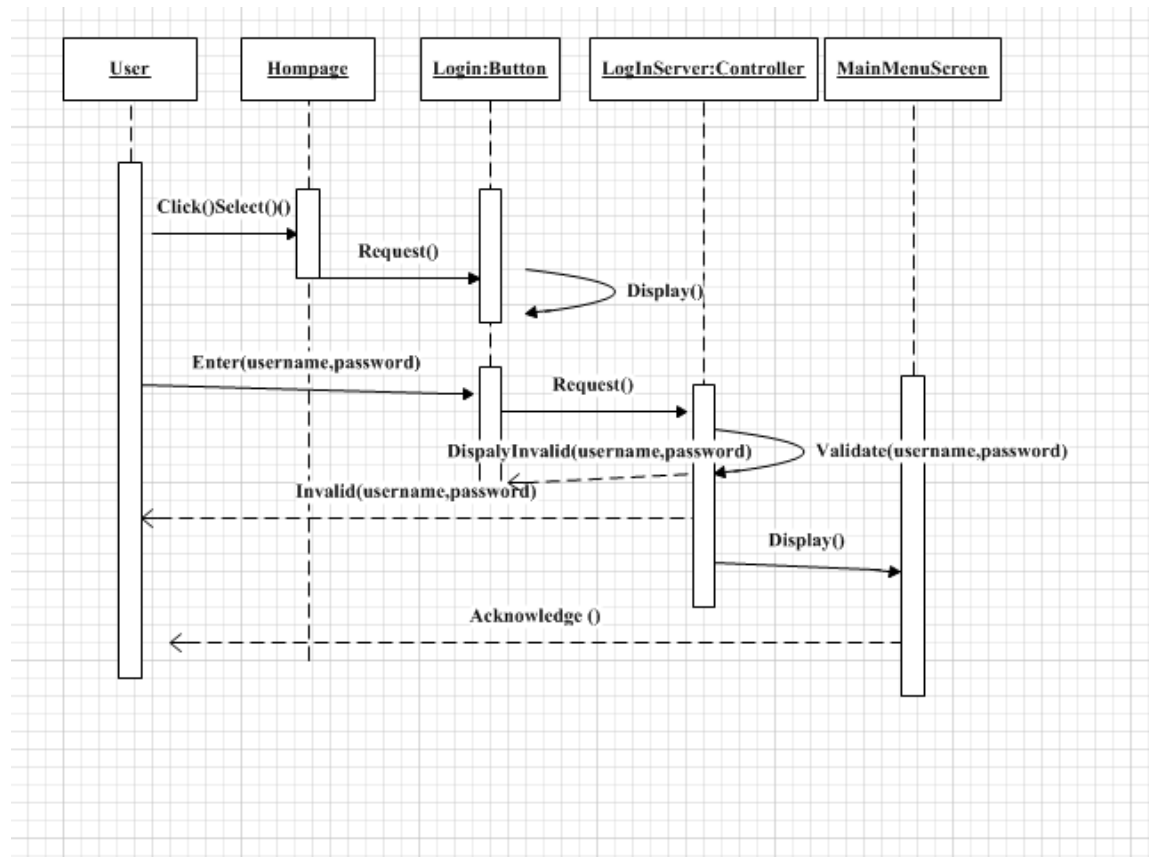


Fig.5.4 Sequence Diagram

5.2.5 Deployment Diagram

The Deployment Diagram also helps to model the physical aspect of an Object-Oriented software system. It models the run-time configuration in a static view and visualizes the distribution of components in an application. In most cases, it involves modeling the hardware configurations together with the software components that lived on. As mentioned in chapter four, IVERS is intended to be Client-Server application that consists of user interface, processing

and data levels. Using this architecture facilitates to support better security that can be achieved by placing controlling mechanisms at the processing level. Figure 5.6 depicts the deployment diagram of IVERS. This system is physically distributed across three nodes. These three are web server, database server and workstations. The web server contains the interface part of the system, business logic and application specific protocols like HTTP, FTP and TCP/IP. The database server stores the database to be managed by the underlying database management system. At the front end, any client can make request through locally existing web browser, to access services provided by the system. The web server provides graphically designed interface to receive request and it transforms the client request to one or more database queries to communicate with the database server. Then the database server returns the result to the web server which is accessible to the end user through the web browser.

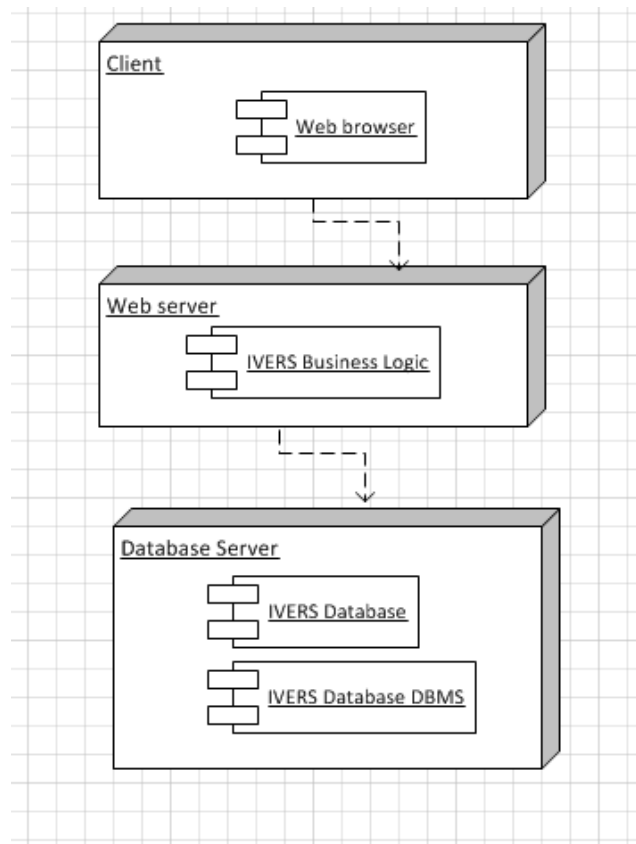


Fig.5.5 Deployment Diagram

5.2.6 User Interface Prototype Presentation

User interface prototype is a model used to simulate the system user interface at an early stage of the system design. It can be developed using hand drawing or CASE tool like Visio. It helps to


make the end user to test the system at an early stage and identify the gaps in very low cost and time. It also helps to communicate ideas between designer, developer, users and stakeholders. The following user interface prototype is developed using Visio presents the new system.

User Interface Prototype Id: UIP-01



User Interface Prototype Id: UIP-02

Main Menu for Registrar



Integrated Vital Event Registration System

— □ ×

Birth **Death** Marriage Divorce Certify Notification Report VA

Federal Democratic Republic of Ethiopia
Vital Event Registration Agency
Birth Registration Form

I. Registration place

Reg Region/City Council

Zone /City council

City

Sub City

Woreda/Special Woreda

Kebele

II. Maternal

Birth_Reg_Pub_no

Birth_reg_ID

Reg_off_no

First Name

Middle Name

Last Name

Nationality

National_id

Birth date

Place of Birth/ Country

Physical Address

Marital Status

Religion

Ethnicity

Educational Level

Job type

II. About the Kid

First Name

Last Name

Last Name

Sex

Nationality

Month

Date

Year

Place/Health Institution

Certificate No

Place of Birth

Region

Woreda/Spec Woreda

Kebele

Birth Type

Birth weight:

Midwife level

III. Biological Father

First Name

Middle Name

Last Name

National

National Civ_id

Label:

Birth date

Place Birth/Country

Physical Address

Marital Status

Religion

Ethnicity

Educational Level

Job type

Signature

User Interface Prototype Id: UIP-03

Main Menu for Registrar

**Federal Vital Event Registration Agency**- □ ×

Birth Death Marriage Divorce **Birth** Notification Report VA

**Federal Democratic Republic of Ethiopia
Vital Event Registration Agency
Birth Certificate**

Birth_Reg_Pub_no
Birth_Reg_ID

Kid's Name Fathers Name Grand Father Name

Sex Birth Day Birth Place

Mother's Full Name Mother's Nationality Father's Name

Fathers Nationality Birth Registration Day Certification Day

Civil Registration Officer Full Name

Signature

User Interface Prototype Id: UIP-04

System Main Menu for Health Professionals

Integrated Vital Event Registration System

Birth Death Marriage Divorce Certify Notification Report VA Enter

Death Notification Form

Notification Serial NO

Notification ID NO

National ID NO

Birth Regl ID NO

Place of birth Hospital Health Center Health Post Clinic Others

Facility ownership Government Private for Non-profit Private for profit

Facility Address

Facility Name

Zone

Town/ Sub City

House no

Region /City Admi

Woreda /S woreda

Kebele

Tele No

Section 1 Deceased's information

Full Name Title Age SeX Male Femal

Section 2 Death information

Date of Death Day Night Time Hr Min

Section 3 Couese of death

A B C D

Section 4 Person who Declare Death Full Name Qualification Date

Section 5. Notification form issued by Full Name Date

User Interface Prototype Id: UIP-04

Main Menu for Registrar & HEW

Integrated Vital Event Registration System

Birth Death Marriage Divorce Certify Notification Report VA Enter

WHO- VA-1014
Death of a Child aged under four weeks

Under four Weeks
4week-11year
12 year-3 year

Birth_Reg_ID Enter Text
Birth_Reg_Pub_no Enter Text
Death_Reg_ID Enter Text
VA_Ques_ID Enter Text

0A100a. Is this region of high HIV/AIDS Prevalence?
Yes
NO

A100b. Is this region of high malaria prevalence ?
Yes
NO

Section 1. Information on deceased

1A100a. what was the first given name(s) of the deceased?
Enter Text

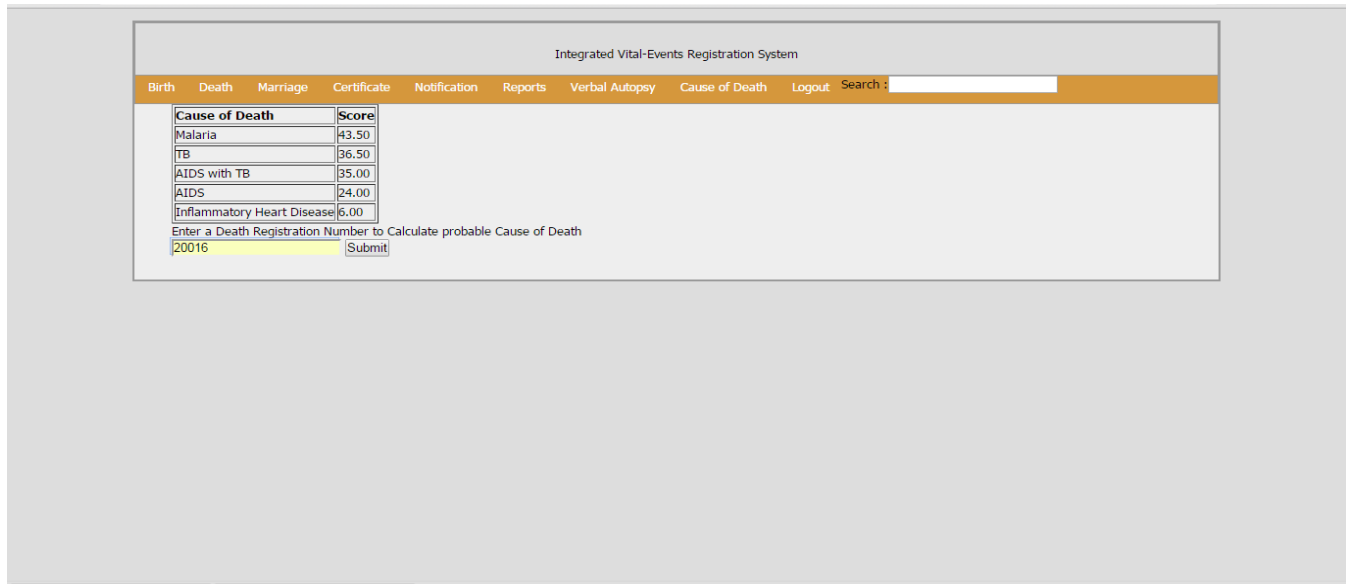
1A100b. What was the surname of the descendant?
Enter Text

Submit Next Rest Generate CoD Logout

5.3 Implementation

The previous parts of the study focused on analysis and design of the IVERS developed in this study. Then this part of the project addresses how to implement the actual system, which includes the detail description of the system developed; how the deliverables implemented, and roll-out problems with the system, and finally evaluation of the system's performance and acceptance test.

The PHMRC Symptomatic Diagnosis study presents a novel source of data and an innovative application of VA research to computational estimation of CoD. Based on the training dataset in which the true cause is known and full VA has been collected, IVERS can compute a tariff as a function of the fraction of deaths for each variable or item that has a positive response. The VA dataset used in this study was obtained from the Institute of Health Metrics and Evaluation (IHME) which was collected as part of the PHMRC project. In the adult module of the PHMRC study, for example, there are 46 potential on causes and so there are 46 different tariff scores based on the tariffs and the response pattern for that death(on adult module). For actual implementation, adult module was selected for death of a person aged 15 years and above with only the top 46 items for each case in terms of tariff to compute tariff score. The set of 46 item used for each case prediction were not mutually exclusive, though cumulatively across all cause predictions the majority of items in the WHO 2014 VA questionnaire were used for at least one cause prediction. For a given death, the tariffs are summed resulting into an item-specific tariff score for each death for each cause. The cause that results into the highest tariff score for a particular death is assigned as the predicted cause of death for that individual. The method uses data sets where the cause of death is known and the tariff is computed as a function of the fraction of deaths for each variable having a positive response. Once a set of tariff scores has been obtained for a given death, the cause of death can be assigned in several ways. The easiest method is to simply assign the cause with the highest tariff score. The cause that claims the highest rank on each death being tested receives the cause assignment for that death. By making cause assignments based on rank for each individual death through the use of the training dataset PHMNC, IVERS also emulate how the method could be used for individual cause assignment as per specification of requirement that have collected from VERA, since cause assignment in the specification of VERA would be predicted based on ranking a single death relative to the entire validation dataset's tariff scores. The results aim to understand the issues and successes of using data driven algorithms and to understand how effective a computational approach would be to replace the physician's decision judgment in ascertaining cause of death. Screenshot of CoD page is shown in Figure 5.1.



Source code for the individual CoD prediction is shown as follows in Listing 1

```

        <?php include('session.php');
        if ($_SERVER["REQUEST_METHOD"] == "POST")
            {
                $sqlDel = "DELETE FROM tmpva";
                mysqli_query($conn, $sqlDel);
                $drg = $_POST["death_reg_no"];
                //echo $drg;
                $sqlVa = "SELECT * FROM indva WHERE death_reg_number = $drg AND response_id = 1";
                //echo $sqlVa;
                $result = $conn->query($sqlVa);
                $sumTariff = array();
                for($i = 0; $i < 46; $i++)
                    {
                        $sumTariff[$i] = 0;
                    }
                while($rowP = $result->fetch_assoc())
                    {
                        $qnn = $rowP["question_number"];
                        //echo $qnn;
                        $sqlTa = "Select * FROM `TABLE 7` WHERE symptom_question_number = '$qnn'";
                        $resultTa = $conn->query($sqlTa);
                        while($rowT = $resultTa->fetch_assoc())
                            {

```

```

        $i = $rowT["cause_of_death_id"] - 1;

        $sumTariff[$i] = $sumTariff[$i] + $rowT["tariff"];
        //echo "<H1>".$sumTariff[$i]."</h1>";
        }
    }

    echo "<table border=1><tr><td><h4>Cause of
Death</h4></td><td><h4>Score</h4></td></tr>";
    for($i = 0; $i < 46; $i++)
    {
        if($sumTariff[$i] != 0)
        {
            $sqlTabler = "Select * FROM `TABLE 7` WHERE cause_of_death_id = $i+1";
            $resultTabler = $conn->query($sqlTabler);
            while($rowTabler = $resultTabler->fetch_assoc())
            {
                $cod = $rowTabler["cause_of_death"];
            }

            //echo "<tr><td>".$cod."</td>";
            //echo "<td>".$sumTariff[$i]."</td></tr>";

            $j = $i+1;
            $sqlTmp = "INSERT INTO tmpva (cod, score) VALUES ('$cod', '$sumTariff[$i]')";
            mysqli_query($conn, $sqlTmp);

            }

        }

        $sqlTmpVa = "Select * FROM tmpva ORDER BY score DESC LIMIT 5";
        $resultTmpVa = $conn->query($sqlTmpVa);
        while($rowTmp = $resultTmpVa->fetch_assoc())
        {
            echo "<tr><td>".$rowTmp["cod"]."</td>";
            echo "<td>".$rowTmp["score"]."</td></tr>";
        }
    }echo "</table>";
    $conn->close();
?>
<form action="cod.php" method="post">

```

```

Enter a Death Registration Number to Calculate probable Cause of Death <br/><input
type="text" name="death_reg_no" >
<input type="submit">
</form>

```

1. Source code of CoD

5.4 Discussion of results (the system)

VERA has no integrated web based vital registration information management system. This project has tried to design IVERS based on the requirement gathered from the study participants. The designed system has a capability to reserve a time slot for registrations, notification and certification of vital events, also records all information regarding birth, death, marriage and divorce. It also performs prediction of most probable CoD at a community level and individual. In addition the system generates different standard reports and VS for the key stakeholders. Moreover, the system is also helpful in serving as a source mortality statistics and VS which is essential for policy making, and setting health targets. The investigator has also undertaken the user test and evaluation concerning the designed web based IVERS.

User Test

User testing is a technique for ensuring that the intended users of a system can carry out the intended tasks efficiently, effectively and satisfactorily. For this particular project user test was done for the developed prototype which is used to address any significant issues identified. Four users are participated in the testing process and are presented with eight different questions that the investigator believes will address the user requirement using Likert scale evaluation methods.

Table 5.1: User test result for the prototype of web based IVERS of VERA, Addis Ababa, 2016.

S.no	Test Questions	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	Characters on the computer screen easy to read			1	2	1
2	I like the font and the color of the interfaces				3	1
3	There is consistency in the system interface		1	1		2
4	I thought the system is easy to			1	3	

	use					
5	Interaction with the system clear and understandable			1		3
6	Screen layouts were helpful				2	2
7	I need less time to learn the user interface			1		3
8	Characters on the computer screen easy to read		2		1	1
	Average result in percentage		9%	16%	36%	39%

Based on the finding of the result of the user test questions presented to the respondents, 75% of the participants in the evaluation and testing has shown positive attitude and response (either agreed or strongly agreed to) for the system attractiveness of the interface, color of the interfaces, consistency of the system interface, easy usability, low cumbersomeness, addressed essential contents, length of time to learn the system, and presence of unnecessary content in the system in general.

5.4 Limitations

The study had some inherent limitations. One of the main limitations and questions in verbal autopsy research is that it seems plausible that the questionnaire responses in a “community” death where an interview is conducted will be systematically different than the responses from the “hospital” deaths on which computational algorithms are changed. As VA relies on the information provided by the caregiver to determine the CoD with no clinical evidence to support, they may be subject to relatively high misclassification errors. This supports the view that a classifier will more accurately predict CoD when symptoms are distinct. Besides, the validity of VA is dependent on its many components and there is a high degree of variability between studies in terms of field procedures, questioners used, CoDs assessed, recall by respondents and metrics performance. Some of the most commonly reported metrics are: sensitivity, specificity, and the CSMF error (the relative difference between the VA and the reference standard CSMFs). The study didn’t assess the performance of IVERS in terms of the three metrics described above, sensitivity, specificity and CSMF accuracy, and in terms of cause fraction absolute error, which allows for inspection of IVERS performance for a given cause. Further study is required to determine its prediction ability to correctly determine individual CoD or accuracy for a given CoD.

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

Generally, this study executed with the objective of designing an IVERS in case of VERA based on vital registration records kept using different paper-based formats and registers. Some of the main findings of this research are outlined below.

- The 2012 law does not provide clear and unambiguous definitions of the vital events and there is no provision in the 2012 law for deaths occurring at home it has only mentioned death at certain facilities. Even though, most of the events expected to occur at home. Considering the specific needs and facts of the country, the study proposed in the absence of routine death registration, VA method can be used to derive probable cause of death.

- Following the required analysis, system use cases were used to describe the basic functions of system boundary and illustrate detailed description of the activities. In this project, system requirements are identified by consulting the users based on their perceptions and core business process activities for integration. Some of functional requirements are, the proposed system registers all births marriage, divorce and deaths, issues certificates, notification from health facility and community, and compiles and disseminates vital statistics, including cause of death information. While non-functional requirements are the system should be protected from an unauthorized users and intruders, encryption techniques to avoid the tapping of the data while in transfer and personal data, in particular name, geographical information and contact information about the respondent, should be kept separate from the epidemiological data. To realize the feasibility and validity of the proposal object oriented software engineering is used to develop the prototype. Accordingly, the requirements identified are analyzed and structured using application domain modeling.

6.2 Recommendation

Based on the finding of the study/project, the following recommendations are forwarded to each concerning bodies.

I. VERA

- VERA should implement the developed integrated vital Event Registration system.
- Start conducting VAs, preferably using electronic data capture at point of vital registration offices and community level
- Discuss with public health researchers, judiciaries and the medical establishment the validity of introducing VA for deaths occurring outside health facilities to introduce VA procedures in vital event registration when medical certification is not possible.
- Provide training to its staff on the awareness of vital event registration using automated systems.

II. RVERA

- Sensitize local authorities and establish ownership.
- Train staff in the areas of Vital event enumeration, VA and reporting of vital events
- Prepare analyses and reports, and disseminate for local demand at district level or regional level.
- Establish an appropriate organizational structure or structures for the efficient management, operation and maintenance of the IVERS.

III. Ministry of Health

- Coordinate a group of stakeholders familiar with the local epidemiological and socioeconomic context to adapt the standard WHO VA questionnaire.
- Translate the standard WHO VA questionnaire into the local language(s), work with a social scientist to determine local meanings and terminology for all signs, symptoms, diseases and condition and set standards.
- Conduct regular validation of CoD certification in Kebele and woreda leve
- Validate and revise the questionnaire
- Review the quality of cause-of-death results, and prepare annual reports for stakeholders and other users.

IV. CSA

- CSA should be responsible and accountable to any document it receive from VERA so that personal information in vital statistics micro-data and any associated statistical reports be safeguarded to an extent consistent with the intended uses of these records for specific administrative and statistical purposes.

Researchers

- Develop further study on adaptation of Computer CCVA coding preferably by using machine-learning methods to utilize local languages.
- Propose a multi lingual vital event registration system based on regional VERA working languages.
- Natural language processing in the medical domain and data mining algorithms which can assist in the computational process to provide an alternative that can handle and predict with a high degree of accuracy and consistency CoD.

7. References

1. Abraham D Flaxman, A. V. (2011). Direct estimation of cause-specific mortality fractions from verbal autopsies: multisite validation study using clinical diagnostic gold standards. *BioMed Central Ltd*, 1-10.
2. Addis Ababa University, A. M. (2013). *Vital Events Indicator and Causes of Death Surveillance System and Addis Ababa Mortality: From Longitudinal Datasets of Health and Demographic*. Ethiopia: The Ethiopian Public Health Association (EPHA).
3. Alan D Lopez and Philip W Setel. (2015). Better health intelligence: a new era for civil registration and vital statistics? *BMC Medicine*, 1-4.
4. Alan Dennis, B. H. (2012). *SYSTEM ANALYSIS AND DESIGN*. Newjersey: John Wiley & Sons, Inc.
5. Araya, T. (2012). *BURIAL SURVEILLANCE IN ADDIS ABABA: PROVIDING AIDS RELATED MORTALITY DATA FOR MONITORING PROGRAM IMPACT*. ADDIS ABABA: Addis Ababa University.
6. Ayalew, T. (2008). *Electronic Vital Event Registration System (EVERS)*. ADDIS ABABA University.
7. B.Salawu. (2009). Strengthening vital registration systems as a source of demographic data for effective socio-economic development planning in Nigeria. *Medwell Journals*, 200-206.
8. Barnaby C Reeves, M. Q. (1997). A Review of Data-Derived Methods for Assigning Causes of Death from Verbal Autopsy Data. *Internation Journal of Epidemiology*, 1080-1082.
9. Berhe Weldearegawi, Y. A. (2015). How much do the physician review and InterVA model agree in determining causes of death? a comparative analysis of deaths in rural Ethiopia. *BMC Public Health*, 1-7.
10. Birru, T. G. (2007). Gender Statistics and the Status of Civil Registration and Vital Statistics in Ethiopia. *GLOBAL FORUM ON GENDER STATISTICS* (pp. 1-13). Rome, Italy: ESA/STAT/AC.140/8.2.
11. Boerma, C. A. (2005). Health information systems: the foundations of public health. *Bulletin of the World Health Organization*, 578-583.
12. Boerma, C. A. (2005). Health information systems: the foundations of public health. *Bulletin of the World Health Organization*, 2-6.
13. Booch, G. (1994). *OBJECT-ORIENTED ANALYSIS AND DESIGN*. Santa Clara, California: Addison Wesley Longman, Inc.
14. Byass, E. F. (2010). Verbal Autopsy: Methods in Transition. *Oxford University Press*, 38- 40.
15. Byass, P. (2007). Who Needs Cause-of-Death Data? *PLOS Medicine*, 2-4.

16. Carine Ronsmans, A. M. (n.d.). A comparison of three verbal autopsy methods to ascertain levels and causes of maternal deaths in Matlab, Bangladesh. *International Journal of Epidemiology* .
17. Carla AbouZahr & Ties Boerma. (2005). Health information systems: the foundations of public health. *Bulletin of the World Health Organization*, 578-79.
18. Carsten Bøcker Pedersen. (2011). The Danish Civil Registration System. *Scandinavian Journal of Public Health*, 3-8.
19. Carsten Bøcker Pedersen, H. G. (2006). The Danish Civil Registration. *Danish Medical Bulletin Vol .53*, 442-445.
20. Central Statistical Agency. (2014). *Ethiopia Mini Demographic and Health Survey*. Addis Ababa: Central Statistical Agency.
21. Chalapati Rio, D. B. (2004). Improving Death Registration and Statistics in Developing Countries: Lessons from Sub Saharan Africa. *South African Journal of Demography*, 81-83.
22. Christopher JL Murray, A. D. (2011). Population Health Metrics Research Consortium gold standard verbal autopsy validation study: design, implementation, and development of analysis datasets. *BioMed Central* , 1-13.
23. Christopher JL Murray, S. L. (2011). Simplified Symptom Pattern Method for verbal autopsy analysis: multisite validation study using clinical diagnostic gold standards. *BioMed Central*, 1-8.
24. Commission, E. P. (2008). *Summary and Statistical Report of the 2007 Population and Housing Census Results*. Addis Ababa: United Nations Population Fund (UNFPA).
25. Corinne L Fligner, J. M. (2011). Synergism of verbal autopsy and diagnostic pathology autopsy for improved accuracy of mortality data. *BioMed Central*, 1-3.
26. Creswell, J. W. (2003). *Qualitative, Quantitative, and mixed methods approaches*. California: Sage Publications, Inc.
27. Daniel Bogale Odo, D. M. (2014). Institutional delivery service utilization and associated factors among child bearing age women in Goba Woreda, Ethiopia. *Journal of Gynecology and Obstetrics*, 1-6.
28. Dathan, S. R. (2011). *Object-Oriented Analysis and Design*. India: Universities Press (India) Pvt. Ltd.
29. Dawson, C. (2002). *Practical Research Methods: A user-friendly guide to mastering research techniques and projects*. Oxford: How To Books Ltd.
30. Division, U. N. (2010). *Status of Civil Registration and Vital Statistics in the SADC Region*. United Nations Department of Economic and Social Affairs Statistics Division.

31. Edward Fottrell and Peter Byass. (2010). Verbal Autopsy: Methods in Transition. *Oxford University Journals*, 38- 40.
32. Ehrlich, J. &. (2007). *Epidemiology: a research manual for South Africa with contributing editors Katzenellenbogen J, Karim SA. 2nd edition*. Cape Town: Oxford University Press.
33. Ethiopia Plan. (September 2005). *A Review of Birth Registration in Addis Ababa and the Regional States of Oromia, Amhara and SNNPR, Ethiopia*. Addis Ababa: Plan Ethiopia.
34. Ethiopian Federal Ministry of Health. (2011). *Community Health Information System, User Manual*. Addis Ababa: USAID/MEASURE.
35. Friedlander, M. P. (2009). *Outbreak: Disease Detectives at Work*. Minneapolis: Twenty-First Century Books.
36. Geoff Walsham. (2006). Doing interpretive research. *European Journal of Information Systems* 1, 320–330.
37. Grady, B. (1994). *OBJECT ORIENTED ANALYSIS AND DESIGN*. Santa Clara, California: Addison Wesley Longman, Inc.
38. James Studnick., D. J. (n.d.). Using Information System for Public Health Administration .
39. (January 2008). *Health Management Information System (HMIS) /*. Addis Ababa.
40. (January 2008). *Health Metrics Network Framework and Standards for Country Health Information Systems*, . World Health Organization.
41. Jordana Leitao, N. D. (2014). Comparison of physician-certified verbal autopsy with computer-coded verbal autopsy for cause of death assignment in hospitalized patients in low- and middle-income countries: systematic review. *BioMed Central* , 2-7.
42. Kamu, K. (2011). *Enhanced Electronic Vital Events Registration System for Ethiopia (EEVERSE)*. Addis Ababa: Addis Ababa University .
43. Kirsti E. Berntsen, J. S. (2004). Interpretive research methods in computer science. *Recuperado em Abril,25, 2008*.
44. Kothari, C. (2004). *Research Methodology Methods & Techniques*. New Delhi: New Age International (P) Ltd.
45. Krogness, K. J. (2011). Numbered Individuals, Digital Traditions, and Individual Rights: Civil Status Registration in Denmark 1645 to 2010. *Ritsumeikan Law Review* (28), 87-126.
46. Larsen, K. H. (2011). The Danish Register of Causes of Death. *Scandinavian Journal of Public Health*, 1-5.

47. Lewis, J. R. (2003). *QUALITATIVE RESEARCH PRACTICE*. London: SAGE Publications.
48. Lu, G. K. (2008). Verbal Autopsy Methods with Multiple Causes of Death. *Institute of Mathematical Statistics*, 78-79.
49. Lucas D, M. P. (2003). *Registration, Administrative, and Qualitative Dat*. Australia: National Centre for Development Studies, Research School of Pacific Studies Australian National University.
50. M.Helther, A. (1997). *History and Organization of the Vital Statistics System*. Hayttsville, Maryland: CENTERS FOR DISEA SE CONTROL AND PREVENTION/National Center for Health Statistics.
51. Merriam, S. B. (1998). *ualitative Research and Case Study Applications in Education. Revised and Expanded from*. Sansome St, San Francisco,: Jossey-Bass Publisher.
52. Naida Soleman, D. C. (2006). Verbal Autopsy:Current practices and Challenges. *Naida Spoleman,Daniel Chanderamohan,Kenji Shibuy*, 239-241.
53. Nations, U. (1998). *Handbook on Civil Registration and Vital Statistics Systems Computerization*. New York: United Nations.
54. O. J. Gadabu, R. C. (2014). An electronic register for vital registration in a rural village with no electricity in Malawi. *Public Health Action*, 1.
55. (October 2007). *Assessment of the Ethiopian National Health Information System*. Final Report.
56. Organization, W. H. (2013). *Strengthening civil registration and vital statistics for births, deaths and causes of death: resource kit*. Geneva: WHO.
57. Organization, W. H. (2015). *Verbal autopsy standards:The 2014 WHO verbal autopsy instrument*. Geneva: World Health Organization.
58. Patrick W. O'Carroll, . A. (2006). *Public Health Informatics and Information Systems*. New York : Springer Verlg New York Inc.
59. PEDERSEN, C. B. (2011). The Danish Civil Registration System. *Scandinavian Journal of Public Health*, 3-8.
60. Peta Darke, G. S. (1998). Successfully completing case study research:combining rigour relevance and pragmatism . *Balckwell Science* , 273-289.
61. Peter Serina, I. R. (2015). A shortened verbal autopsy instrument for use in routine mortality surveillance systems. *BMC Medicine*, 2-5.
62. Philip W Setel, S. B. (2007). A scandal of invisibility: making everyone count by counting everyone. *Lacent*, 1-9.

63. Philip W Setel, S. B. (2007). A scandal of invisibility:making everyone count by counting everyone. *Series*, 2-4.
64. Philip W. Setel, C. R. (2006). Core Verbal Autopsy Procedures with Comparative Validation Results from Two Countries. *PLoS MEDICINE*, 1-6.
65. Philip W.Setel, O. S. (2005). Sample Registration of Vital Events With Verbal Autopsy: A renewed Commitment to Measuring and Monitoring vital Statistics. *Bulletin of the World Health Organization*, 611-615.
66. Plummer, A. A. (2001). Information Systems Methodology for Building Theory in Health Informatics:. *Hawaii International Conference on System Sciences* (pp. 2-10). Hawaii, USA: IEEE Computer Society.
67. Polit, D. a. (2008). *Nursing Research: Generating and Assessing Evidence for Nursing practice; 8th edition*. Philadelphia.: Lippincott. Williams & Wilkins.
68. Priestly, M. (2000). *Practical Object-Oriented Design with UML*. McGraw -Hill Companies, Inc.
69. Rasika Rampatige, S. G. (2013). Assessing the reliability of Causes of Death reported by the Vital Registration System in Sri Lanka. *Health Information Management Journal*, 1-9.
70. Setel, A. D. (2015). Better health intelligence: a new era for civil registration and vital statistics. *BMC Medicine*, 1-4.
71. Sheila S Mudenda, S. K. (2011). Feasibility of using a World Health Organization standard methodology for Sample Vital Registration with Verbal Autopsy (SAVVY) to report leading causes of death in Zambia: results of a pilot in four provinces, 2010. *BioMed Central*, 2-8.
72. Spencer L James, A. D. (2011). Performance of the Tariff Method: validation of a simple additive algorithm for analysis of verbal autopsies. *BioMed Central*, 3-16.
73. UNECA. (2012). Reforming and Improving Civil Registration and Vital Statistics Systems in Africa Regional Medium-Term Plan: 2010-2015. *Second Conference of African Ministers Responsible for Civil Registration* (pp. 4-13). Durban, Republic of South Africa: UNITED NATIONS ECONOMIC AND SOCIAL COUNCIL.
74. United Nations Economic Commission for Africa, A. U. (2012). Africa Programme on Accelerated Improvement of Civil Registration and Vital Statistics. *APAI-CRVS* (pp. 2-5). Durban, South Africa: African Union Commission, African Development Bank, United Nations Economic Commission for Africa.
75. United Nations Statistics Division. (2014). *Department of Economic and Social Affairs Statistics Division Statistical Papers, Series M No. 19/ Rev.3*. New York: United Nations.

76. UNSD. (2014). *Principles and Recommendations for a Vital Statistics System*. New York: United Nations.
77. Vrasidas, C. (2000). CONSTRUCTIVISM VERSUS OBJECTIVISM:IMPLICATIONS FOR INTERACTION, COURSE DESIGN,AND EVALUATION IN DISTANCE EDUCATION. *International Journal of Educational Telecommunications*, 2-9.
78. W.Creswell, J. (2003). *Qualitative, Quantitative, and mixed methods approaches*. California: Sage Publications, Inc.
79. WHO. (2004). *WHO Technical Consultation on Verbal Autopsy Tools*. Geneva: Department of Measurement and Health Information System Evidence and Information for Policy World.
80. WHO. (2012). *Verbal autopsy standards:The 2012 WHO verbal autopsy instrument Release Candidate 1*. Geneva: World Health Organization.
81. WHO. (2012). *Verbal autopsy standards:The 2012 WHO verbal autopsy instrument Release Candidate 1*. Geneva: World Health Organization.
82. WHO. (2013). *Civil Registration and Vital Statistics 2013: challenges, best practice and design principles for modern systems*. Geneva: World Health Organization.
83. WHO. (2014). *Civil Registration and Vital Statistics Investment Planning*. Geneva, Switzerland.: WHO Document Production Services,.
84. William A. Yasnoff, P. W. (2000). Public Health Informatics: Improving and Transforming Public Health in the Information Age. *Public Health Management Practice*, 67-70.
85. World Health Organization. (2014). *Improving Mortality Statistics through Civil Registration and Vital Statistics Systems*. Geneva, Switzerland: WHO/HIS/HSI/2014.4.
86. Yazoume Ye, M. W. (2012). Health and demographic surveillance system:a step towards full civil registration and vitalstatistics system in sub-Sahara Africa. *BMC Public Health*, 1-6.
87. Zewoldi, Y. (2013). *Towards sustainable vital events registration and vital statistics systems of Ethiopia:trategy and Action Plan July 2013 – June 2018*. Addis Ababa: UNFPA.

ANNEXES

Annex-A: Questionnaire

QUESTIONNAIRE
ADDIS ABABA UNIVERSITY
DEPARTMENT OF HEALTH INFORMATICS
QUESTIONNAIRE FOR THE DESIGNING AN INTEGRATED VITAL REGISTRATION
INFORMATION SYSTEM IN THE CASE OF FEDERAL VITAL EVENT REGISTRATION
AGENCY

The purpose of this study is to design an integrated vital registration information system in case of Federal Vital Event Registration Agency. Your participation in this study is important and is completely voluntary. The information requested from you will be used only for the study purpose. If you agree to complete the questionnaire, you will answer questions regarding yourself, your knowledge about vital events, registration of civil status, declarant and other related subjects. Your answers will be kept confidential and only the principal investigator will have access to this information. Your name will not be written on the questionnaire or be kept in any other records. Your participation is voluntary and you may choose to stop the interview at any time. Completing the questionnaire will take about 30 minute.

I confirm that I am a permanent employee of VERA.

I understand what my participation in this research will involve.

I understand that my participation in this research is completely voluntary.

I agree that my participation in this research is confidential.

I understand that this interview is for study purpose only.

I understand that I can discontinue my participation in this research at any time.

I have read and understood the entire document (which has further been explained to me) and have agreed to participate in the research conducted by ABDI MEKONNEN

I voluntarily sign this agreement.

Name: _____ Signature : _____

Thank you for your assistance. Questionnaire Code_____

Annex-B:

System Analysis Requirement Elicitation For Vital Registration Vital Statistic Information System KEY INFORMANT INTERVIEW December 2015

QUESTIONNAIRE

Hello! My name is Abdi Mekonnen from Addis Ababa University. I am here to conduct a Project entitled “Designing Vital Registration Information System in the case of VERA.” The purpose of this research is to:

- Understand people’s and organizations’ experiences on the importance of vital registration.
- Understand the requirements and processes by which vital registration and certification is undertaken by the institution.

Therefore, the knowledge of this will contribute to the overall design of the integrated vital registration information system for the organization.

Your responses and suggestions will be treated confidentially and will be used only for the purpose of facilitating and improving work flow of VERA. Results from the interview will be kept confidential until after the consent from the organization is gained to use for other purposes.

This series of subject matter interview will follow a semi-structured approach. Some questions are yes/no type questions but other questions seek your opinion and experience as a key informant and I would very much welcome your help on increasing understanding and experience of vital registration. So please elaborate your answers as much as you feel appropriate as your experiences will be valuable in contributing to the reform of exiting system.

I would very much appreciate hearing your experiences. The questions have related to your experience and the experience of your department on aspects of vital registration, certification, information sharing, and services provided by VERA. As such I am interested in government performance (VERA) and not the performance of your department alone.

I expect the questions to take about half an hour. Would you be willing to help me by answering as fully as possible? Do you have any questions at this point? Can I proceed?

Yes, we can proceed_____

Code No. _____

No, we can't _____

Terminate _____

CRVS KEY INFORMANT INTERVIEW

Interview ID:

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<table border="1" style="display: inline-table; width: 30px; height: 20px;"></table> <table border="1" style="display: inline-table; width: 30px; height: 20px;"></table>	<table border="1" style="display: inline-table; width: 30px; height: 20px;"></table> <table border="1" style="display: inline-table; width: 30px; height: 20px;"></table>	End Time (Ethiopia time)
1. Interviewed by		
2. Date of Interview DD MM YY (use Ethiopian calendar here)		

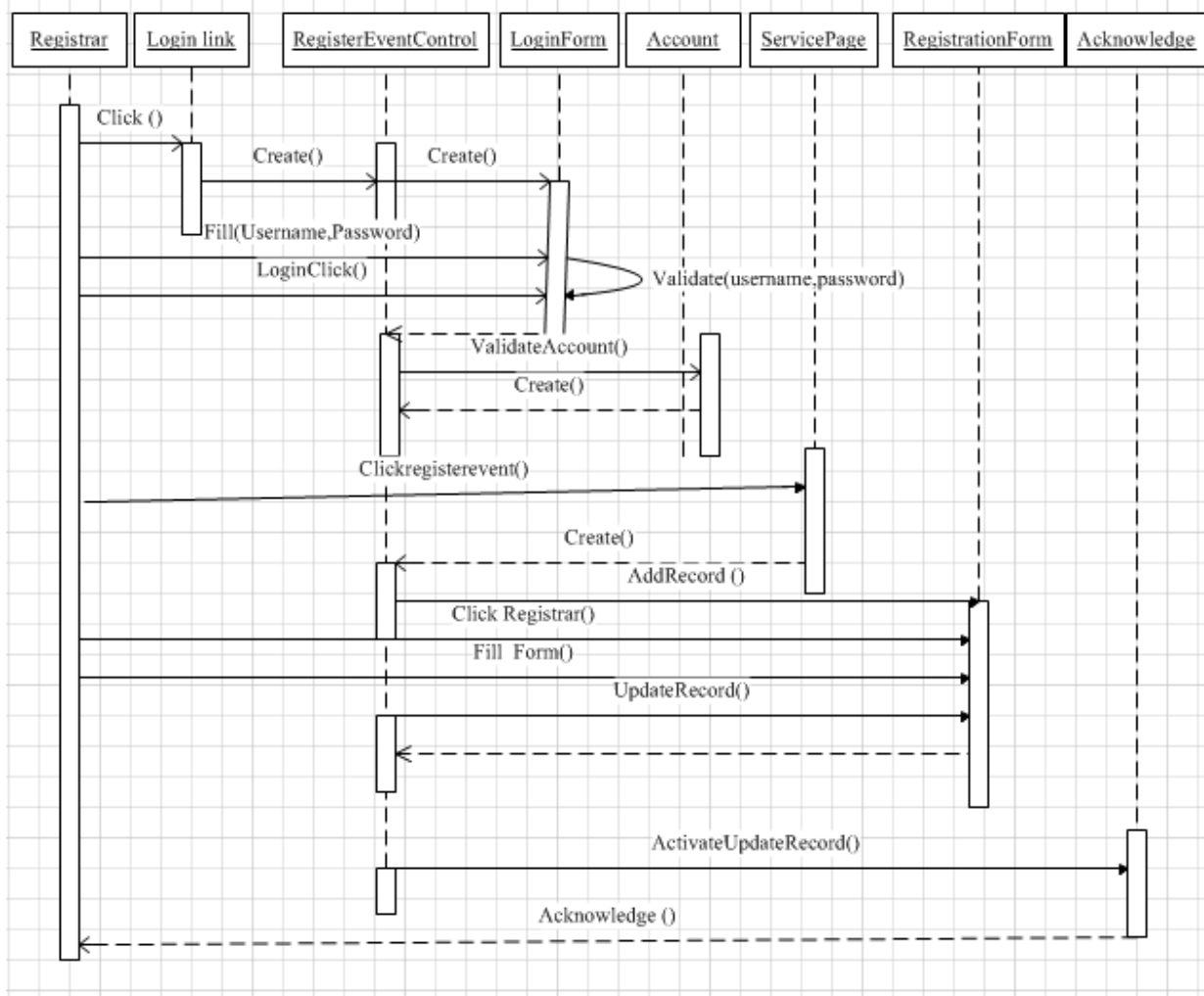
RESPONDENT NO. :		RANDOM :	1
		TAG ON :	2
RESPONDENT NAME. :			
DEPARTMENT NAME :			
POSITION :			

Q.1	For how long have you been working here?	Experience		
		less than 1 year	(a)	
		1 to 2 years	(b)	
		2.1 to 3 years	(c)	
		3.1 to 5 years	(d)	
	More than 5 years	(e)		
Q.1.1	Please describe the main functions of your department? Functional requirement			
Q.2	<p>Is there an integrated VRIS at your organization? Yes_____ No_____</p> <p>If Yes, do you think that the current VRIS at your office is helping you attain the objective of your organization? Yes_____ No_____</p> <p>If No, please can you explain?_____</p>			
Q.3	<p>A. Can you identify the inputs and outputs of the current information system VERA is using? Probe : Services Delivered at VERA</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td> Death, Birth , etc Data Recording system Input ,certificate and Reporting Formats Problems with the Current Recording System </td> </tr> </table> <p>Inputs and Outputs</p> <p>B. What are the existing control mechanism on data entry, security, and processing?</p>			Death, Birth , etc Data Recording system Input ,certificate and Reporting Formats Problems with the Current Recording System
Death, Birth , etc Data Recording system Input ,certificate and Reporting Formats Problems with the Current Recording System				

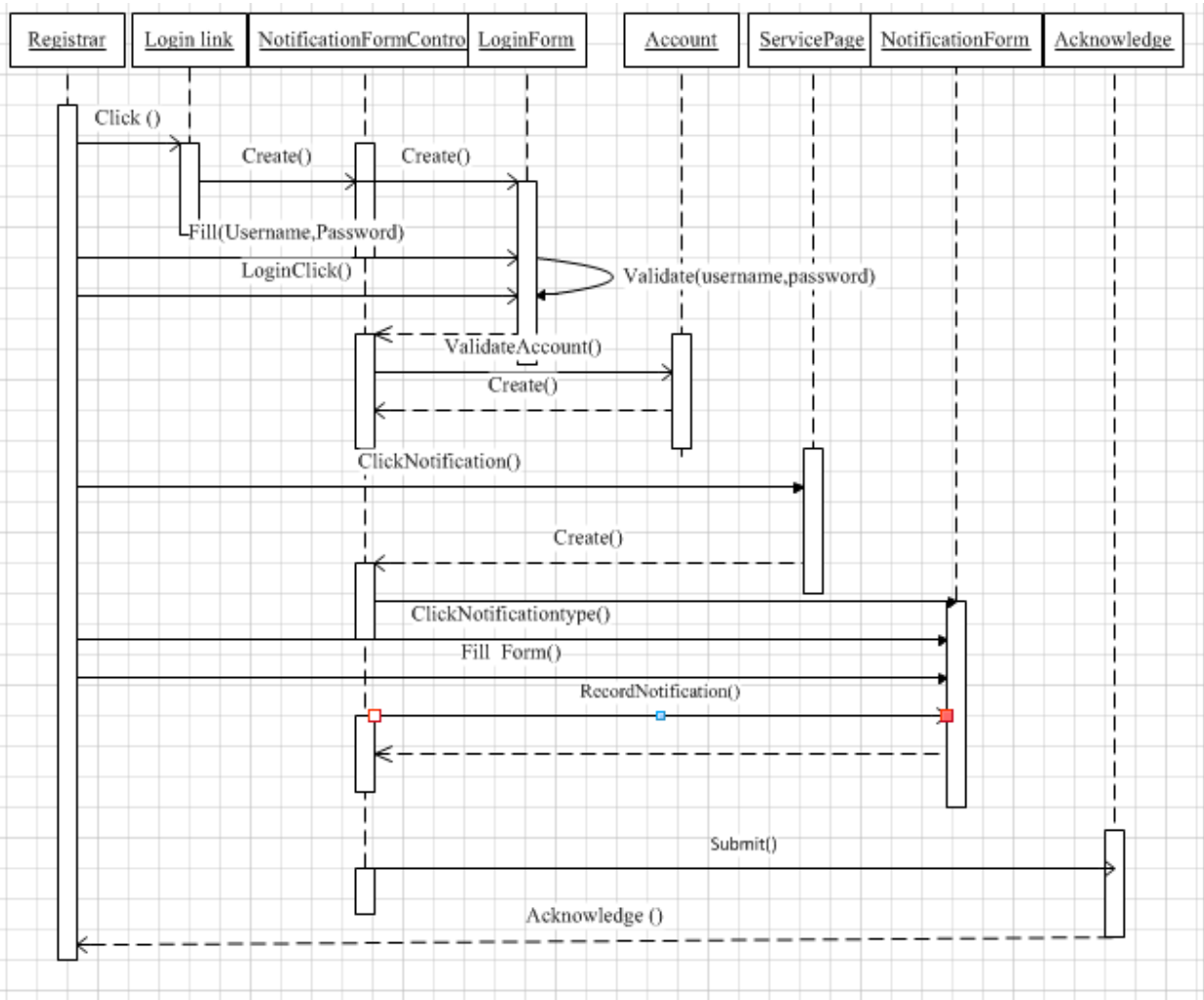
Q.4	<p>What are the problems on the existing vital event registration forms? (Probe: Birth registration form, marriage, divorce and death forms)</p> <p>A. What possible improvements would you suggests on the above mentioned problems?</p> <p>B. What further activities do you think should be done to standardize the vital event registration forms nationally?</p>				
Q.5. A	Which of the following list best describes the current information system in VERA?	Automated	Manual		
Q.5. B	<p>What ICT infrastructures are available in your organizations? (Probe: Database) Identify Data center and Network Architectures</p>				
Q.6	<p>A. Do you think an integrated system in necessary in this organization? Yes_____ No_____</p> <p>B. Who are the possible stakeholders responsible in the making of integrated vital event registration system?</p>				
Q.7	C. What additional information would you like the new system to provide in addition to registering and certifying certificates? As per (User Requirements)				
Q.9	How easy or difficult is it to register the Vital events?	Very easy	Fairly easy	Fairly difficult	Very difficult
Q.10	How do you identify the CoD for a given client?				
	A. Medical Certificate				
	B. Community-based organizations Idder				
	C. Religious organizations				
	D. Verbal Autopsy				

	E. Health Extension Workers				
	F Other (specify and describe)				
Q.11	<p>A. Do you consider COD is mandatory for your organization to certify death? Yes___ No___</p> <p>B. Can VERA capture events like Death at community to ascertain CoD(Apply verbal autopsy?) Yes___ No___</p> <p>C. Can VERA independently generate vital statistics currently? How?</p> <p>ONLY FOR LEGAL SERVICE DEPARTMENT WORKER Is there any mechanism in which you register if a newborn baby died before 48 hours which is not considered as death in the eye of the country's law?</p>				
Q.12	How easy or difficult is it to obtain a Vital Event registration certificate for a given client from your organization?	Very easy	Fairly easy	Fairly difficult	Very difficult
Q.13	Please name the most severe problems or challenges in the obtaining vital event certificates				

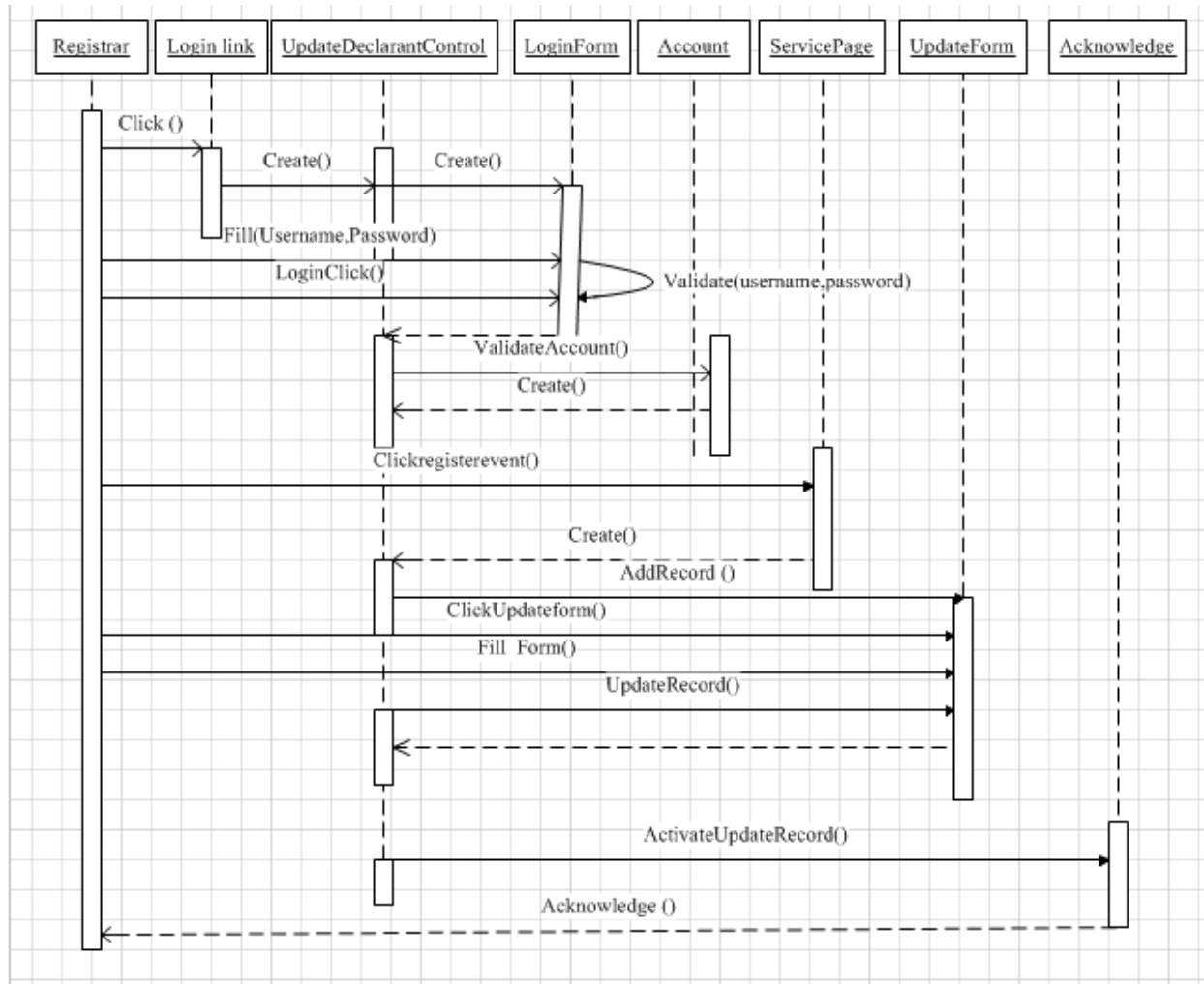
Annex- C: Sequence Diagram for Registration Form



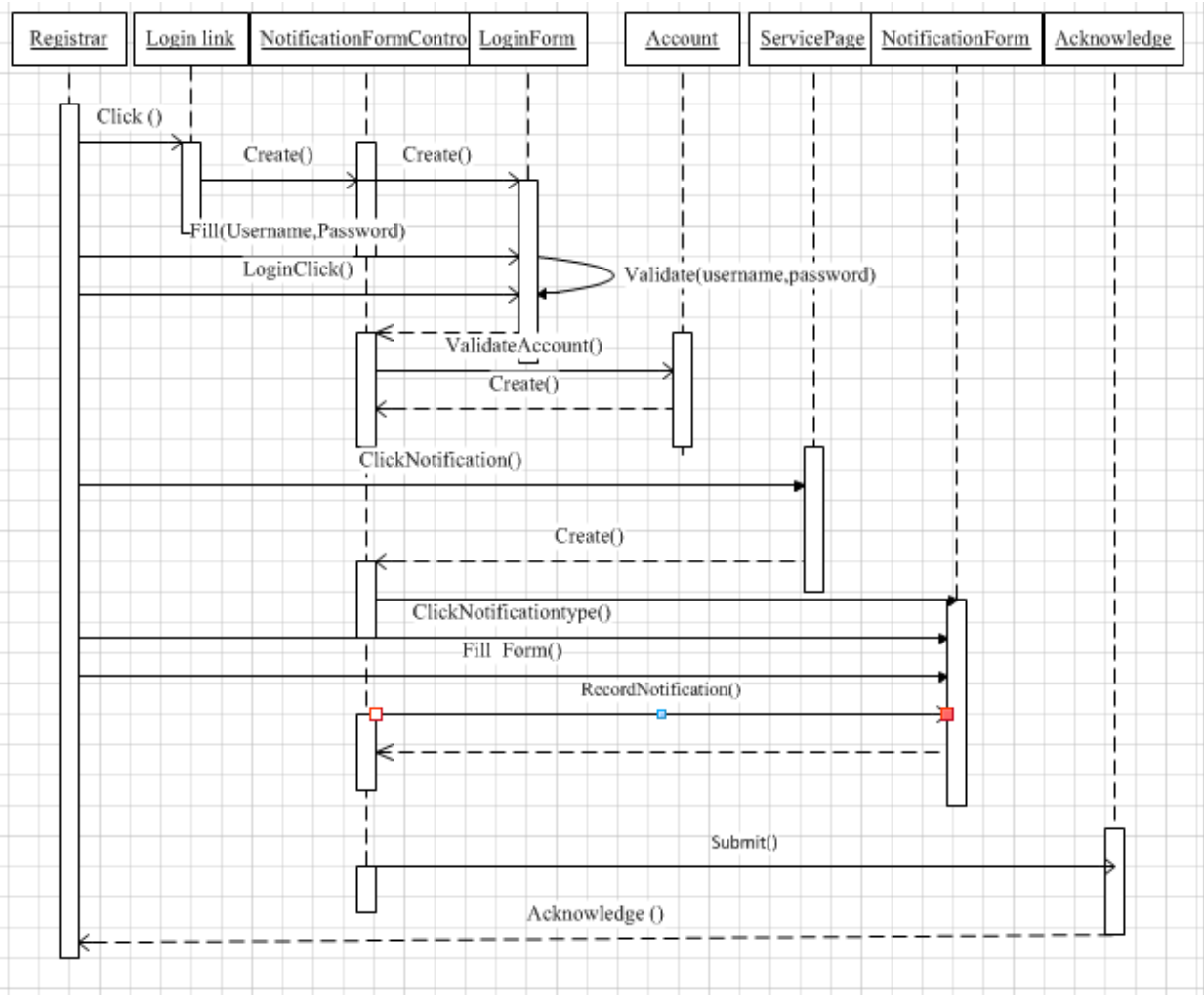
Annex- D: Sequence Diagram for Notification Form



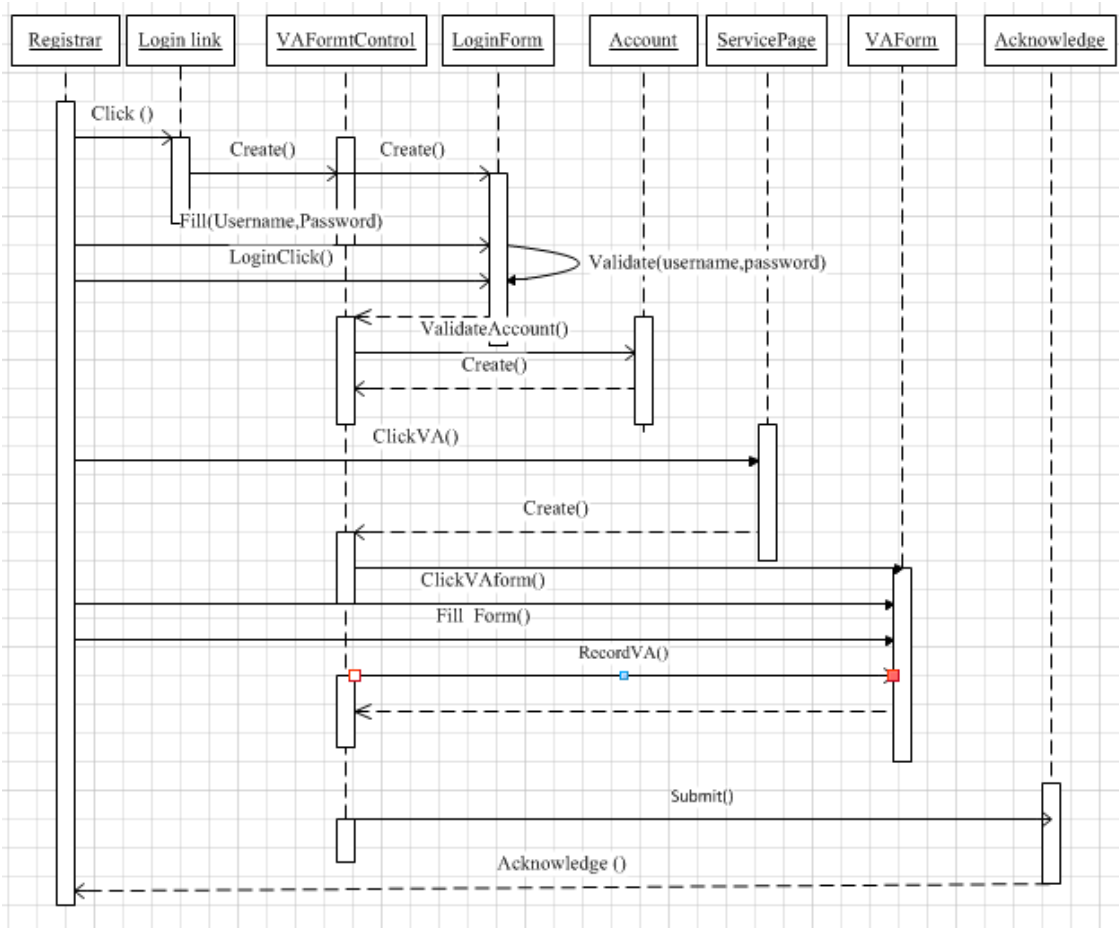
Annex- E: Sequence Diagram for update Form



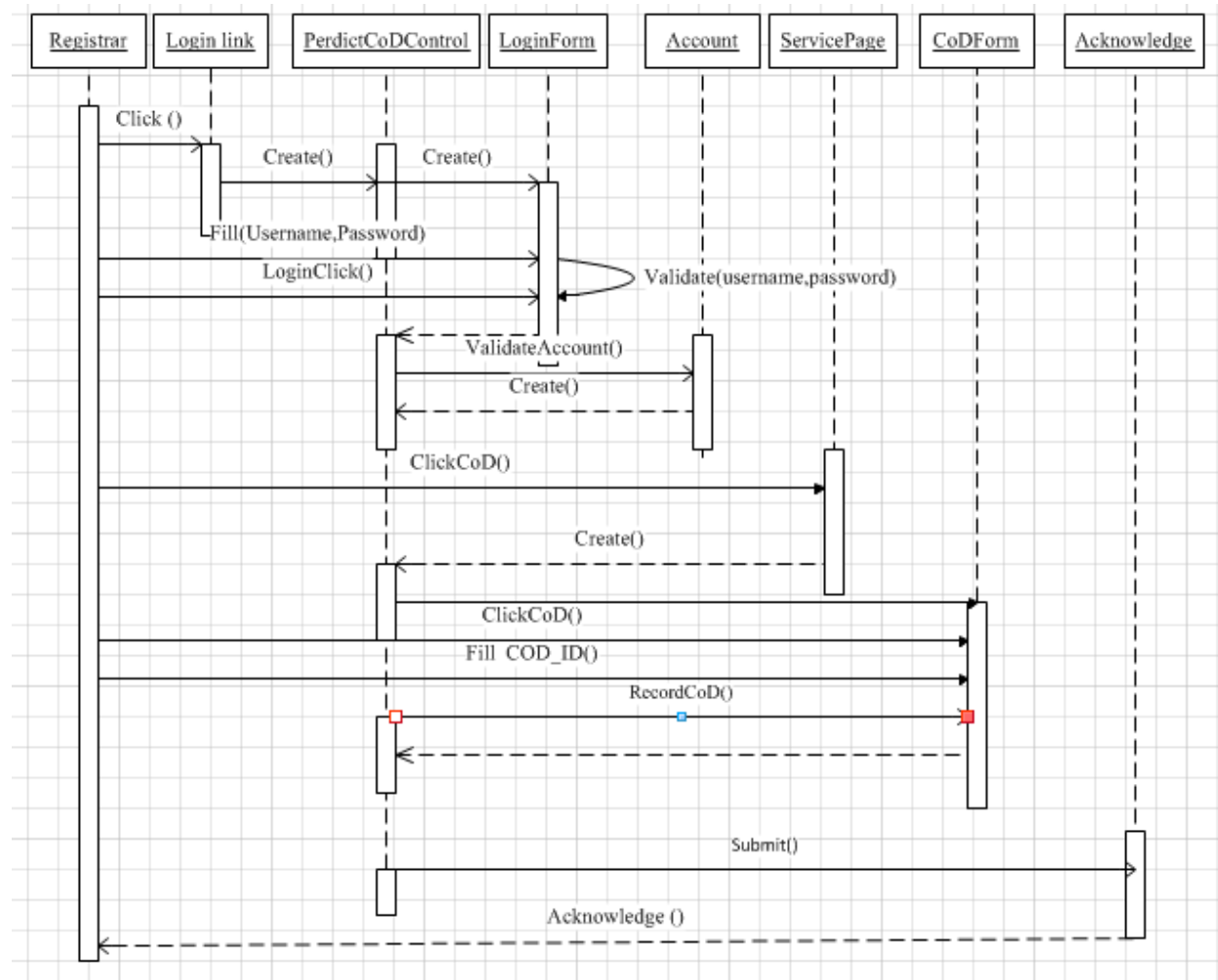
Annex- F: Sequence Diagram for Notification Form



Annex- G: Sequence Diagram for VA Form



Annex- H: Sequence Diagram for COD Form



Annex- I: Vital Event Registration forms and Certification forms

 በኢትዮጵያ ፌዴራላዊ ዲሞክራሲያዊ ሪፐብሊክ የወሳኝ ኮንት ምዝገባ የሞት ክብር መዝገብ ቅጽ		Code 11 የክብር መዝገብ ቁጥር ቋጂ 0
		የሞት ክብር መዝገብ ቅጽ ቁጥር በሀገራዊ ወቅት የሚሰጥ የምዝገባ ፅሁፈት ቤት መለያ ቁጥር የሞት ምዝገባ ልዩ መለያ ቁጥር የልዩት ምዝገባ ልዩ መለያ ቁጥር
I. የምዝገባ ቦታ 1. ክልል /ከተማ አስተዳደር/ ዞን /ከተማ አስተዳደር/ ከተማ ከፍለ ከተማ ወረዳ /ልዩ ወረዳ/ ተባሌ	18. የሞት ምክንያት 1. 2. 3.	
II. ሚናዎችን በተመለከተ 2. ስም የአባት ስም የእያት ስም 3. ዜግነት 4. የነዋሪነት/ብሄራዊ መታወቂያ ቁጥር 5. ማዕረግ 6. ጾታ 7. ስድሜ 8. የትውልድ ወር ቀን ዓ.ም 9. መደበኛ መኖሪያ ቦታ/ሀገር 10. ብሔር 11. ሃይማኖት 12. የትምህርት ሁኔታ 13. የሥራ አይነት 14. የጋብቻ ሁኔታ	19. ለሞት ምክንያት የተሰጠ ማስረጃ አይነት 20. ለሞት ምክንያት የተሰጠ ማስረጃ ቁጥር 21. ሚናዎች የሞተው በእርግጠኛ ወቅት /በወላድ ወቅት /ከወላድ በኋላ በሌላ 42 ቀናት ውስጥ ነው? 22. ተገኝ የተፈፀመበት ለፍራ	
III. ሞቱን በተመለከተ 15. የተከሰተበት ወር ቀን ዓ.ም 16. የተከሰተበት ሥፍራ (ተቋም) ዓይነት 17. የተከሰተበት ቦታ/ሀገር ክልል /ከተማ አስተዳደር/ ዞን /ከተማ አስተዳደር/ ከተማ ከፍለ ከተማ ወረዳ/ልዩ ወረዳ/ ተባሌ	IV. አስመዝጋቢን በተመለከተ 23. ስም የአባት ስም የእያት ስም 24. መደበኛ የመኖሪያ ቦታ 25. ከሚኛ ጋር ያለ ገምጋሚ 26. የነዋሪነት/ብሄራዊ መታወቂያ ቁጥር ፊርማ	
18. የሞት ምክንያት (ተጨማሪ) ዓይነት 19. የተከሰተበት ቦታ/ሀገር ክልል /ከተማ አስተዳደር/ ዞን /ከተማ አስተዳደር/ ከተማ ከፍለ ከተማ ወረዳ/ልዩ ወረዳ/ ተባሌ	V. የክብር መዝገብ ሹምን በተመለከተ 27. ስም የአባት ስም የእያት ስም 28. የተመዘገበበት ወር ቀን ዓ.ም ፊርማ	



የኮንትራት ስም
 የጥያቄ ስም
 የሥራ ስም

በኢትዮጵያ ፌዴራላዊ ዲሞክራሲያዊ ሪፐብሊክ የወላጅ ኩነት ምዝገባ

የጥያቄ ስም ወረቀት

የሚገኝ ስም የአባት ስም የእያት ስም

ማዕረግ ፆታ የትውልድ ወር ቀን ዓ.ም

ዜግነት ሞቱ የተከሰተበት ቦታ

ሞቱ የተከሰተበት ወር ቀን ዓ.ም ሞቱ የተመዘገበበት ወር ቀን ዓ.ም

የምስክር ወረቀት የተሰጠበት ወር ቀን ዓ.ም

የክብር ምዝገባ ስም ሙሉ ስም

ፊርማ



የልዩ ክብር ማዘጋጀት ቅጽ ቁጥር

የልዩ ምዝገባ ልዩ ሙሉ ስም ቁጥር

**በኢትዮጵያ ፌዴራላዊ ዲሞክራሲያዊ ሪፐብሊክ የወሳኝ ኩነት ምዝገባ
የልዩ ምዝገባ ወረቀት**

የህጻን/ኗ ስም የአባት ስም የእያት ስም

ጾታ የትውልድ ወር ቀን ዓ.ም

የትውልድ ቦታ ዜግነት

የእናት ሙሉ ስም የእናት ዜግነት


የአባት ሙሉ ስም የአባት ዜግነት

ልዩ የተመዘገበበት ወር ቀን ዓ.ም የምስክር ወረቀት የተሰጠበት ወር ቀን ዓ.ም

የክብር መዝገብ ስም ሙሉ ስም

ፈርማ

 <p>በኢትዮጵያ ፌዴራላዊ ዲሞክራሲያዊ ሪፐብሊክ የወሳኝ ኩነት ምዝገባ የልደት ክብር ሙዝገብ ቅጽ</p>		የልደት ክብር ሙዝገብ ቅጽ ቁጥር የምዝገባ ልዩ ልዩ ሙሉ ስም ቁጥር የልደት ምዝገባ ልዩ ሙሉ ስም ቁጥር
I. የምዝገባ ቦታ 1. ክልል /ከተማ አስተዳደር/ ዞን /ከተማ አስተዳደር/ ከተማ ክፍለ ከተማ ወረዳ /ወ/ ወረዳ/ ቀበሌ		IV. ወላጅ ለባትን በተመለከተ 23. ስም የአባት ስም የእያት ስም 24. ዜግነት 25. የገደብ/ገቢ/ገቢ ሙያ/ሙያ ቁጥር 26. የክውልድ ወር ቀን ዓ.ም 27. የክውልድ ቦታ/ሀገር 28. ሙያ/ሙያ የሙያ/ሙያ ቦታ/ሀገር 29. የጋብቻ ሁኔታ 30. የራሳቸው 31. ብሄር 32. የጥያቄ ሁኔታ 33. የክፍለ ስልጣን ፈርማ
II. ሁለት/ሁለትን በተመለከተ 2. ስም የአባት ስም የእያት ስም 3. ስያ 4. ዜግነት 5. የክውልድ ወር ቀን ዓ.ም 6. ልዩ የገንዘብ/ገንዘብ ገደብ/ገንዘብ ገደብ የተሰጠ የገንዘብ ገደብ ቁጥር 7. የክውልድ ቦታ ክልል /ከተማ አስተዳደር/ ዞን /ከተማ አስተዳደር/ ክፍለ ከተማ ክፍለ ከተማ ወረዳ /ወ/ ወረዳ/ ቀበሌ 8. የልደት ቦታ 9. የልደት 16 የተደረገ ወረዳ 10. የልደት ቦታ ስልጣን 11. የጥያቄ/ቅጽ የሙያ ፈርማ		V. ለስምዝገባን በተመለከተ /ለስምዝገባ ክፍለ ስልጣን ውጭ ከሆነ ብቻ የሚሞላ/ 34. ስም የአባት ስም የእያት ስም 35. ስያ 36. የገንዘብ/ገንዘብ ገደብ/ገንዘብ ገደብ 37. የክውልድ ወር ቀን ዓ.ም 38. የክውልድ ቦታ 39. ሙያ/ሙያ የሙያ/ሙያ ቦታ/ሀገር 40. የገንዘብ/ገንዘብ ገደብ ሙያ/ሙያ ቁጥር ፈርማ
III. ወላጅ ለባትን በተመለከተ 12. ስም የአባት ስም የእያት ስም 13. ዜግነት 14. የገንዘብ/ገንዘብ ገደብ ሙያ/ሙያ ቁጥር 15. የክውልድ ወር ቀን ዓ.ም 16. የክውልድ ቦታ/ሀገር 17. ሙያ/ሙያ የሙያ/ሙያ ቦታ/ሀገር 18. የጋብቻ ሁኔታ 19. የራሳቸው 20. ብሄር 21. የጥያቄ ሁኔታ 22. የክፍለ ስልጣን ፈርማ		VI. የክብር ሙዝገብ ስምን በተመለከተ 41. ስም የአባት ስም የእያት ስም 42. የገንዘብ/ገንዘብ ገደብ ሙያ/ሙያ ቁጥር ቀን ዓ.ም ፈርማ

 <p>በኢትዮጵያ ፌዴራላዊ ዲሞክራሲያዊ ሪፐብሊክ የወሳኝ ኩነት የጋብቻ ምስክር ወረቀት</p>		የጋብቻ ክብር ሙዝገብ ቅጽ ቁጥር የጋብቻ ምዝገባ ልዩ ሙሉ ስም ቁጥር የጋብቻ ልዩ ልዩ ሙሉ ስም ቁጥር የጋብቻ ልዩ ልዩ ሙሉ ስም ቁጥር
የሚሰጥ ሙሉ ስም የትውልድ ወር ቀን ዓ.ም ዜግነት ጋብቻው የተፈጸመበት ወር ቀን ዓ.ም ጋብቻው የተመዘገበበት ቦታ-ክልል /ከተማ አስተዳደር/ ዞን/ከተማ አስተዳደር/ ከተማ ክፍለ ከተማ ወረዳ/ወ/ ወረዳ/ ቀበሌ ጋብቻው የተመዘገበበት ወር ቀን ዓ.ም የምስክር ወረቀት የተሰጠበት ወር ቀን ዓ.ም የክብር ሙዝገብ ስም ሙሉ ስም ፈርማ	የባል ሙሉ ስም የትውልድ ወር ቀን ዓ.ም ዜግነት ጋብቻው የተፈጸመበት ወር ቀን ዓ.ም የምስክር ወረቀት የተሰጠበት ወር ቀን ዓ.ም የክብር ሙዝገብ ስም ሙሉ ስም ፈርማ	



በኢትዮጵያ ፌዴራላዊ ዲሞክራሲያዊ ሪፐብሊክ የወሳኝ ኩነት ምዝገባ

የጋብቻ ክብር መዝገብ ቅጽ

የጋብቻ ክብር መዝገብ ጽ/ቤት ቁጥር _____
 የምዝገባ ጽ/ቤት ስም _____
 የጋብቻ መዝገብ ልዩ ጽ/ቤት ቁጥር _____
 የመዘጋጀት ባለሙያ ስም _____
 የመዘጋጀት ባለሙያ ስም _____

<p>I. የምዝገባ ዐቃ 1. ስም (በተግባር) _____ የጋብቻ ስም (በተግባር) _____ በተግባር _____ የጋብቻ ስም _____ ወ/ሮ (ይ/ሮ ወ/ሪ) _____ ተ/ሪ _____</p>	<p>26. የመዘጋጀት የሥራ ስም 1. ስም _____ ስም _____ ስም _____ መዘጋጀት የሥራ ስም _____</p>
<p>II. መዘጋጀትን በተመለከተ 2. ስም _____ ስም _____ ስም _____ 3. ስም _____ 4. የምዘጋጀት/የሥራ መዘጋጀት ቁጥር _____ 5. የተወሰደ ወር _____ ቀን _____ ሳ.ዎ _____ 6. የተወሰደ ቦታ _____ 7. መዘጋጀት የሥራ ስም _____ 8. ብሔር _____ 9. የጋብቻ ስም _____ 10. የወረቀት ጋብቻ ስም _____ 11. የተወሰደት ቦታ _____ 12. የሥራ ስም _____ ራርም _____</p>	<p>የምዘጋጀት/የሥራ መዘጋጀት ቁጥር _____ ራርም _____ 2. ስም _____ ስም _____ ስም _____ መዘጋጀት የሥራ ስም _____ የምዘጋጀት/የሥራ መዘጋጀት ቁጥር _____ ራርም _____ 27. የመዘጋጀት የሥራ ስም 1. ስም _____ ስም _____ ስም _____ መዘጋጀት የሥራ ስም _____</p>
<p>III. መዘጋጀትን በተመለከተ 13. ስም _____ ስም _____ ስም _____ 14. ስም _____ 15. የምዘጋጀት/የሥራ መዘጋጀት ቁጥር _____ 16. የተወሰደ ወር _____ ቀን _____ ሳ.ዎ _____ 17. የተወሰደ ቦታ _____ 18. መዘጋጀት የሥራ ስም _____ 19. ብሔር _____ 20. የጋብቻ ስም _____ 21. የወረቀት ጋብቻ ስም _____ 22. የተወሰደት ቦታ _____ 23. የሥራ ስም _____ ራርም _____</p>	<p>የምዘጋጀት/የሥራ መዘጋጀት ቁጥር _____ ራርም _____ 2. ስም _____ ስም _____ ስም _____ መዘጋጀት የሥራ ስም _____ የምዘጋጀት/የሥራ መዘጋጀት ቁጥር _____ ራርም _____</p>
<p>IV. ጋብቻውን በተመለከተ 24. የተወሰደ ወር _____ ቀን _____ ሳ.ዎ _____ 25. የተወሰደ ቦታ _____</p>	<p>V. የክብር መዝገብ ስምን በተመለከተ 28. ስም _____ ስም _____ ስም _____ 29. የተወሰደ ወር _____ ቀን _____ ሳ.ዎ _____ ራርም _____</p>



የፍቺ ኩባንያ ማዘገብ ቅጽ ቁጥር
 የፍቺ ምዝገባ ልዩ ማለያ ቁጥር
 የተፋቺዎች ልዩ ምዝገባ ልዩ ማለያ ቁጥር
 የተፋቺው ልዩ ምዝገባ ልዩ ማለያ ቁጥር

በኢትዮጵያ ፌዴራላዊ ዲሞክራሲያዊ ሪፐብሊክ የወሰኝ ኮንት ምዝገባ
የፍቺ ምስክር ወረቀት

የተፋቺዎች ሙሉ ስም	የተፋቺው ሙሉ ስም
የትውልድ ወር ቀን ዓ.ም	የትውልድ ወር ቀን ዓ.ም
የትውልድ ቦታ	የትውልድ ቦታ
ዜግነት	ዜግነት
ፍቺው የተፈጸመበት ወር ቀን ዓ.ም	ፍቺው የተፈጸመበት ቦታ
ፍቺው የተማዘገበበት ወር ቀን ዓ.ም	የምስክር ወረቀት የተሰጠበት ወር ቀን ዓ.ም
የኩባንያ ማዘገብ ስም ሙሉ ስም	
ፈርማ	



በኢትዮጵያ ፌዴራላዊ ዲሞክራሲያዊ ሪፐብሊክ የወሰኝ ኩነት
የፍቺ ክብር መዝገብ ቅጽ

የደብዳቤ መዝገብ ቁጥር ቁጥር _____ በስም ስም የሚለካ

የየደብዳቤ ባለቤት ስም የሚለካ _____

የደብዳቤ አድራሻ የሚለካ _____

የአድራሻ ስም የሚለካ የሚለካ _____

የአድራሻ ስም የሚለካ የሚለካ _____

<p>I. የመዝገብ ቦታ</p> <p>1. ስልጠና (የተማሪው ስም) _____ የትምህርት ደረጃ _____</p> <p>ከተማ _____ ክፍለ ከተማ _____</p> <p>ወ/ሮ/ሀ/ሮ/ወ/ሪ/ሲ/ሪ _____ ቆይታ _____</p>	<p>IV. ፍቺውን በተመለከተ</p> <p>22. የሥራው ጋብቻ የሚመለከት ድር _____ ዓ.ኅ. _____ ዓ.ም. _____</p> <p>23. የሥራው ጋብቻ የሚመለከት ቦታ _____</p> <p>24. የፍቺው መነሻ _____</p> <p>25. ፍቺው የሚመለከት ድር _____ ዓ.ኅ. _____ ዓ.ም. _____</p> <p>26. ፍቺውን የሚመለከት የሥራ ስያሜ _____</p> <p>የሥራ ስያሜ የሚለካ _____</p> <p>27. ሥራው ጋብቻ ውስጥ ይተገበራል የሚለካ የሚለካ _____</p>
<p>II. ተጨማሪ መረጃ በተመለከተ</p> <p>2. ስም _____ የአባት ስም _____ የእያንዳንዱ ስም _____</p> <p>3. አገሩ _____ 4. የትምህርት/የሥራ ስም የሚለካ _____</p> <p>5. የተቀረፀ ድር _____ ዓ.ኅ. _____ ዓ.ም. _____</p> <p>6. የተቀረፀ ቦታ _____</p> <p>7. የደብዳቤው አድራሻ _____</p> <p>8. ስራ _____ 9. ስም የሚለካ _____ 10. የትምህርት ደረጃ _____</p> <p>11. የሥራ አይነት _____</p> <p>የአድራሻ ፊርማ _____</p>	<p>V. የክብር መዝገብ ስምን በተመለከተ</p> <p>28. ስም _____</p> <p>የአባት ስም _____</p> <p>የእያንዳንዱ ስም _____</p> <p>29. የተመለከተ ድር _____ ዓ.ኅ. _____ ዓ.ም. _____</p> <p>ፊርማ _____</p>
<p>III. ተጨማሪ መረጃ በተመለከተ</p> <p>12. ስም _____ የአባት ስም _____ የእያንዳንዱ ስም _____</p> <p>13. አገሩ _____ 14. የትምህርት/የሥራ ስም የሚለካ _____</p> <p>15. የተቀረፀ ድር _____ ዓ.ኅ. _____ ዓ.ም. _____</p> <p>16. የተቀረፀ ቦታ _____</p> <p>17. የደብዳቤው አድራሻ _____</p> <p>18. ስራ _____ 19. ስም የሚለካ _____</p> <p>20. የትምህርት ደረጃ _____ 21. የሥራ አይነት _____</p> <p>የአድራሻ ፊርማ _____</p>	