ADDIS ABABA UNIVERSITY

FACULTY OF THE SCHOOL OF INFORMATION SCIENCE

HEALTH INFORMATICS PROGRAM

A WEB-BASED NATIONAL DATA CENTER FRAMEWORK TO INTEGRATE HEALTH RELATED PUBLICATIONS IN ETHIOPIA

By

Birhan Atnafu Asrat

June, 2012

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I, the undersigned, declare that this thesis work is my original work, has not been presented for a degree in this or any other universities, and all sources of materials used for the thesis have been duly acknowledged.

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As thesis research advisors, we hereby certify that we have read and evaluated this thesis prepared under our guidance by Birhan Atnafu entitled "A Web-based National Data Center Framework to Integrate Health Related Publications in Ethiopia". We recommend that it be submitted as fulfilling the thesis requirement.

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Advivor (1)	Signature	Date

_____	_____	_____
Advisor (2)	Signature	Date

As a member of the Board of Examiners, we certify that we have read, and evaluated the thesis and examined the candidate. We recommended that the thesis be accepted as fulfilling the thesis requirements for the Degree of Master of Science in Health Informatics.

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This thesis is dedicated to my mother

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LIST OF ABBREVIATIONS

HIS	Health Information Systems
HSD	Health System Development
HSP	Health Service Providers
ICT	Information Communication Technology
MoH	Ministry of Health
NDC	National Data Center
OS	Operating System
POP	Post Office Protocol
PHI	Public Health Institute
UML	Unified Modeling Language
WMS	Warehouse Management System
WNDC	Web-Based National Data Center
WWW	World Wide Web
WYSIWYG	What You See What You Get

Abstract

Background—Managing and integration health information has been possible and improved through different technologies such as web-based systems and computer applications. The objective of this study is to search for a solution to integrate health related publications from various nationwide hospitals and health associations and institutes using a central web-based national data center for publications to mobilize the new fragmented, but inter-related health publications.

Methods— There are many hospitals, health associations and institutes throughout Ethiopia; but the activities in these institutes within health care delivery and management are almost similar. Therefore, variables and definitions for activities are almost identical for the proposed Web-based National Data Center application. For this reason, only limited numbers of health institutes are taken from Addis Ababa for data gathering using purposive and stratified sampling methods. Data were collected and analyzed to obtain representative input requirements to design the new system. Based on the results of the analysis, common services, practices, information technology usage, locally available and international health websites and publications were identified; methods for data security are assessed, interpreted and devised..

Results — This is the first web-based national data center proposed to integrate health related publications from local and foreign sources in Ethiopian context. The health sector is vast and broad that encompasses different resources. In this thesis, based on the results of the requirements analysis, the web-based national data center for health related publications system is proposed as a solution for integration of health related publications. Only one of the segments of the health resources, publication, is addressed using web-based application. Even though there are many services which can be done in the same area yet, the researcher believes that this application may serve as a pilot to design and implement a full-fledged system. Therefore, this application is open, flexible and amendable for any change which is found to be essential.

Key Words: Data center, Databank, web-services, web-based application in Health, Web-based Health publication, Ethiopia and ICT, Health publication Database.

CHAPTER ONE: INTRODUCTION

1.1. Background of the study

Health information systems (HIS) comprise the entire infrastructure, organization, workforce and components for the collection, processing, storage, transmission, display, dissemination and disposition of information in the healthcare industry. In most of the cases, the programs are written in different computer languages, compiled on different platforms, run on different hardware and have different data structures, types and formats. They function independently and do not share their data. As a result, the IT infrastructure in such organizations consists of a number of autonomous and heterogeneous solutions, which cause integration problems and their interconnectivity and interoperability have continued to be a big issue, as in any healthcare organization it is essential to be able to retrieve information from disparate information systems [1].

The internet is the biggest Wide Area Network on the planet. It interconnects millions of computers and other electronic equipments that are linked by different means of telecommunications and allows people to share information and resources. Utilization of ICT information and resources vary greatly among countries. The major bottlenecks that limit performance are lack of integration, organization and inability to efficiently move large amounts of data among these computers and other electronic equipments.

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.

Changing work in healthcare, e.g. to support patient-centered care and regional healthcare networks, requires integrating health information systems and many workflows in the healthcare facilities involve more than one application. At the same time, the application architectures for the new systems in healthcare are evolving towards the use of web-enabled, distributed and component and service-based systems [1].

Therefore, there is a need for a novel approach to evaluate the solution for integration of health related publications considering web-based application as a tool. As the number of heterogeneous health information systems grow, integration becomes an issue and it has to be given priority.

1.2. Concepts and Trends of web application and Integration

Web applications are popular due to the presence of web browsers, and the convenience of using a web browser. The ability to update and maintain web applications without distributing and installing software on potentially thousands of client computers is a key reason for their popularity, as is the inherent support for cross-platform compatibility. Common web applications include web mail, online retail sales, online auctions and many other functions [2].

Many software products have been built and acquired from heterogeneous sources during a long period of time, and the systems have differences in implementation technologies and architectures. These legacy systems, the heterogeneous environment and an increasing pressure to introduce new software rapidly add even more pressure on the systems integration. Furthermore, there are many complementary and also overlapping technologies and standards available for integration [1].

Data integration involves combining data residing in different sources and providing users with a unified view of these data. This process becomes significant in a variety of situations, which include both commercial; when two similar companies need to merge their databases and scientific; combining research results from different repositories. Data integration appears with increasing frequency as the volume and the need to share existing data explodes. It has become the focus of extensive theoretical work, and numerous open problems remain unsolved [5].

1.2.1. Benefits of Web-based Applications and Integration

Web applications have versatile benefits from all life aspects. Few of these are: web applications do not require any complex "roll out" procedure to deploy in large organizations, a compatible web browser is all that is needed, browser applications typically require little or no disk space on the client, web applications require no upgrade procedure since all new features are implemented on the server and automatically delivered to the users, web applications integrate easily into other server-side web procedures, such as email and searching. Web applications also provide cross-platform compatibility in most cases (i.e., Windows, Mac, Linux, etc.) because they operate within a web browser window [3].

Through integration, poorly coordinated and largely independent processes and systems are linked to remove redundant operations and administrative overheads.

Countries like Ethiopia and Nigeria are taking development of ICT infrastructure and human resource factors in the health sector to enhance health information systems [4]. Ministry of health has made a reform in the sector to improved access and quality of health services via use of ICT [14]. But technology alone does not yield value unless it is actively and appropriately employed to appropriate processes. As the researcher assured from MoH, health related publications in Ethiopian health institutes are scattered and there is no common web-based system to integrate inter-related publications.

1.3. Statement of the Problem

Data integration appears with increasing frequency as the volume and the need to share existing data explodes. It has become the focus of extensive theoretical work. Regarding this issue, there are different healthcare systems integration works done so far. Their focus is more on the system, not on the resources and institutes. These studies define selecting appropriate standards or approaches for each integration need are a complex task for the integration [1]. But, differently, this study is especially an understanding of the context through an assessment where this fretwork can be applicable for understanding the effectiveness of web-base application as a solution to integrate and mobilize health publications.

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 health care information system. Existing fundamental problems being the motivation for this study are poor and fragmented data quality which results from lack of integrated and mobilized system.

The framework proposed helps physicians and other health stakeholders and researchers to be able to get health publication information. It minimizes data duplication, and allows users to query, exchange experiences, use, analyze, and combine digital health publications in their activities across the WNDC where there is integrated data from different systems.

This research intends to advance the overall integration effort for health sector resources through web-based application.

1.4. Research questions

1. Do health workers have ICT literacy and experience of using publications?
2. Which publications are common across different health institutes?
3. What are those system specifications which help to design a WNDC application?
4. Can a WNDC be a solution to integrate and alleviate the problems of lack of integration of health related publications?

1.5. Objectives of the study

General Objective

The general objective of the study is to analyze, propose and design appropriate central WNDC application to integrate and avail health related publications.

Specific Objectives:

To attain the general objective the following specific objectives were identified.

i To assess health institute workers' ICT literacy and health publication usage.

ii To identify different health institutes' heterogeneous inter-related publications.

iii To perform systems specifications for technical description of the WNDC system.

iv To analyze and design working WNDC application in order to integrate health related publications in Ethiopian context.

1.6. Significance of the Study

This study enables private, governmental hospitals, and others who have similar interests in the health sector that are currently unknown to one another to create a partnership to share resources easily for mutual benefit. Direct system beneficiaries will be physicians and other health professionals. Moreover this Web-based system will help different stake holders like government, industry, academia, and individuals to share information easily form one WNDC via a web-based interface.

The WNDC framework is designed to allow secure data exchange between the host entity and the health industry, including data submission, communication and access via the Web. In this way, the presence of a WNDC creates an environment that facilitates communications among different stake holders. It removes the barriers to poor data organization and lack of integration of inter-related health data. In addition, it assures an automated tool that would be used 24 hours without limitation of distance and helps to save time, storage place and effort. Patients, health professionals, government, and researchers needing health information will be able to get integrated information when they are in need of some particular publications.

Research works of different scholars can be collected in a central system so that other fellow students can have opportunities to see others' works and at the same time educators can be able to get list of works in order to prevent duplication of research works.

1.7. Scope and Limitations of the Study

The scope of this research is limited to sketching out and designing the WNDC for integration of health and health related publications of different health institutes which are found in Ethiopia. Publications can be of local, regional or international type. The main inclusion or exclusion criteria are existence of the publication and research experience. The thesis does not incorporate all health related data, documentations, and Health Information Systems (HIS) of health institutes which are found in Ethiopia due to time and the complex nature of these resources to be handled by an individual researcher.

1.8. Organization of the Paper

The rest of this thesis comprises of six chapters. The next chapter contains reviews of problem related literatures. Chapter three covers the research methodology which includes research design, research approaches and methods, research techniques, requirements gathering and analysis and methods of data analysis. Chapter four contains results that are all about analysis of qualitative and quantitative variables of assessment results. Chapter five presents discussion and interpretation. It is about object oriented analysis and system design of major function of the system which includes functional and non-functional requirements, deals implementation strategy and testing. Chapter six is about conclusion and the final chapter is recommendation for future work.

CHAPTER TWO: LITERATURE REVIEW

In this chapter, firstly, the key challenges for enterprises are raised and the concept of integration is summarized based on previous studies, and gaps in the previous literature are presented. Finally, several web-based applications and the trends of using web-based application in the health sector are reviewed.

From the evidence obtained from the assessment done by McKinsey [29], the huge sums invested in information technologies (IT) have not really served organizations' business strategies as effectively as expected. Therefore, there is a need to justify IS expenditure by examining its contribution to achieving organizational goals.

One of the key challenges for different size enterprises is how to efficiently integrate the different business functions using the information technology. The key challenges for enterprises nowadays are, how efficiently to integrate business functions and associated systems using web services. There are different integrations; systems integration, applications integration, process integration and services integration.

There exist a number of studies done in the concept of integration of systems. Within the domain of healthcare information systems, for example, it is raised that different types of integration requirements cannot be satisfied by one integration approach only. Moreover, selecting appropriate standards or approaches for each integration need is a complex task for the integration projects, and systems integration in healthcare facilities requires defining more specific processes for integration [1].

In recent years, healthcare institutions have had problems accessing, maintaining and integrating the large amounts of data they deal with [6]. Even though ICT penetration in the health sector appeared to be low relative to the education sector and public institutions [7], as in other sectors, the health industry in Ethiopia is applying ICT as a tool in different government hospitals and health centers and private hospitals, clinics (higher, medium and lower) and pharmacies in different activities. In general, ICT investment and expenditure are low in the health sector [7].

Due to the heterogeneous and distributed nature of information and communicating technology (ICT) in the healthcare industry, sharing of the data has become an issue. There is an urgent need for the integration of these distributed systems. Several efforts have been made to achieve the integration, but traditional methods can only in part address integration problems. There have been a few studies that specifically examine the role of healthcare systems integration problems [1].

Now days health care and other disciplines heavily depend on timely access to information and require the distribution of information services in support of clinical care and use of information is an important factor for problem solving and decision-making to integrate patient information and health resources [10].

A web-based application is one of the technologies which are applicable in health care. The Web is becoming the standard interface for accessing remote services of information systems, hosting data centers and application service providers. Demands placed on Web-based services continue to grow and Web based systems are becoming more stressed than ever [11]. Shaikh A. and Misbahuddin M. in their article defined the term health care system as a country's system of delivering services for the prevention and treatment of disease. This system is now being changed due to the dynamic nature of technological and scientific medical practices. The health care systems are applying technologies into their health care procedures [12]. However, it seems that it is more concerned with the application of science and technology. The idea of integration is not raised in the article. This article neglects the effect of the performance aspect of the application of technology and IS.

The development of web based database systems has led to a remarkable new dimension of information retrieval and distribution [5].

Supporting integrated health information services does not mean that everything has to be integrated into one package. The aim is to provide services which are not coherent for the user and which the user can easily navigate [14]. An integrated health information infrastructure is important and need to be based on common standards for information

sharing and exchange between information systems, and programs. Implementing integrated health information system is difficult for a number of reasons, including lack of coordination between programs, absence of a strong vision for an integrated information system, and difficulties in accessing and communicating [9]. However, this work mainly focused on common standards and systems, not on giving a methodology or concept for integrating different health resources. More generally, there are approaches to address this issue.

2.1. Technologies in Healthcare Computing

WNDC is one of the services of the ICT industry. Though the efficiency differs, many developed and developing countries are using ICT in different disciplines. In Africa some countries have embraced ICT as modern tools for transforming service delivery and facilitation of socio-economic development [1]. But there are many concerns in the efficient and effective utilization of ICT. According to Meke et.al [1], the degree to which Health Service Providers (HSP) and patients use available ICT to provide and access health services respectively remains relatively unknown. Without a clear understanding of the patterns of ICT use by HSP and patients alike, the full potential for ICT use in Health System Development (HSD) may not be realized. The above concerns may result in underutilization and inefficient use of ICT in HSD in Africa.

In the work proposed by Moges G. [16], the huge problem of retrieving data and literature in the developing world is obviously due to the prohibitively expensive journals and books. Here, although problems of retrieving data and literature are discussed, integration which is fundamental for alleviating these problems is not raised.

Parmanto B. et al. [17] have described three factors that should be considered in the decision to adopt emerging technologies for use in the healthcare environment. First, the technology must contribute to lowering the overall costs incurred in the delivery of healthcare services. Second, the technology should offer a competitive advantage. Finally, the technology should have an impact in improving patient care. Web-based healthcare applications can potentially bring unprecedented information access to

everyone and can provide a unique competitive advantage while at the same time playing a part in improving patient care.

2.2. Web-based Health Publications

There are several web-based health applications and publications worldwide. Harvard Health Publications is one of these web-based health publications. This website contains different health related publications in different formats like health newsletters, reports, books, and websites/ HTML under the publishing division of the Harvard Medical School of Harvard University. The goal of the publications is to bring people around the world the most current health information that is authoritative, trustworthy, and accessible, drawing on the expertise of 9,000 faculty physicians at Harvard Medical School The Health newsletters module contains Health Letter that provides medical information from research articles and direct advice from the than 8,000 doctors [14].

2.3. The Web Structure and Essential Technology Requirements

Design of high performance, scalable and dependable data centers has become a critical issue because of the increasing use of the Internet in supporting various Web-based services [2].

For this reason, applications are usually broken into logical tiers, where every tier is assigned a role. Traditional applications consist only one tier, which resides on the client machine. The most common structure is the three-tiered application. These are called presentation, application and storage, in this order. A web browser is the first tier that serves as an intermediate for relaying requests and data between the front and back-ends.; an engine using some dynamic Web content technology (such as Active Server Page (ASP), ASP.NET, Java, PHP) is the middle tier (application logic), and a database is the third tier (storage).The web browser sends requests to the middle tier, which services them by making queries and updates against the database and generates a user interface [5].

Similarly, the three main components of the WNDC are: the user interface, the server and database and the medical devices/ data modules. The front-end Web server is closest to the edge of a data center and is responsible for handling the static requests. The middle tier, called the application server, is responsible for handling the dynamic Web contents, while the back-end database server is dedicated for complex database transactions [28]. While Web servers and application servers may share the same machine or set of servers, it is common to separate the database on a separate machine or set of servers dedicated to that task [19].

2.3.1. Presentation Tier: Front-end: User Interface Design

User Interface layer usually consists of a mix of HTML, JavaScript, CSS, Flash, and various server-side code like ASP.Net, ASP, PHP, etc [15].

Applications are designed to help people get their job done, so the success of an application often depends largely on how people use it. Rich user interface design affects application success. The way a user interface is designed has a great impact on how people use the application. In general, applications with well designed rich user interfaces are received well and used well, while applications with poorly implemented user interfaces are received poorly and are not used to their fullest extent. A well designed rich user interface draws the user in and encourages the user to interact with it and learn from the application. This process makes the user more inclined to achieve some level of expertise with the application, thereby making them more effective with the application [21].

The type and the quality of the design of the user interface has an impact on the level of the need for application training. The more well-designed an application is, the less time they have to spend in training before they can effectively use the application on their own [21].

2.3.2. Data Access Tier: Backend-Database Design

The system must have a database back-end that stores all the necessary pieces of information that are related to health related publications and their contents. A back-end database is a database that is accessed by users indirectly through an external application rather than by application programming stored within the database itself or by low level manipulation of the data [16]. There are different database schema languages like Oracle, MS-SQL, MySQL, SAP, and various off-the-shelf software. Schematic representation of the System includes Database system, Web Server, Data source and Request handling mechanisms [10].

2.3.3. Application Tier: Process Design

This tier is also known as "Business Logic", "Functional Process", data access tier, or middle tier. This layer connects the User Interface (UI) and the database ends. It controls an application's functionality by performing detailed processing. Data coming from the two tiers is coordinated and processed. Operations in the business logic tier are mostly automatic and done in the background without the knowledge of the end user.

There are some bottlenecks in this tier as motioned below.

1) Database or back-end processing: This can vary from system to system where the throughput to the database is extremely busy.

2) Middleware bottlenecks: This would be where some web service may be hitting capacity but the front and back ends have bandwidth to handle more traffic.

3) Front-end bottlenecks: This can happen either from client or server-side. If a client has a slow end computer and run lots of data, bottleneck happens. Similarly, the server could be queuing up requests if it is getting hammered with overloaded requests [21].

2.4. Conceptual Framework

The aim of this study is to assess the determinants of health related publication and ICT usage and to collect requirements from sample health institutes. The conceptual framework is drawn from the perspectives of health related publication usage.

In the conceptual framework, different factors supposed to influence workers' health related publication usage particularly, those related to computer literacy, type of computer skills, internet access, experience of reading health publications, type of publication, place where publications are found, and availability of in office publications variables were considered. The conceptual framework emphasized mainly on the impact of these variables in implementing web-based application.

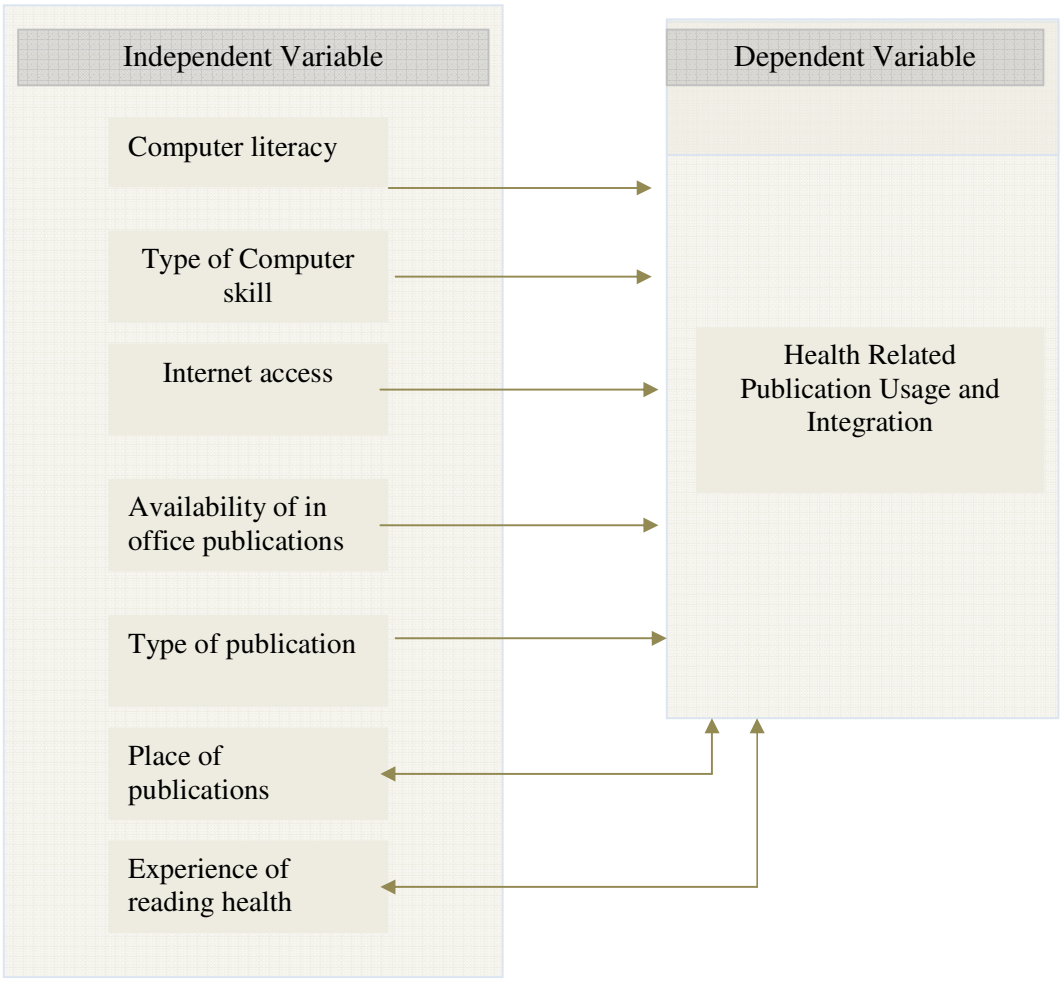


Figure 1: Conceptual Framework for the Study Showing the Relationship between the Dependent and Independent Variables

CHAPTER THREE: RESEARCH METHODOLOGY

Study Area: this study is conducted in Addis Ababa particularly in health institutes which include government hospitals, health associations and NGO which deals with health publications.

3.1. Nature of the Study

The nature of this study is limited only by describing and identifying the possible requirements which are fundamental to search for a solution for integration of health related publications using web-based framework. There is no proposed model from which to study the impact and interaction of the variables among one another. This study has no intention to draw general statistical analysis.

3.2. Research Design

Since the purpose of this study is to identify facts, taught, ideas, and feelings about the current practices of integration of health related publications using web-based application and it adopts a Case study, descriptive research design is appropriate for the problem at hand.

3.2.1. Research Approaches

To gather the needed primary and secondary data, the researcher used both qualitative and quantitative approaches. Questionnaires were distributed and open and close-ended interview was conducted to the target respondents to collect primary quantitative and qualitative data respectively.

3.2.2. Sampling Method and Technique

The researcher defined study population at Addis Ababa health institutes level. Once the target population was defined, the next task performed was taking representative samples. The researcher used both probability and non-probability sampling methods with stratified and purposive sampling techniques respectively.

Proportional stratified random sampling technique was used to select respondents from Zewditu and Tikur Anbessa Hospitals, MoH, Ethiopian Public Health Association, and Ethiopian Medical Associations.

Purposive sampling technique was also applied to get qualitative data from 20 respondents; 9 ICT personnels, 9 institute managers and 2 personnels from MoH and quantitative data from Oxfam.

Parameters of interest: in determining this sample design, the researcher's specific parameter of interest is to estimate the proportion and frequency of workers with some ICT and health related publication usage among available health institutes to gather some inputs in designing the system.

3.2.2.1. Source Population

The sample units for the study were from health institutes which are found in Addis Ababa. The total number of public hospitals in Addis Ababa city is 10 (Health Indicators, FMOH: EFY 2001) and 73 NGOs (Center for National Health Development in Ethiopia (CNHDE) index) work in the health sector.

3.2.2.2. Target Population

The target population of this study is employees and scholars of Zewditu and Tikur Anbessa Hospitals, MoH, Oxfam (NGO), Ethiopian Public Health Association, and Ethiopian Medical Association.

3.2.2.3. Sample Size

A total of 107 respondents were involved in the actual study. In using the stratified method, there were steps which the researcher followed. The steps which the researcher used in stratification were:

a. Dividing the population into different strata (institute wise).
b. Listing population size in each stratum
c. Taking samples randomly from each stratum

To divide the institutes into strata, the basic criteria used were availability of one's own health related publications and research practices. The number of population in each stratum is different in size. For this reason, samples were taken proportionally. This means that samples vary from one stratum to the other. The number of respondents selected from each stratum is proportional and representative for the target population.

Listing of workers and scholars in areas of interest were obtained from responsible institute bodies. Even though the number of available workers and scholars could be known, not all of them were important for the study at hand; therefore, the researcher arbitrarily distributed questionnaires to 30% of the workers in each institute from known groups.

There were 35 and 19 workers and scholars selected respondents from Tikur Anbessa and Zewditu Hospitals respectively, 6 respondents from Ethiopian Medical Association and 15 from Ethiopian Public Health Association which are selected by this stratified sampling method. The following table gives the summary where questionnaires were distributed for respondents which were selected using both sampling methods.

Table 1: Sample Size taken from health respondents in Addis Ababa, 2012.

Stratum	***Institute Stratum Composition***	***Population Size(N)***	***Sampling Fraction***	***Sample Size***
1	Tikur Anbessa Hospital	117	30%	35
2	Zewditu Hospital	64	30%	19
3	Ethiopian Medical Association	20	30%	6
4	Ethiopian Public Health Association	50	30%	15
			Total	75
5	Oxfam Ethiopia	Purposively		12
			Grand Total	**87**

Source: Own survey, (2012)

Table 2: Socio-demographic characteristics of health respondents in Addis Ababa, 2012.

Selected number of respondents

Respondents	Status	Male	Female	Total
Institute workers and scholars (n=87)	High school graduate	1	3	4
	Diploma	8	8	16
	Degree	16	13	29
	Masters and above	30	8	38
	Total	49	38	87
ICT personnel (n=9)	Diploma	2	1	3
	Degree	2	3	5
	Masters and above	1	-	1
	Total	5	4	9
Institute Managers and MoH (n=11) **N=107**	High school graduate	-	-	-
	Diploma	-	-	-
	Degree	2	6	8
	Masters and above	2	1	3
	Total	4	7	11
		Grand Total (N)		107

Source: Own survey, (2012)

Respondents taken from Oxfam Ethiopia and MoH are 12 and 2 respectively.

3.3. Methods of Data Analysis

Collected quantitative data were analyzed using simple descriptive statistics using frequency and percentage. The qualitative data obtained through interviews were analyzed and interpreted based on themes. Institute managers were interviewed about the availability and number of publications, ICT usage in relation to publication. Randomly selected institute workers and scholars were asked questions which were related to publications and ICT skills. ICT and MoH personnels on their part were asked about available publications and ICT technologies and the contribution of ICT in publication usage and management. Questionnaires were distributed for respondents which were grouped among four categories (strata).

3.4. Definition of Variables

Dependent variable

A dependent variable is a variable that can be affected by another variable/ variable(s). In this study, health related publication usage and integration are considered as the dependent variables, i.e. these can be influenced by other variables.

Independent Variables

Independent variable is a variable that can impact institutes' health related publication usage and integration.

Regarding the quantitative data, research questionnaires contained a series of ten questions all had to deal with the following variables like Computer literacy, type of computer skills, internet access, availability of in office publications, type of publication, place of publications, and experience of reading health.

CHAPTER FOUR: RESULTS

This chapter is devoted to results and discussion of the study. Based on questionnaires that were extracted from research problems of this study, the descriptive analysis is provided and discussed under different appropriate subheadings.

There are different computer skills under computer sector in general. Each skill has its own impact in performing a particular application. Identifying the accessibility of internet and the type of application it serves in health institutes is essential for the system design as the WNDC is a web-based application.

Workers computer literacy, type of computer skills, availability of internet and types of internet services are raised. Regarding this variable, this study was done to understand workers' computer literacy in each institute. Accordingly, workers' computer literacy in the study areas was proved by identifying whether they are computer literate and the types of computer skills they do have.

The results given in Table 3 shows that 87 out of 87 (100%) of workers replied that they have computer literacy. Out of these computer literate workers and scholars, the majority (43.67%) have computer basic skills like MS- Office and Email and internet usage. Of those respondents who are working in sampled health institutes, majority (75.86%) workers have internet access and 24.14% do not have.

Table 3: Computer literacy, internet access and usage health respondents in Addis Ababa, 2012.

Worker respondents

No	*Questions*	*Frequency*		*%*
1	Do you have any computer literacy?			
	A. Yes		87	100
	B. No		-	-
		Total	87	100
2	The type of computer skills for those who are computer literate.			
	A. Computer basic skill like MS- Office.		38	43.67
	B. Email & internet		19	21.84
	C. Advanced applications		9	10.34
	D. A, B		15	17.24
	E. A, B, C		6	6.89
		Total	87	100
3	Availability of internet access in office.		66	75.86
	A. Yes		21	24.14
	B. No	Total	87	100
4	The application of internet in offices which have the access.		31	46.69
			11	16.66
	A. Email service		10	15.15
	B. As a source of information browsing		9	13.63
	C. Data sharing		5	07.57
	D. A,B	Total	66	100
	E. A,B,C			

Source: own data from survey, 2012

The other issue that needs attention is the accessibility of internet and the type of its applications in these areas. Of those who have internet access, 46.69% workers and scholars use internet for Email service, 16.66% as a source of information browsing and 15.15% for data sharing.

Respondents experience in reading health related publications, sources, publications file formats and available own publications are summarized in the table 4. The results reveal that 77.01% of workers read health related publications which are found in different formats and from different sources. Majority (55.22%) workers get these publications from the internet. That is the main source of publications for workers is the internet.

Table 4: Respondents experience in reading health related publications and sources of publications in Addis Ababa, 2012.

No	*Questions*	*Institution workers*		
			Frequency	%
5	Do use and/or read health related publications?		67	77.01
	A. Yes		20	22.99
	C. No			
		Total	87	100
7	The sources of publications		14	20.89
	A. office		37	55.22
	B. internet		14	20.89
	C. library		5	07.46
	D. A,B		4	05.97
	E. A,B,C		13	19.40
	F. B,C			
		Total	67	100

As shown in Table 5, more than half of the workers surveyed (55.17%), have their own health publications in their institutes. Health publications in these institutes are in different formats. They are available in hard copy, soft copy, or in both hard and soft

copy. Assessment results are 33.33%, 45.83%, and 20.83% respectively. Most of these publications are available on the institutes' websites (31.25%), in local computers (29.17%) and office shelves (22.91%).

Table 5: Institutes workers own publications and the type of publications formats in health institutes' respondents in Addis Ababa, 2012.

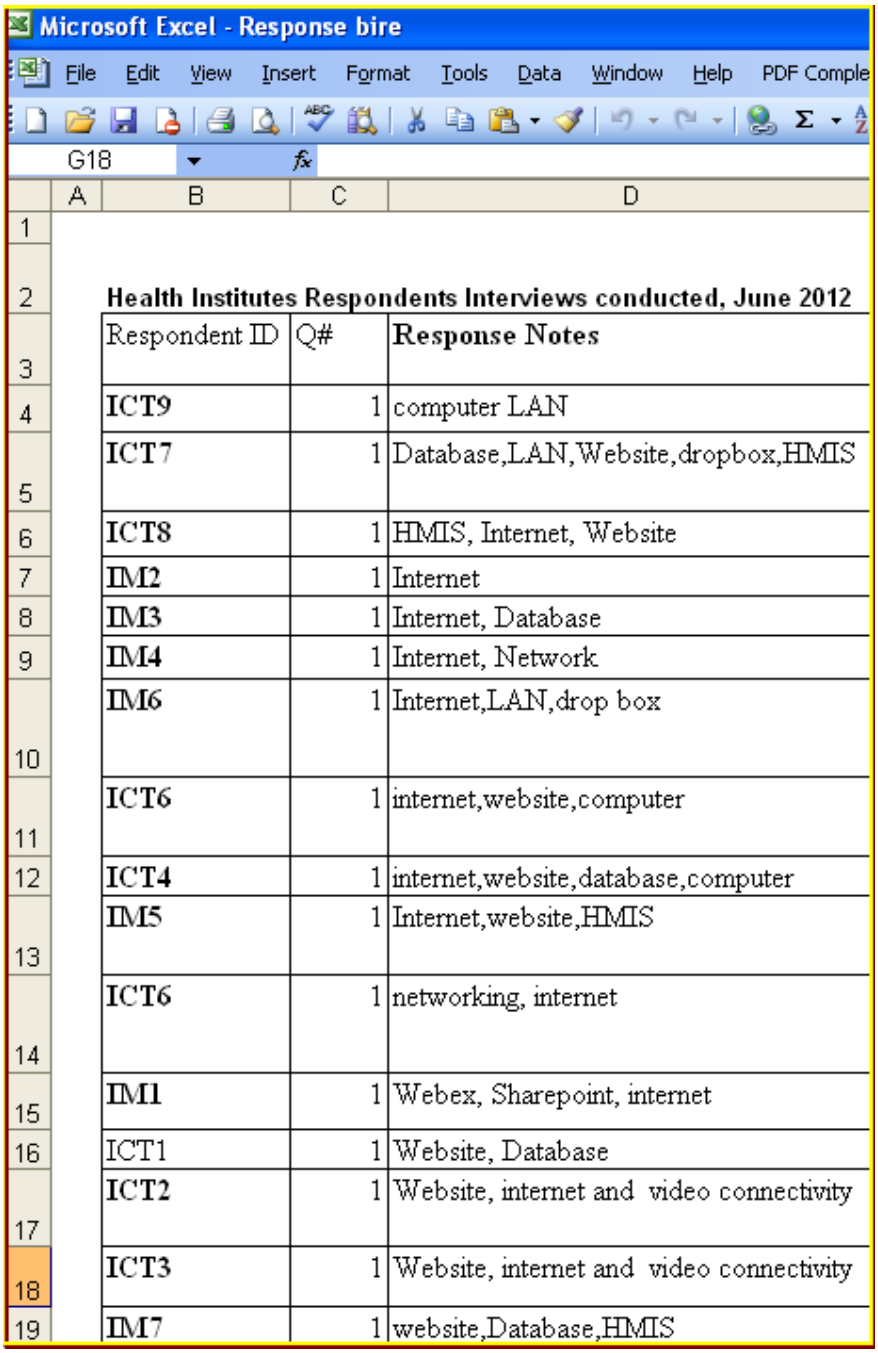
No	*Questions*	*Institution workers*		
			Frequency	%
8	Does your office have its own heath related publications? A. Yes B. No		48 39 Total 87	55.17 44.82 100
9	The types of publications file format for those who have own publications. A. Hard copy B. Soft copy C. In hard and soft copy		16 22 10 Total 48	33.33 45.83 20.83 100
10	Place where these publications are kept. A. On the website B. In a local computer C. In a library D. In office shelf		15 14 8 11 Total 48	31.25 29.17 16.66 22.91 100

Qualitative Data

After the interviews were made with different respondents from different institutes, the process of coding and analyzing the qualitative data was made using general inductive approach. 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 [13]. 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 question responses.

Respondent Name	**Respondent ID**
ICT Department	ICT
Institute Managers	IM
Ministry of Health	MOH

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.



Health Institutes Respondents Interviews conducted, June 2012

Respondent ID	Q#	Response Notes
ICT9	1	computer LAN
ICT7	1	Database,LAN,Website,dropbox,HMIS
ICT8	1	HMIS, Internet, Website
IM2	1	Internet
IM3	1	Internet, Database
IM4	1	Internet, Network
IM6	1	Internet,LAN,drop box
ICT6	1	internet,website,computer
ICT4	1	internet,website,database,computer
IM5	1	Internet,website,HMIS
ICT6	1	networking, internet
IM1	1	Webex, Sharepoint, internet
ICT1	1	Website, Database
ICT2	1	Website, internet and video connectivity
ICT3	1	Website, internet and video connectivity
IM7	1	website,Database,HMIS

Data entry continued in this manner until all responses have been entered. After all responses have been entered, sorting was made so that all the responses to each question are gathered together that give most useful information.

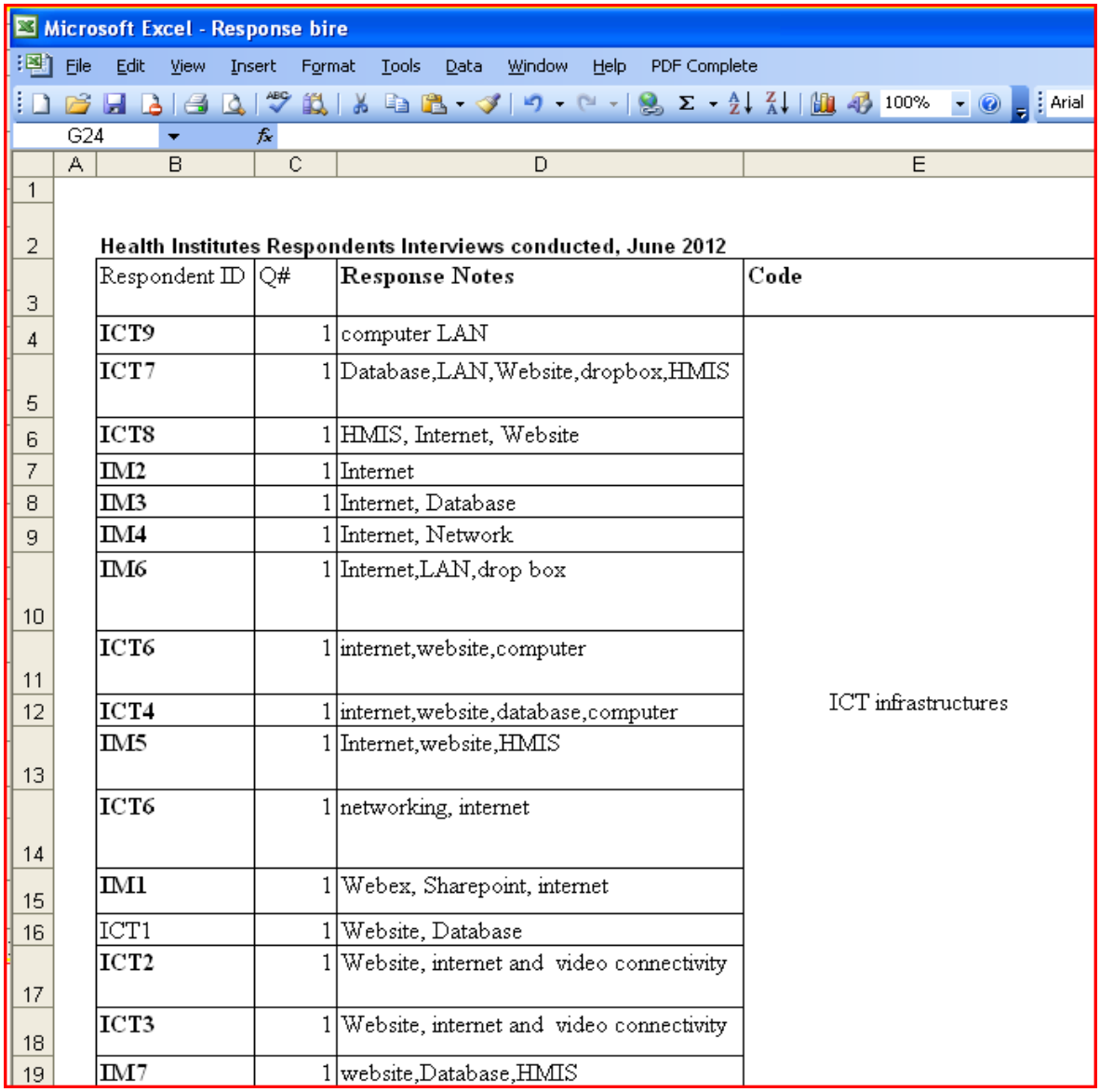
Coding the Data

The next task done was coding and analyzing the data question by question. Coding is a process for categorizing the data. The researcher went through the data looking for things relevant to answering the research questions. The raw data were read 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 are predefined codes that are categories and themes that the researcher expects to see based on prior knowledge. For this task a two-column table is created for listing the categories which are anticipated and the code that will be used for that category.

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.

Creation of Inductive Category



Health Institutes Respondents Interviews conducted, June 2012

Respondent ID	Q#	Response Notes	Code
ICT9	1	computer LAN	ICT infrastructures
ICT7	1	Database,LAN,Website,dropbox,HMIS	
ICT8	1	HMIS, Internet, Website	
IM2	1	Internet	
IM3	1	Internet, Database	
IM4	1	Internet, Network	
IM6	1	Internet,LAN,drop box	
ICT6	1	internet,website,computer	
ICT4	1	internet,website,database,computer	
IM5	1	Internet,website,HMIS	
ICT6	1	networking, internet	
IM1	1	Webex, Sharepoint, internet	
ICT1	1	Website, Database	
ICT2	1	Website, internet and video connectivity	
ICT3	1	Website, internet and video connectivity	
IM7	1	website,Database,HMIS	

Interview dataset preview (the rest of the data set is attached in appendix-4)

The research identifies and defines categories or themes based on the coded data.

Overlapping and Uncoded Data

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.

Continuing Revision and Refinement of Category System

To categorize is to arrange things in a systematic order. Within each category, search for sub-topics 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.

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: (1) Health ICT infrastructure, (2) health related publications, (3) website, (4) perspective for designing WNDC and (5) additional services in WNDC.

(1). Health ICT infrastructure

In information technology, ICT infrastructure refers to the physical hardware used to interconnect computers and users. These include the communication media, satellites and routers, and other devices that assist the health care service.

Q1. What ICT infrastructures are available in your institutes?

Regarding this topic, most interviewees mentioned website, database, and internet and LAN connectivity as their main health ICT infrastructures available in their institutes.

(2). Health related publications

Health related publications refer to any available articles and journal which are known, used or published by institutes and respondents.

Q. Do you have health related publications that are available in your institutes?

Q. Where are these resources kept?

Q. What are other several health publication websites you read/ know?

Concerning publications, most respondents read either their own or others health publications. Few of the local publications are Ethiopian Medical Journal, Ethiopian Journal of Health Development, WASH, HIV/AIDS report, Ethiopian Journal of Reproductive Health and Ethiopian Journal of Epidemiology, Pubmed, Ethiopian Health Journal, and Ethiopian Journal of Biological Sciences. International publications and news release are Hay Fever, Migraine Headache, Shine from Yahoo healthy living, Google Scholar, WebMed, and Harvard Medical School. Among these publications, Ethiopian Medical Journal and PubMed are very common and well known by most respondents. The file format for most publications is either Hypertext Markup Language (HTML) or Portable File Format (PDF).

(3). Related to Website

This category represents the data which are related to web-based application usage like availability of website, method of organization of the website, and the types of contents found in the website.

Q. Does your organization have its own website?

Q. Does this website have any health related publications?

Q. How do you organize your publications?

Here, the category under website represents any information which is raised related to the website. Except three, all institutes have their own institutional websites, but except three of these websites, others do not contain any health related publications in their contents. Most respondents have no idea how data and contents of their websites are organized.

(4) Respondents' Perspective in designing WNDC

All interviewed respondents support the design of a common WNDC application that can be a solution for integration of all health institutes' publications together.

(5) Respondents' additional services in WNDC.

Q. What are those additional services that this system should provide in addition to publications?
The most commonly requested services that should be added with the WNDC framework are report system and notice board.

4.1. Requirements of the proposed system

Common requirements are identified for the new system based on the results of the assessment made and data collected from secondary sources. These requirements are representative of different health institutes for web-based national data center for publications management and processing.

4.1.1. Functional Requirements

A functional requirement is a description of activities and services a system must provide. These are requirements identified in terms of inputs, outputs, processes, and stored data that are needed to satisfy the system improvement objectives [11]. The functional requirements of the system are divided among the customer and the administrator of the application. Requirement definition determines the functional requirement which refers to what fundamental functionalities the system should perform for the users in the future. It produces a broad outline of the system that identifies the function to be performed. It explains the requirement of the proposed system in terms of defining functional requirement and supplementary specification [2]. System functionality is the interactions between the user and the system, the errors that the system can detect or/and handles and the environmental conditions in which the system functions are part of the requirement analysis.

The functional and non-functional requirements of the proposed system are described and modeled using Unified Modeling Language (UML) and myUML (starUML) as a main tool. UML is one of the Object oriented analysis tools. Object oriented analysis and

design methodology is chosen over structural approach to improve quality and complexity management. This methodology is suitable to use UML modeling. The main reasons for using UML are: using standardized notation without sacrificing specialized model data, increased domain and design model reuse, increased customer involvement/understanding of problems translation to product solution.

Based on this methodology, the researcher tried to identify basic functional and non-functional requirements of the system. Classification of health stake holders among categories (institute managers, ICT department professionals, public health associations, institute workers and MoH) helped the researcher to compare the response rates and level the response of web-based electronic publication usage among institute workers and institutes. This helped to distinguish similarities and differences in web-based publication usage among different populations. Details are discussed in the following sections.

4.1.1.1. **Functional Requirement Operations and Role Players**

Even though there were many Functional Requirements identified, not all were common across sampled health institutes. Only functions mentioned below are found to be essential for the proposed system.

Login**:** System Administrator, Doctor, Nurse, Health officer, and Members login to the system. It is responsible for the authentication of users and the maintenance of user profiles. Every item in the data center is secured and control is made for accessing the content. This part controls access and provides security based on users' role in the system. This module is responsible for user registration, user login, user profile management, and security for document accessibility.

Register: users register and become members when they want to download/upload some access limited publications.

Manage user account: this module enables web administrators to control members' user accounts.

Search: it is about searching publications from the WNDC system. This system is capable of supporting of publications using author name, title of publication or keywords from the content of the publication.

Read: ordinary users can read/view publications without registering.

Process publication: This is about updating of the publications. The administrator manages publications based on the given comments from members. He/she can make approval. The approval may be eliminating existing publications or adding new ones.

Delete: this helps supports deleting submitted articles with limited privilege.
Upload: this function helps to upload/add pdf format contents to the system.

4.1.1.2. **Identified website modules and their Description**

Common modules across sampled health institutes which found under functional requirements are listed below.

Search Module: The Search functionality is one of the most useful features of the system. This tool provides flexible and efficient search functionality through the Search module. The WNDC system supports web crawling, sometimes called web scraping or web harvesting. The search module provides search for:

Search: this is based on search criteria and keywords, title or content of the publication. Keyword search is a simple technique that let users specify a query using one or more key words. The user can search for publications from the system. It is also possible to download publications and/or view on the browser.

Comment Module: This module can help users to give comments on publications. The system administrator gets feedbacks on publications through this module.

Login module: Members or administrators can login using this module. The administrator has control over all functionalities in the system. It seems that the administrator is a special user with some extra capabilities.

Publication module: This module contains pages for publications for any user.

Contact us Module: Contact us Module enables users and site visitors to contact site administrators.

Submit Publication Module: any user uses this function when he/she needs to contribute publication for the system without registration. Here is the process to add publication into the system:

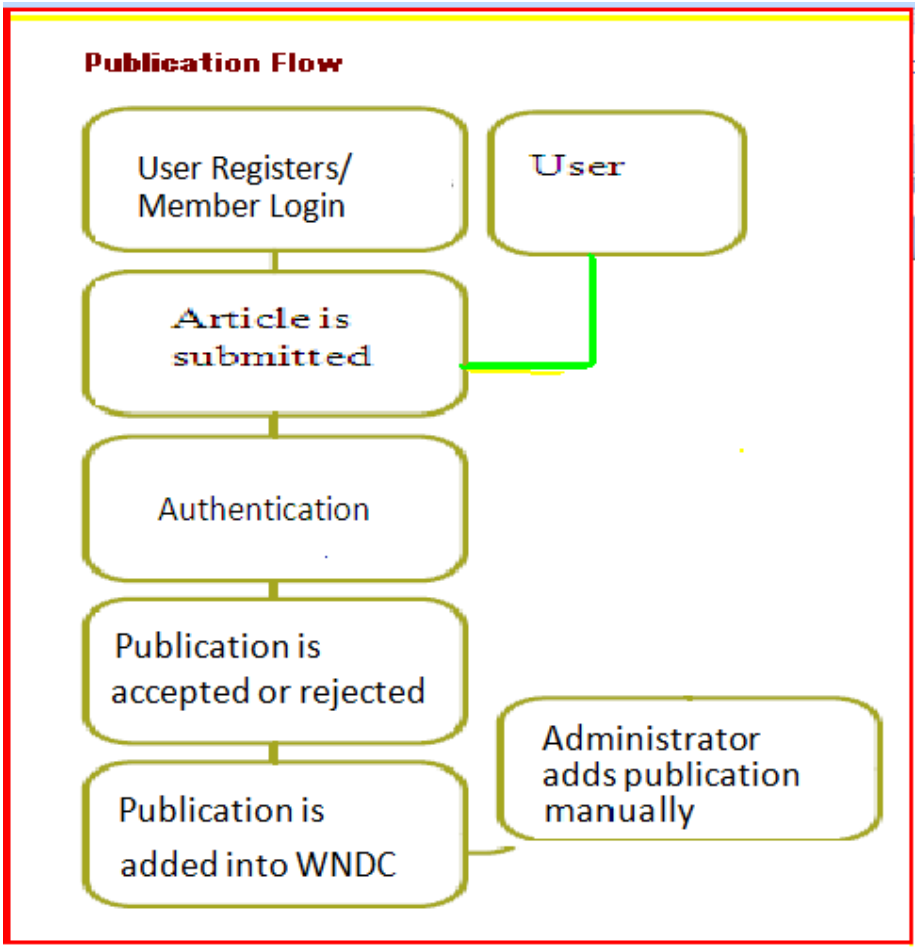


Figure 2: Submit article process

Job Notice-board Module: This module is an additional utility for the system. Institutes release vacancies easily on the notice board for job seekers. Vacancies are added in the system by an administrator. It contains job title, short description/abstract, detail information, post date and dude date. Users can easily apply and/or see these releases easily. In addition they can attachment and submit their curriculum Vitae (CV).

Not all releases are public. Based on visibility status, post date and dude date, contents are automatically managed. This means, the system checks the date and the visibility of the document then when the due date is elapsed; the system makes the vacancy invisible to the public.

Help Module: This module provides built-in hints about how to use the system. For each and every aspect of the system, there has to be full user manual to support the system functions and importance although there is no on-line help as of yet.

4.1.1.3. System Roles and Role Players

An actor represents anything or anyone that interfaces with a system. This may include people, external systems, and other organizations and they are always external to the system being modeled [17]. This system has two main types of audiences. These are the customer (the end user) and the administrator of the website. The end user may be author, member or user.

System role players	Definition
Author(content contributor)	Refers to any writers of an article who contributes (uploads) to the WNDC.
System administrator	A professional who receives publications and makes publications evaluation.
Member (Nurse, Doctor, and	A registered user in the WNDC which can login,

System role players	Definition
Health Officer)	upload/download publications
User	Any unregistered reader visiting the website to read publications/articles.
WNDC system	Refers to the system itself

Administrator Activities: the administrator of the system will be able to:

Edit/ Delete/ Create database.
Add/ Modify Customer Information
Create/ Edit/ Delete publications
Edit/ Delete/ Create user accounts
Change/ manage password.
Take backup of the database

Customer / End user activities: users of the system will be able to:

Login/ Logout:/register, read/ different publications without having user account.
Request for membership account and be able to publish/download publications.
Edit/ delete own user account information, change password.

Even though the main aim of the research is to create a central access point for health related publications, based on the findings of the survey the system is designed with additional features which are additional functionalities for communication. Currently vacancies in almost all institutes are announced for applicants either on News papers or in office vacancy notice boards. Application for the job is done whenever an applicant goes to the institute physically. This consumes time and effort of both sides. To tackle this problem a notice board as a utility service is added on the WNDC application.

4.1.1.4. Use Case Modeling

Use Case Diagram (UCD) is developed as a part of the analysis phase of the system development process. The UCD can be changed during the development process. System Use Case modeling is intended to capture the functional and non functional requirements of the system from the perspective of users and the system (Actors). Use case diagrams are behavior diagrams used to describe a set of actions (use cases) that some system or systems (subject) should or can perform in collaboration with one or more external users of the system (actors). Each use case should provide some observable and valuable result to the actors or other stakeholders of the system. These Use Case models reflect the behavioral requirements of the system to be developed. They include identifying actors and use cases. Use cases are mainly used in requirement document to depict clarity regarding a system. There are three important parts in a use case: scenario, actor and use case.

Scenario: A scenario is a sequence of events which happen when a user interacts with the system.

Actor: Actor is the end user. Actor's are represented by simple stick man.

Use Case: Use case is task or the goal performed by the end user. The use case figure attached in the appendix shows a simple scenario with 'Actor' and a 'Use Case'. Scenario represents an accountant entering accounts data in the system. As use case's represent action performed they are normally represented by strong verbs [17].

4.1.1.5. Use Case Identification

A use case describes a sequence of actions that provide a measurable value to an actor. In other words, it shows a way in which a real world actor interacts with the system. An essential use case may be abstract, generalized use case that captures the intentions of the user in a technology and implementation independent manner. Here are some of the possible use cases and actors that are identified for the system:

Functional Requirements Specification

Function	Actor
Login	Author, Member, administrator.
Register	User
Search Publication	Member, user.
List Publication	System
Submit Publication	Author, Content contributor user, member
Approve Submitted Publication	Administrator
Manage user account	Administrator
Edit Publication	Administrator.
Receive Articles	Administrator.
Process Publication	Administrator
Download Publication	Member
Logout	Author, Member, administrator.

Use Case Diagram

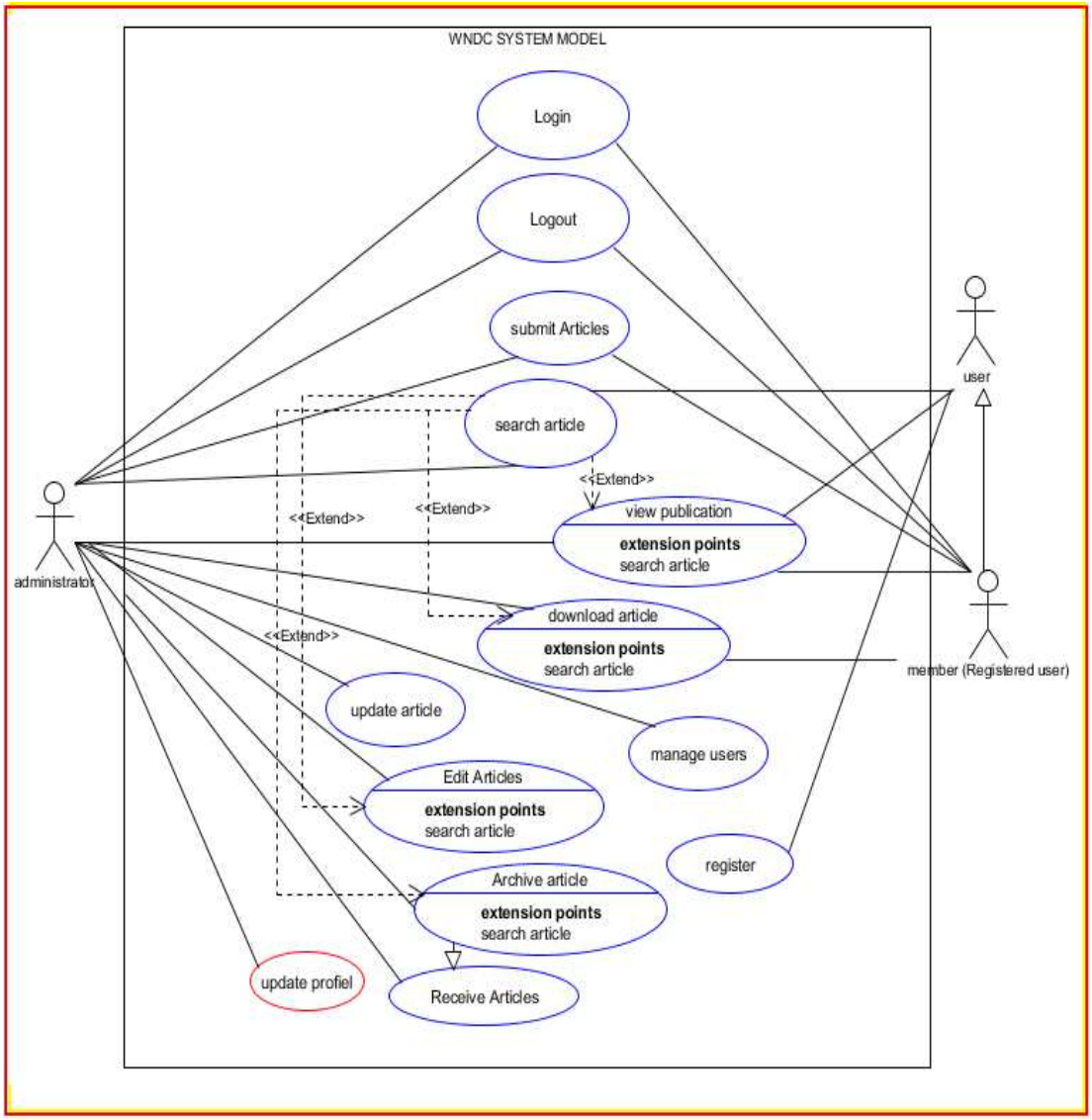


Figure 3: WNDC system model overview

4.2. Non-functional Requirements

A non-functional requirement pertains to the technical aspects the system must fulfill, such as performance-related issues, reliability issues, and availability issues. Non-functional requirements are often referred to as technical requirements. [5] Non-functional requirement is a description of other features, characteristics, and constraints that defines a satisfactory system. [2]. It includes user interface, performance, documentation, quality, error handling and exception and security of the system. The newly proposed system has a web-based interface which is friendly for anybody with basic skills of using computers and Internet. After a successful login, the system displays the home page for registered user. The main GUI entries in the system are: search for raw data, search for publications, search for articles, and search for journals. There are different types of interfaces that this application uses.

User Interface: Users spend the majority of their search time on user interfaces other than other parts of the system. For this reason, due attention was given in designing it in a way it is friendly and easy to use manner. Graphic Design for the user interface is done with Adobe Photoshop CS3 and Dreamweaver CS3.

Software Interface Components: The required components for the WNDC System are MySQL and VertirgoServer (web-server) supported Database and web Server. The performance, documentation, quality, error handling and exception and security of the WNDC system are mentioned in the system design part of this document. The following are software packages which are used in the development.

Web server software: VertirgoServer, Server side scripting tool: Personal Home Page (PHP); Database tool: MySQL. These software packages are chosen due to their extensive support over many popular architectures and operating systems and the experience of the researcher. Moreover, these programs are found in a package together as open source. Virtual Paradigm (VP) and Macromedia Dream weaver design tools were also used.

Client Side Software and Compatibility

The web application is built using PHP which is compatible to run with many platforms. This web-based application is tested for compatibility with common web browsers (Mozilla Firefox, Internet Explorer, and Google Chrome) and Microsoft Windows XP Last Xp, Windows 7 and Vista operating systems.

4.3. System Analysis

Design of high performance, scalable and dependable data centers has become a critical issue because of the increasing use of the Internet in supporting various Web-based services [26]. In order to provide better scalability and reliability, currently deployed cluster-based data centers can have thousands of nodes. In this highly distributed structure, it is difficult to analyze these systems. Therefore, most of the data centers consist of several tiers of servers in order to simplify the design and monitoring of large-scale systems. With the increasing use of dynamic Web contents, a multi-tier architecture provides a clean abstraction of different functionalities [28].

For this reason, applications are usually broken into logical chunks called "tiers", where every tier is assigned a role. Traditional applications consist only one tier, which resides on the client machine. The most common structure is the three-tiered application. These tires are presentation, application, and storage, in this order. A web browser is the first tier (presentation). It serves as an intermediate script or web service for relaying requests and data between the front and back-ends.; an engine using some dynamic web content technology (such as) Personal Home Page (PHP) is the middle tier (application logic), and a database is the third tier (storage). The web browser sends requests to the middle tier, which services them by making queries and updates against the database and generates a user interface [5].

The three main components of the Web-based National Data Center (WNDC) are: the user interface and the modules of the website, the web server and WNDC database. The front-end web server is responsible for handling the static requests. The middle tier, the application server, is responsible for handling the dynamic web contents, while the back-end database server is dedicated for database transactions [28].

4.3.1. **Architecture of the WNDC System**

The main purpose of this section is to describe the design of the architecture of the WNDC application. The presentation tier is the interface which is designed using macromedia Dream weaver, the middle tier by class diagrams and the back-end by MySQL.

This three-tier architecture mainly consists of three layers namely: Presentation Tier, Business Tier and Data Access Tier.

Three-Tier Architecture and their application Preview

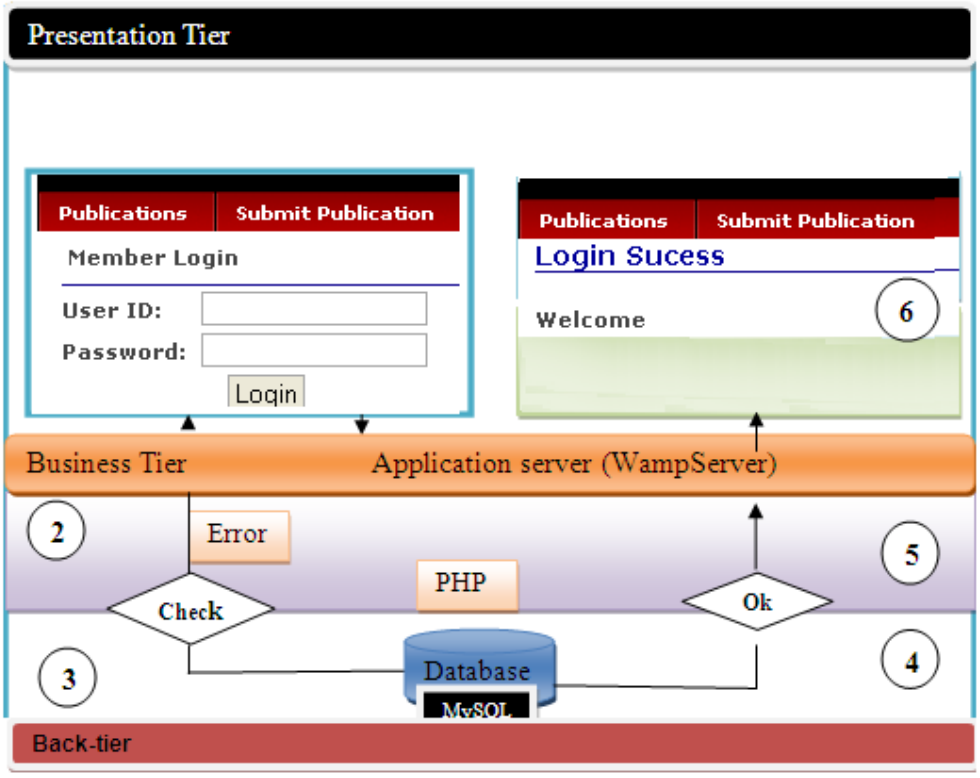


Figure 4: The Three-Tier Architecture of the WNDC System

The essential components within three-tier architecture are client work station, application server and database server.

4.3.1.1. **Presentation Tier**

This tier refers to the user interfaces of the system that helps to present data to the end user.

Front-end: Interface Design

User interface refers to the detail description of Schematic Representation of the Proposed System and Web Model with website screen, different web page interfaces through which a user interacts with the system. A user interface should at all times speak to the user, when user actions are both right and wrong or misunderstood. Always the system has to inform users about their actions, changes in state and errors, or exceptions that occur. Visual cues or simple messaging can show the user whether his or her actions have led to the expected result. These points are considered in this system.

A browser will be used as a graphical user interface. As mentioned earlier, we have two types of users; the customer and the administrator. The Home Page with navigation system is available for any visitor. The home page is designed in a way that all users can access modules easily as needed. The navigation schemes are friendly. This page contains links to the Search page, the Login screen, to the Lost Password Screen, User ID, and buttons like the cancel, and register. All users of this application use this interface. These interfaces are designed using Macromedia Dreamweaver which is one of the WYSIWYG editors. Dreamweaver is a web development tool which supports CSS, PHP, and a number of other web-related technologies to develop dynamic web pages that can interact with a back-end (database).

The following are the required front-end web forms interface and their purposes identified in this system.

WNDC Web forms and their purpose		
Web Forms/ pages	Purpose	Interface
UI-1: Login	A page for member and administrator entrance	back end
UI-2: Invalid Username and Password	Registration error confirmation	back end
UI-3: Index/Home	The first and home page for the WNDC website that lists most recent articles.	front end
UI-4: Signup	A page provided for new member registration	back end
UI-5: Submit Publication	A page provided a way for visitors to add content into the system	back end
UI-6: Search	A page which helps the user/member to search and view for the available publications in the WNDC system.	back end
UI-7: Process publication	A page that helps the administrator to edit a publication for change in the WNDC system.	back end
UI-8: Notice Manager	Through this page the administrator is able to manage notices and vacancies	back end
UI-9: Comments Manager	Using this page the administrator is able login to the system to manage given comments.	back end
UI-10: Account Manager	This page gives the administrator a role to manage user accounts	back end
UI-11: Publication	Lists all publications	back end
UI-12: Comments	Helps users to send comments on publications	back end

4.3.1.2. User Interface Prototype Sketches

UI-3: Home Page

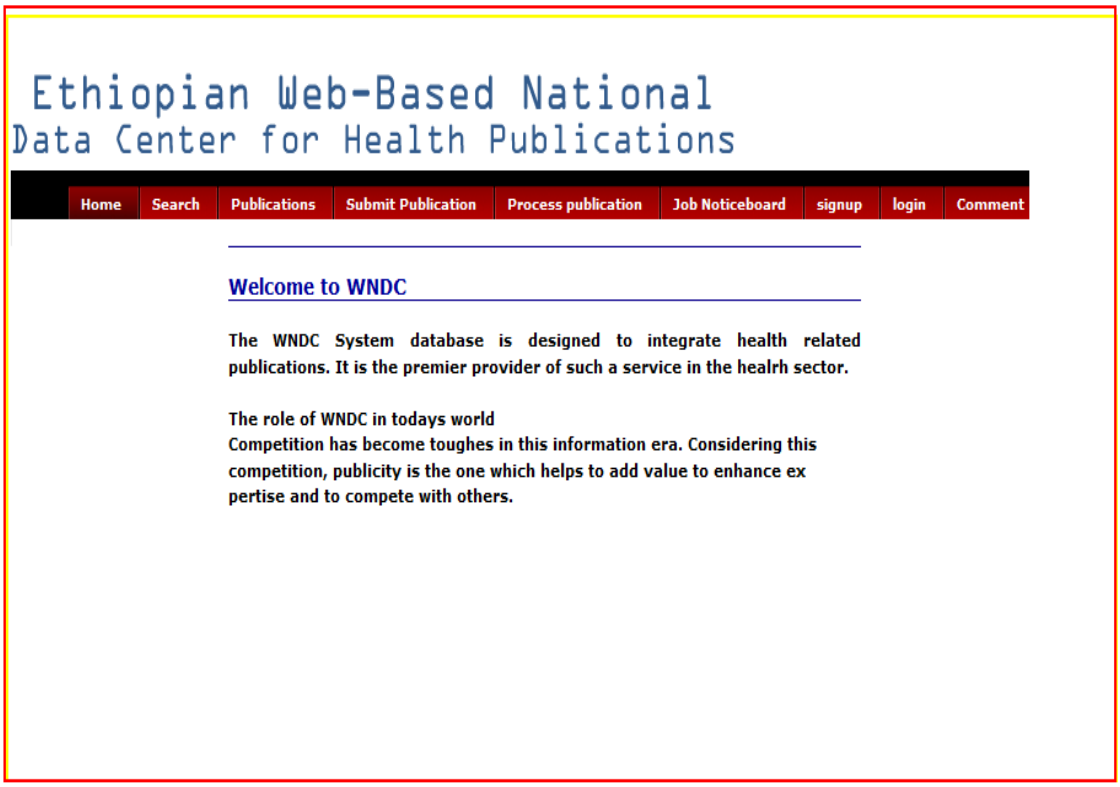


Figure 5: Index Page

UI-4: Signup

Figure 6: User Registration (Signup) page

Login

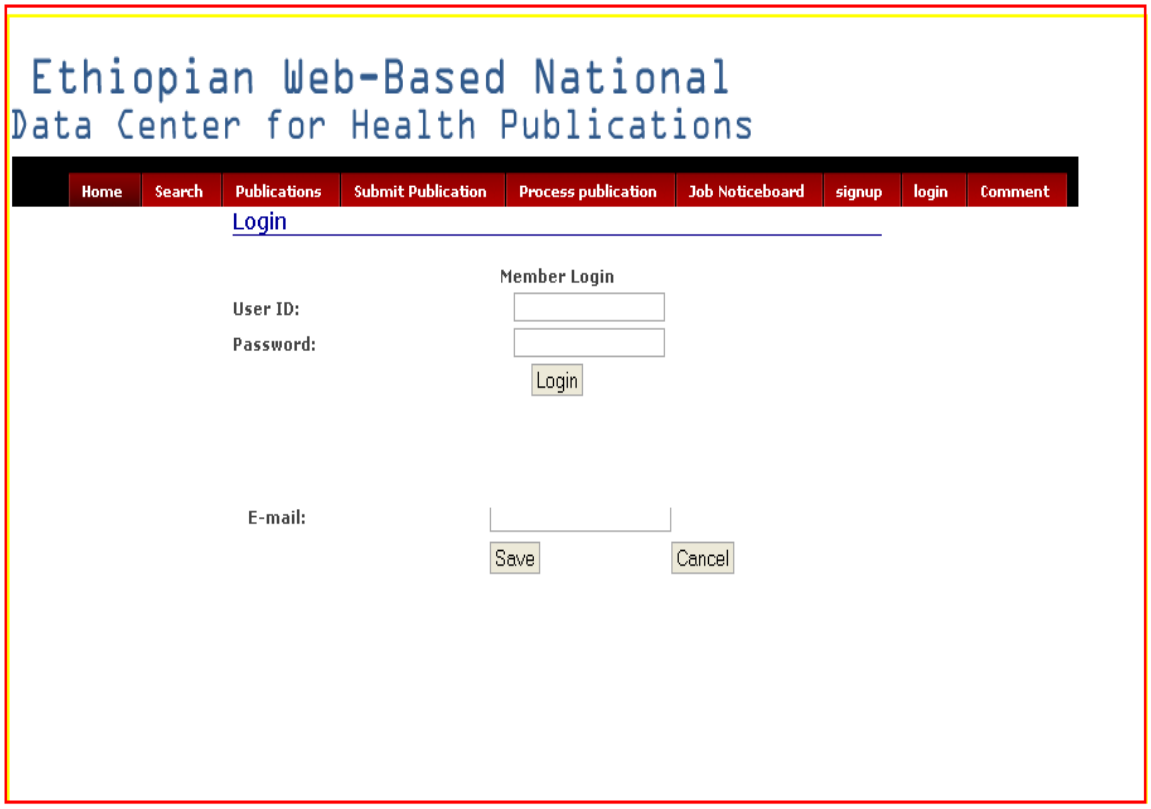


Figure 7: Login Page

The Login Page is the first page that members visit before they ennter into the system. Members login through this interface. The system will identify the members by their user Id and password. If there is an error in authentication, an error message is displayed. New users have an option to register and to be members. This is the main menu of the system. The application offers Non-registered users to see and search for publications without logging into the system. They can simply search for publications. However, to be able to use some secured resources and/or to provide a new publication, the user has to login to the system through the Login interface. In addition, unregistered users can provide publications to the system.

New Registration Notification

Whenever a new registration is requested, notification message will be sent to user's email.

Administration Interface: This screen is for use by the database administrator and will contain links to other sub screens like edit article, edit user account and add article.

Edit article: This screen will contain a dropdown window containing the entire list of articles in the database. Selecting any publication directs the user to the full detail of that publication screen.

Edit user account – This screen contains a form displaying all member users of the system in the database in an editable form.

UI-5: Submit Publication

This page has a text input field for entering Title, sort story or abstract, detail, save button, visibility and a cancel button. The user can click on the submit button after filling the form to submit the article into the WNDC. Article will be public after approval is made by the administrator or by authorized personnel.

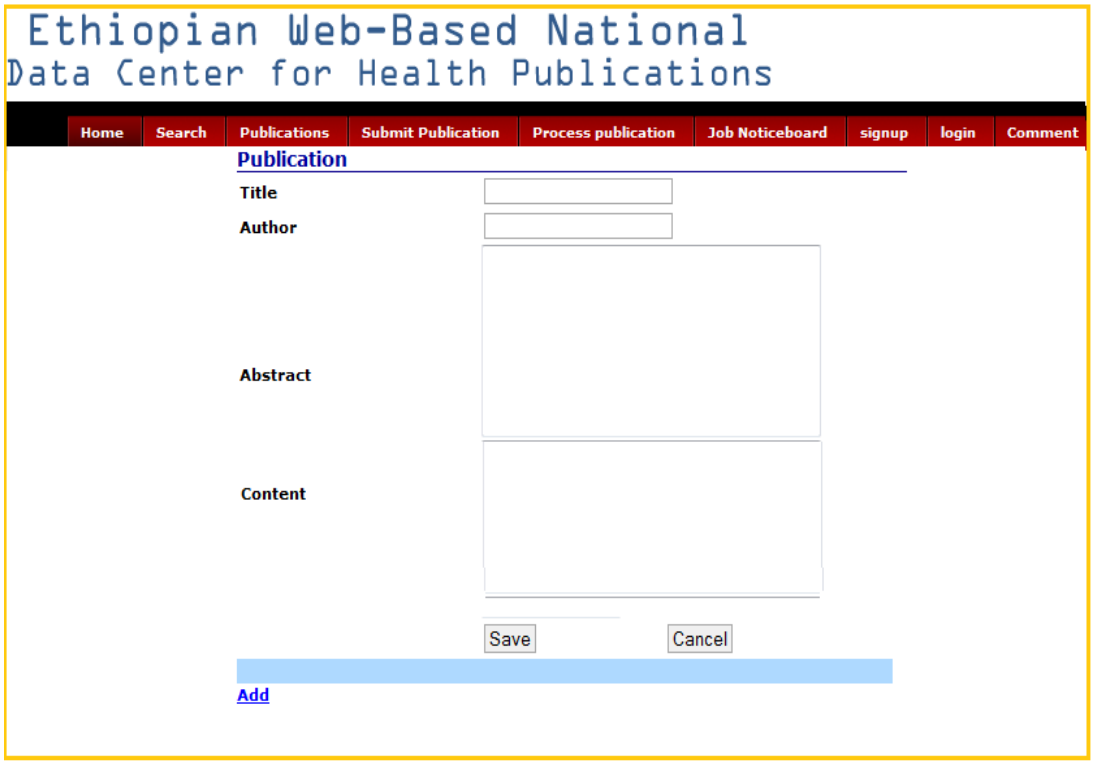


Figure 8: Submit Article Page

UI-6: Search Article page

The user can enter keywords in the fields provided and clicks on the search button. The user does not need to fill in all fields. Filling only the keywords may be enough for simple search.

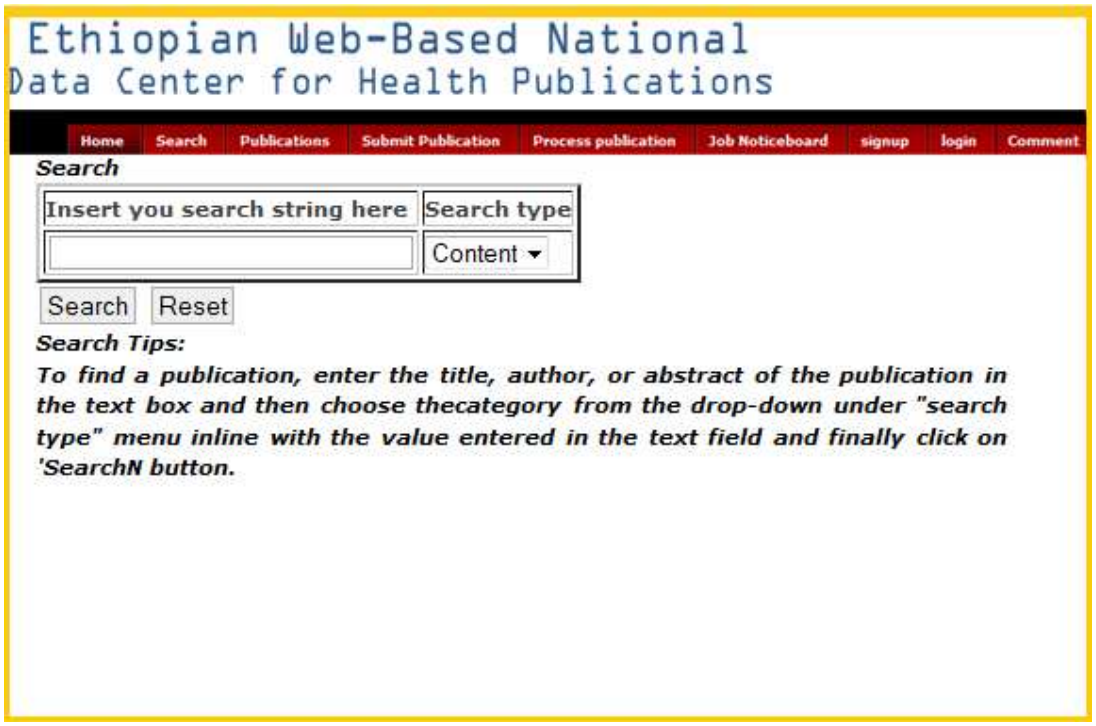


Figure 9: search page

UI-7: Process publication/ Publication Manager

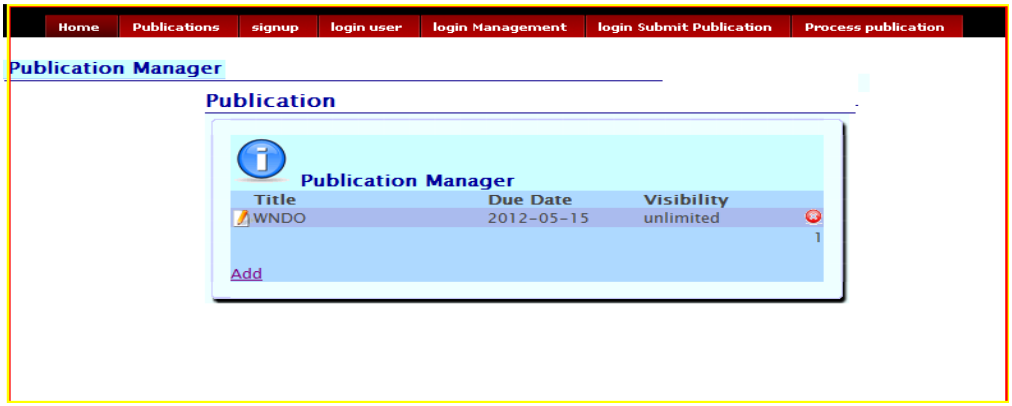


Figure 10: Manage Article Interface

Delete Article Alert

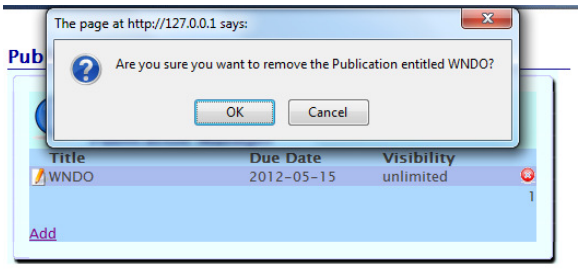


Figure 11: Delete Article User Interface

Notification is given before deleting an article.

UI-12: Comments page

Users of the system can provide their views on the publications released to the public directly to the system. At the same time, the system administrator manages forwarded comments and then makes approval on publications.

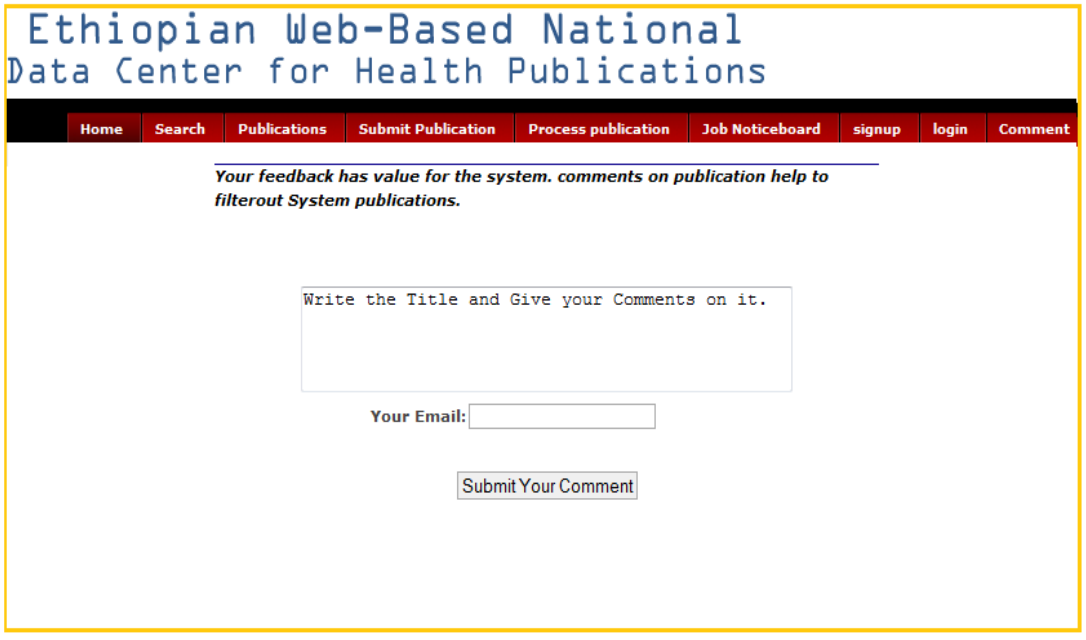


Figure 12: Comments page

5.1.1. Business/Application Tier

This is the middle tier in the three-tier architecture. Business logic is defined as any application logic that is concerned with the retrieval, processing, transformation, and management of application data; application of business rules and policies; and ensuring data consistency and validity. The business logic layer fills the responsibility of determining where the data comes from and how it should be formatted for the user interface. It also applies constraint rules on the data coming from the user interface before posting the data to the database.

VertirgoServer with PHP script is chosen to serve this service for the WNDC application. This layer serves as a gateway between the presentation and the database access layers. The WNDC system, as mentioned above, has categories of users which are classified into unregistered user, member, and administrator. These users are represented by the php sequence and class diagrams that represent the duty of the business logic.

UML sequence diagram

UML sequence diagrams are used to represent or model the flow of messages, events and actions between the objects or components of a system. In sequence diagrams time is represented in the vertical direction showing the sequence of interactions of the header elements, which are displayed horizontally at the top of the diagram. Sequence Diagrams are used primarily to design, document and validate the architecture, interfaces and logic of the system by describing the sequence of actions that need to be performed to complete a task or scenario. Sequence diagrams illustrate the objects that participate in a use-case, show the messages that pass between objects for a particular use-case over time. Typically, it captures the behavior of a single use-case.

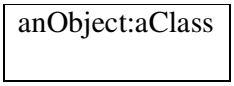
- Sequence Diagram and its syntax

An Actor

- Is a person or system that drives benefit from and is external to the system.
- Participates in a sequence by sending and / or receiving messages
- Is placed across the top of the diagram

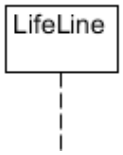
An Object

- Participates in a sequence by sending and/or receiving messages
- Is placed across the top of the diagram



A lifeline

- Denotes the life of an object during a sequence
- Contains an X at the point at which the class no longer interact

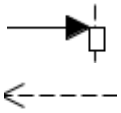


An execution occurrence

- Is a long narrow rectangle placed at the top of a lifeline.
- Denotes when an object is sending of receiving messages.

A message

- Conveys information from one object to another one
- The operation call is labeled with the message being sent and a solid arrow, where as a return is labeled with the value being returned.



For object destruction

- An X is placed at the end of an object's lifeline to show end of process.

Sequence diagram drawings

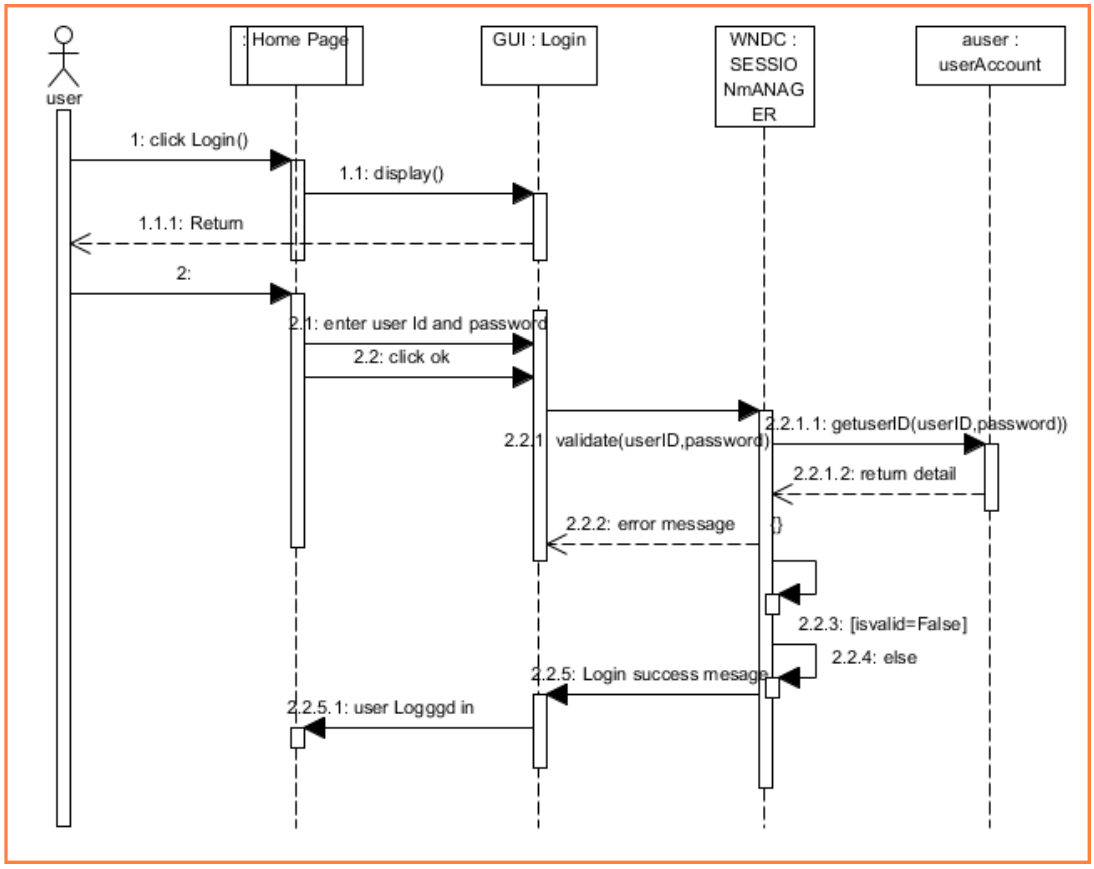


Figure 13:- Sequence diagram for Login use case

In the above sequence diagram the user enters his/her user id and password and then he/she clicks on login button on the login screen.

The Session Manager gets the user id and user details from user database and verifies the user id and password. If user details are invalid user will not be allowed to login and an appropriate error message will be displayed, otherwise the user logs in.

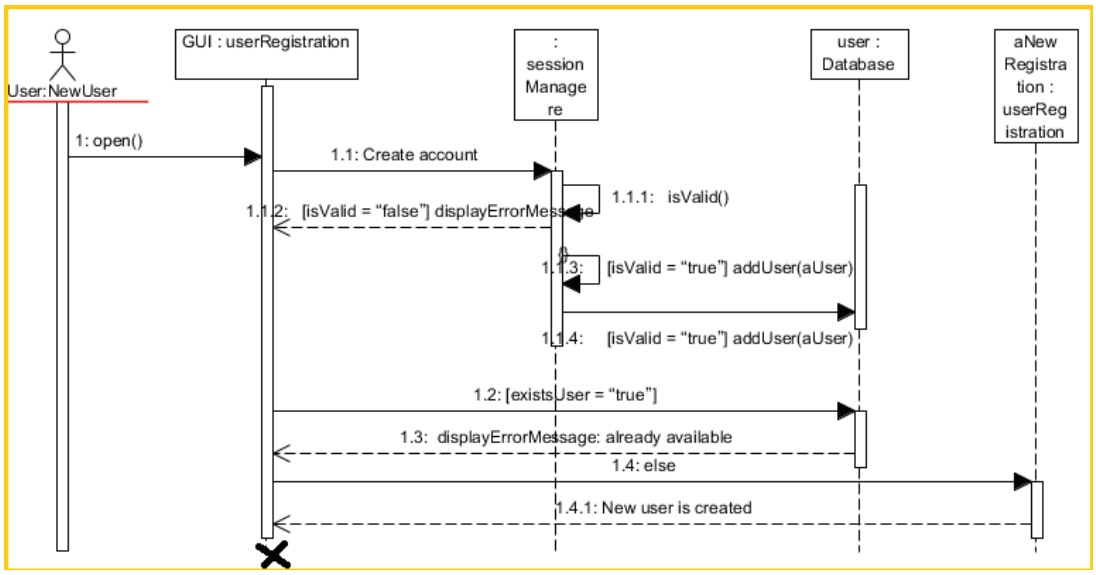


Figure 14:- Sequence diagram for user registration use case

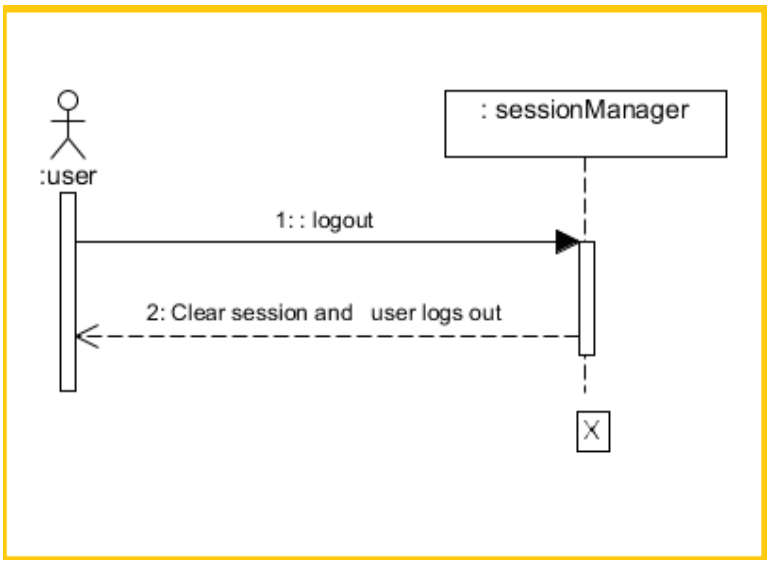


Figure 15:- Sequence diagram for Logout use case

Other sequence diagram drawings are included in the appendix.

UML Activity Diagram

Activity diagrams show the procedural flow of control between two or more different entities (people, things, and data) while processing an activity.

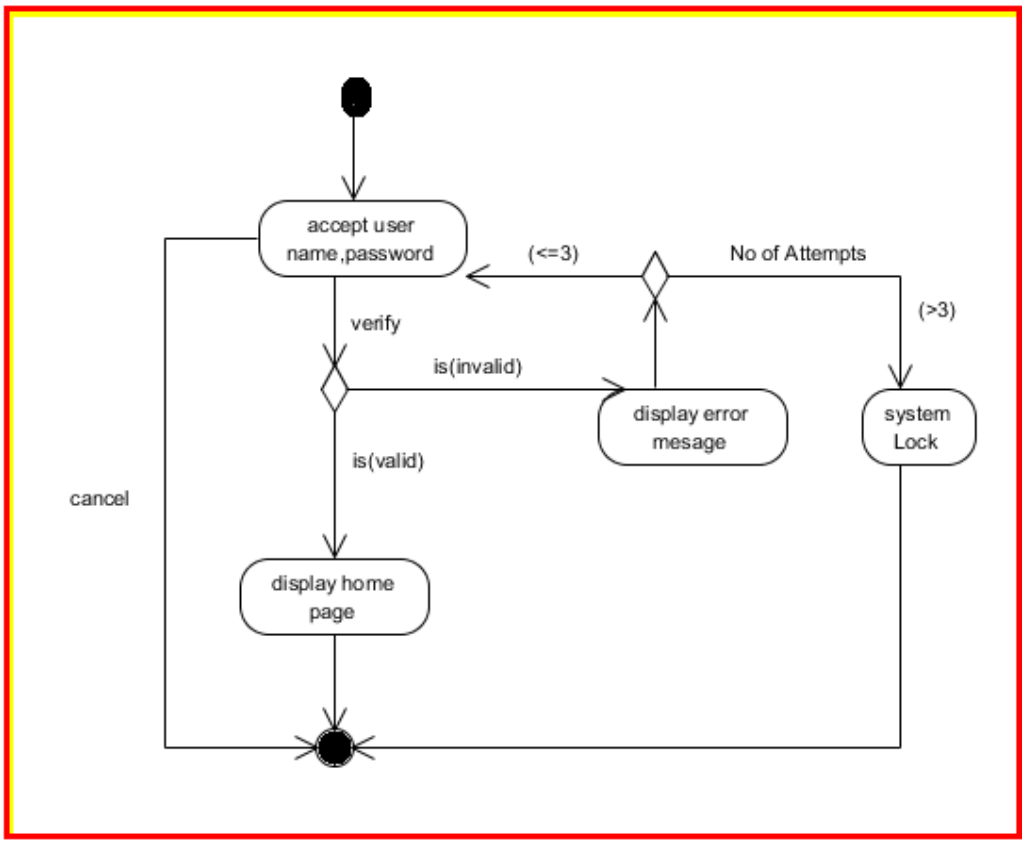


Figure -16:- Activity diagram for login use case

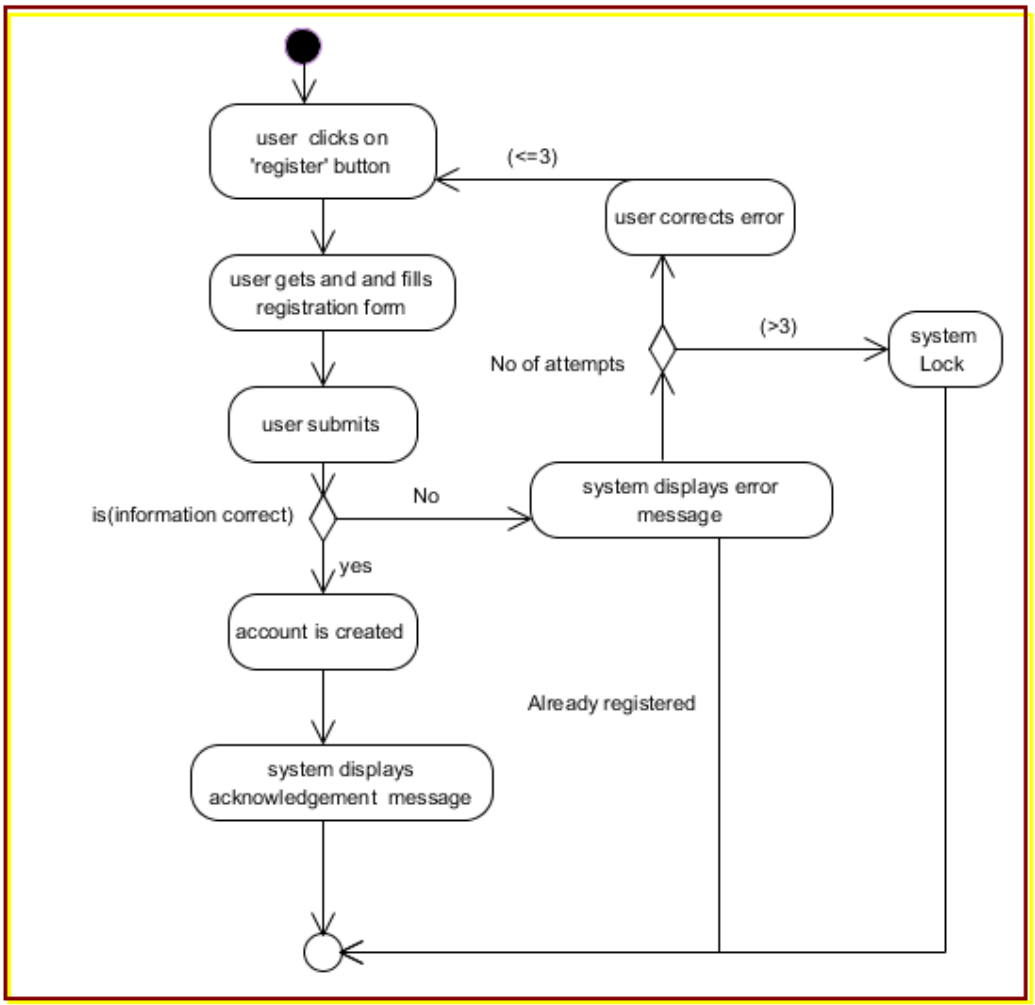


Figure-17:- Activity diagram for user registration use case

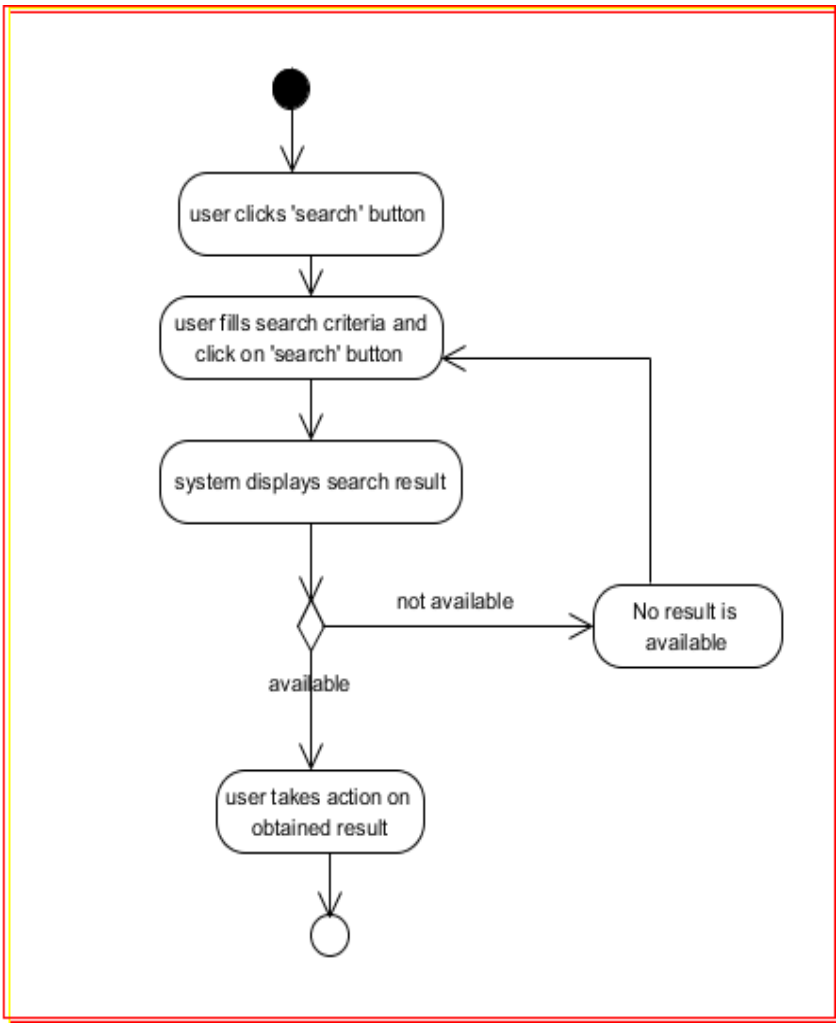


Figure -18:- Activity diagram for search use case

(Additional activity diagrams are included in the appendix.)

Functional Requirements Specification	
Function	**Actor**
Login	Author, Member, administrator.
Register	User
Search Articles	Author/ administrator, Member, user.
List Articles	System
Submit new Article	Author, Content contributor, member
Approve Submitted Article	Administrator
Manage user account	Member, administrator
Edit Articles	Administrator.
Receive Articles	Administrator.
Update Articles, account	Administrator
Download Articles	Member
Logout	Author, Member, administrator.

UML Class diagram

The Class diagram represents a collection of objects with common structure, common behaviour, common relationships, and common semantics. It is the most important entity in object-oriented analysis and design. It describes the types of objects that exist in the system and shows the static relationships among internal classes of the system. Classes form the main building blocks of an object-oriented application. The Class Diagram can be used to show the attributes and the operations of a class and also the constraints that apply to the way the objects are connected. Class diagrams are the foundations of object-oriented modeling. Class models show the classes of the system, their interrelationships (including inheritance, aggregation, and association), and the operations and attributes of the classes. Class diagrams are used for a wide variety of purposes, including both conceptual/domain modeling and detailed structural design modeling. They can be used for both the analysis and design of systems.

The UML modeling elements found in class diagrams include: classes and their structure and behaviour, association, aggregation, dependency, and inheritance relationships, multiplicity and navigation indicators and role/verbs to show its functions. Class diagram contains three main - sections: class, attribute and method. The researcher created classes named member and administrator. These classes inherit from user class. The user class is the root class. The diagram and notations of the class diagram are included in the appendix.

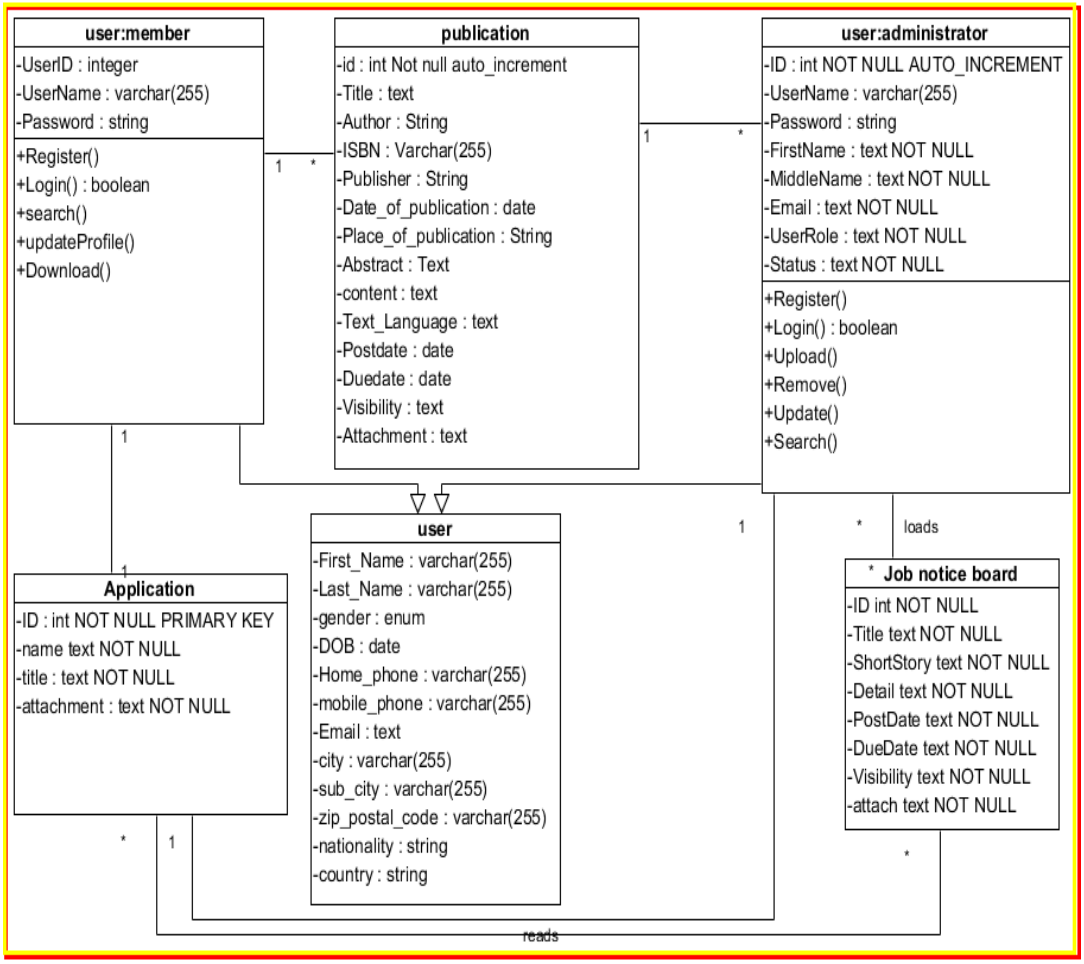


Figure 19: Class diagram of WNDC

4.4. System Design

In the analysis model the researcher described the system requirements. This section, on its part, describes the internal structure of the system that helps to realize the system. Analysis focuses on the application domain where as design focuses on the solution domain. System design is the transformation of the analysis model into a system design model. It bridges the gap between desired and existing system in a manageable way. It states about the internal structure of the system, the hardware configuration and how the system should be realized. The system design describes about design goals, security features, and decomposition of the main system among Sub-systems, deployment diagram, Hardware/Software Mapping, essential access and global Software issues.

Design, objects and data are the primary concerns in object oriented approach. As the WNDC system is object oriented and it is designed to integrate different health related publications in a central data center to enable users to get and/or provide resources in an easy and mobilized manner, it encompasses design goals. Design goals include good documentation, efficiency, high-performance, well-defined interfaces, user-friendliness, rapid development ease of use, low-cost, fault tolerance and reliability of the system.

Generally, the relationship between design goals can be categorized in to:
client (customer, sponsor- low cost, increased productivity, backward-compatibility, rapid development, flexibility), developer/ maintainer (minimum number of errors, modifiability, readability, reusability, adaptability, well-defined interfaces) and end user (functionality, user-friendliness, ease of use, ease of learning, fault tolerant, and robustness).

Design goal refers to design implementation, system maintenance, feasible, reliability, availability, fault tolerance (ability to operate with erroneous conditions), robustness (ability to work with invalid user input), Security and system performance Criteria/ efficiency are among few.

4.4.1. **Privacy and Security**

Privacy and security are two of the most important aspects of any information system. Any confidential Health information needs to be protected from malicious attacks, misuse and unintentional mistakes. These issues are common to all networked databases and websites. As a first line of defense standard network security measures are set. In addition putting in place database security measures such as access control are appropriate. Access control allows different people and programs to have different levels of access to the database. Common unregistered users are given free control over information that is displayed for the public.

Authorization: determines whether an identity should be granted access to a specific resource. Restricts the user to specific activity based on their defined roles. An administrator has the highest authority to edit/delete/create database and contents in the system. Users can only add/ publish and view publications, Members can view/ Add publications in the website and download publications. Passwords should be in encrypted format. Encryption-is the conversion of data into a form, called a ciphertext that cannot be easily understood by unauthorized people.

Constraints:

1. Visibility of publication: when a user sends a publication, the content will not be displayed for the public unless the administrator makes approval. All members have the right to view public publications but members have a special privilege to see unpublished publications and they can send comments to the administrator.
2. Based on the comments given on each publication, the content will be public. Of course this may bring additional load on the administrator; but this is the option preferred at this time.

4.4.1.1. **Data Access Tier**

The database is the last tier in the architecture. This is the back-end of the system. It is all about the database and its structure. The system contains a database (back-end) that stores all the necessary pieces of information that are related to health related

publications and their contents as well as accounts information. The Data Center (DC) is a database that serves as back-end storage of health related publications from multiple health institutes.

The Database schema language that is selected for this system is MySQL. MySQL is a Relational Database Management System (RDBMS) that uses Structured Query Language (SQL). SQL is the most popular language for adding, accessing and managing content in a database. It is most noted for its quick processing, proven reliability, ease and flexibility of use. It is the most popular open source database server. It is commonly used in conjunction with PHP scripts to create dynamic server-side applications. Schematic Representation of the System includes Database system, Web Server, Data source and Request handling mechanisms. The Database schema includes a vast number of fields, keywords including the search keywords, the author(s) of the publication, the title, the type of publication (i.e. book, journal, conference paper, News paper, and article), page numbers, URL (Uniform Resource Locator), publisher, year of publication, abstract, and the like. The system should also be able to store information related to number of publications per an author(s) and specific member's information.

All data must be stored in such a way that the information is easily retrievable. In general the back-end helps to perform the following functions. Login/ logout from the system, retrieving articles, helping to add, edit and archive articles, managing users and articles, providing security actions for users and resources (authentication and authorization).

The WNDC System database is designed using MySQL. The design is open for flexibility in terms of future growth and development of the database. The database includes the following: list of role players of the system; administrator, registered members, and users who are not registered. The following are database terminologies used in design.

Entity

Entity is an object which has its own attributes. An entity may be real, abstract, living, non-living or ideal. An attribute is a property of an entity or a relationship type. WNDC entities and their attributes are mentioned in following tables (Table 5-9).

Database schema and Tables

Table 6: user table and its attributes

Attribute name	*Data type*	*Description*
ID	bigint(20)	NOT NULL pk
Username	varchar(255)	NOT NULL
FirstName	text	NOT NULL
Password	text	NOT NULL
Email	varchar(255)	NOT NULL
UserRole	text	NOT NULL
Status	text	NOT NULL

4.4.1.2. Overview of adding publication on the website

The design of this WNDC application for publications has taken into account different requirements from different heath institutes. Publications' information is collected centrally in to the database. This function allows members/authors/system administrators to upload their publications to the data center. Uploading publication needs the information of the title, author of the publication details. The system performs data validation on required fields and shows an error message. For successful submission, the system returns a confirmation message to the content contributor. While sharing and using health data, ethical issues have to be met across inter-institutes.

4.4.1.3. Source of Data for the system

Sources of data for the website may be Health related published Articles, NGOs, Private and governmental hospitals and academic institutes, associations which have publications, users and members of the system. Publications can be added to the system either online or directly by the administrator.

The publications that the system accepts will be different types. These publications may be thesis, conference paper or an Article from a journal. While entering these publications, the content contributor or the system administrator must provide details about the author(s), title, abstract and content of the publication. For each publication type, appropriate publication entry forms are designed. The system is designed to handle different file formats. Examples of the document types that are supported by this WNDC system are in HTML, DOC and PDF.

4.4.1.4. Process Design and deployment

Web servers are computers either on the internet and intranet or local computer that host websites serving pages to viewers upon request. This service is referred to as web hosting. Every web server has a unique address so that other computers connected to the

internet know where to find it on the internet. WNDC is designed using VertirgoServer web server software.

4.5. Implementation Strategy

Implementation is the decisive phase where the application is put in place. It is operation and execution time for a new system developed. In any technological project the end result may not necessarily be as what was originally planned. The competitive environment may change or newer technologies may be discovered along the way. The researcher has developed a working prototype of the WNDC system for health related publication that is open for modification based on feedbacks from any concerned body to enhance the application. At time of System implementation, the following are essential steps and requirements.

4.5.1. Website Hosting Services

A web hosting service is a type of Internet hosting service that allows individuals and organizations to make their website accessible via the World Wide Web. There are different companies locally and internationally which provide web hosting services to the various Government or nongovernmental Organizations. Domain name is given based on the purpose of the website and the application. The web hosting services are extended on other domains like gov.et, Org.et, .Com, .Edu, .Org etc.

4.5.2. Access Tools

Institutions are different in domain analysis and experience to handle, share, and use and implement publications. Therefore, as per the results of the assessment conducted, the system is designed to accommodate different stakeholders of the system even if visitors may not be technically oriented that they may require very easy navigation throughout the site.

4.5.3. Bandwidth

Some users may not have high bandwidth internet access and therefore they may have slower connection speeds. As a result graphics and multimedia information may not be accessible. This issue was given particular attention in using graphics and multimedia while designing. Important evaluations were made by the researcher to confirm that the system handles its intended purpose.

4.5.4. User documentation and User Training

In order for the application to be successful, users of the system must get appropriate training. From this perspective, users will get trainings when the system is put functional. User documentation is a detail document which is used by end users of the application. It serves as a point of reference at time of operating the system. For each and every aspects of the system, there has to be a detail user manual to enhance the system functionality.

4.5.5. Testing

System development and integration has different processes to approve system functionalities from different perspectives. One of these processes is testing. After requirements document is done, sub- system development for the framework is done. What come next are pre-formal test and general integration. After general integration is made, formal test is applied, followed by formal certification and customer acceptance assessment. Among these processes, therefore, the researcher has conducted only a non-formal test on major parts of the system based on different criteria. The rest of the processes are left for future work.

4.5.5.1. Page testing preview

Test	***Function***	***Remark***
1	User Login	Successful
2	User Registration	successful
3	Adding publications	successful
	Displaying added publications	Successful
4	sign in and Signup	Successful
5	Insertion of invalid username and password	Appropriate error message is displayed
6	Passwords do not match	Appropriate error message is displayed
7	Duplicated user registration	Successfully prevented
8	Link check	Successfully

CHAPTER FIVE: DISCUSSION AND INTERPRETATION

This paper summarizes and details the integration of a new Web-Based application system into the health sector. It reviews the process of verifying that common requirements are incorporated from different health institutes having health related publications. These requirements were collected from the survey made and documents reviewed. Different variables that were used for the study are discussed below.

The main objective of the assessment was to add more value on the researcher's endeavor to gather functional and non-functional requirements to design a common WNDC application. Different independent variables were set to assess their influence on the dependent variable which is publication usage. For each independent variable used, quantitative data the proportion is observed explicitly.

It is obvious that there are several factors which influence workers' publications usage for accessing web-based publications. In order to understand the influence of independent variables with respect to the dependent variable, the descriptive analysis is discussed and summarized under each category. This study is significant as it piloted an innovative WNDC BASED on an assessment process for integration and hindering the barriers to discussed problems. The assessment yielded different interesting implications.

Obtained results show that workers and scholar respondents in assessment areas have basic computer literacy and they have other computer skills that help them to operate different applications. From this evidence, we can get insights that there is a high possibility for this WNDC application in these areas to be used if it is implemented. Once again it is found that majority of the users get most health resources like publications from the internet and most institutes have internet access at this time. From here we can imply that this WNDC application can contribute a lot for these users as a storage places and communication medium to share health resources. Depending only on the above findings the researcher can infer that a WNDC application for publications will have many users if put functional for health institutes.

Most institutes who have their own publications keep these publications in local computers and few released only the abstracts part of the publication online. Some respondents expressed their belief that this system will help health professional to access publications from a central system. In addition to publications, respondents wish the system to have additional services like notice-board and email services. Especially, a respondent from MoH assured that there is no such a system in Ethiopia and the ministry appreciates the endeavor and it is ready to cooperate to integrate this new system with other existing ministry's web-based systems. Other respondents suggested that a system like this could be a solution to collect works of master and doctorate students as there is no system so far.

As confirmed by MoH, there is no central system for health related publications in Ethiopia currently. From the analysis, it is visible that most (60.42%) health publications are found recently either in a local or in sampled institutes' libraries. Generally, this study highlights the potential to efficiently integrate health publications using interactive WNDC application across different health institutes.

CHAPTER SIX: CONCLUSION

Technology has changed the way health care activities are done and the characteristics of the information systems and their environment by providing different opportunities for integration of different systems together. This change needs the necessity of assessment of different systems for integration. Consequently, evaluation of a system to integrate resources cannot be independent of its users. Due to this fact, WNDC framework proposes assessment based on stakeholder perceptions and preferences for integration. This study aimed to create a WNDC effectiveness assessment which would allow the identification of the possibility of integration of health related publications for different health institutes in Ethiopian context.

In this assessment, experts' knowledge (ICT specialists), MoH personnels and institute managers' concerns (questionnaires and interviews), web-based related data and other stakeholder perceptions were considered.

The assessment applied a descriptive survey method using purposive and proportional stratified random sampling techniques to get qualitative and quantitative data.

The objectives of this study were:

i To assess health institute workers' ICT literacy and health publication usage.

ii To identify different health institutes' heterogeneous inter-related publications.

iii To perform systems specifications for technical description of the WNDC system.

iv To analyze and design working WNDC application in order to integrate health related publications in Ethiopian context.

In order to fulfill these objectives, the starting point was to review previous studies on web-based system information system integration. In this regard, literatures were explored and their insufficiencies were identified. Even though the literatures reviewed

on integration are valuable in their own perspectives, they are far from providing a broad inter-institutional, comprehensive framework for Ethiopian context. Hence, an assessment was made which encompasses both web-based related, and publication related aspects for the capability of web-based application for integration. In this regard, ICT literacy and health publication usage in each environment was taken into account as the first measurement to implement web-based application. Implementation of web-based application success was evaluated in terms of its relationships with users' capability of computer literacy and health related publication usage.

For health institutes' heterogeneous inter-related publications, initial consideration was identification of availability of health related publications in each institute and probing the types of health related publications that users read and know. This consideration adds value for the preference of using WNDC for integration. Common system specifications for technical description of the WNDC system were taken from different health institutes. Based on the results of the technical system specifications, analyses and design of working WNDC application prototype is done.

The following research questions were answered through the analyses of the study:

1. Do health workers have ICT literacy and experience of using publications?
2. Which publications are common across different health institutes?
3. What are those system specifications which help to design a WNDC application?
4. Can a WNDC be a solution to integrate and alleviate the problems of lack of integration of health related publications?

First of all, in all institutes where the case study is undertaken, it was observed that all health workers have ICT literacy and experience of using publications. This was made after obtained results were justified by comparing the outcomes of statistics.

Secondly, from the results obtained, common publications across different health institutes are identified. Based on these results common website modules across institutes' websites are identified.

Based on gathered information from different health institutes, most institutes have similarities in experiences and ICT and health publication usage. Substantial evidences are found from the survey that web-based application can be proposed in health institutes to integrate health related publications.

The assessment for a solution for integration of health publications and those web-based application implementation factors gave promising results; by supporting the fact that integration is possible using WNDC application. Moreover, respondents support and believe the proposed framework to be a solution to integrate health publications across different institutes. From this fact, WNDC framework is proposed as a generic framework for integration of any type of health publication for any health institute. For a specific domain, the application of WNDC may differ and appropriate assessment, according to the characteristics of the domain, is needed. The researcher found WNDC framework to be a feasible tool that can integrate health publications and alleviate raised problems.

In general, this study can be considered as a milestone to develop a comprehensive and full-fledged WNDC application for an integrated and clustered web-based application to share information about health related research projects, publications, articles, conference papers, and other health resources in order to contribute a lot in the sector. Moreover, the results of this study have shown the importance of WNDC publications in familiarizing a new approach to integrate health related publications together.

Limitations

The study was undertaken aiming to integrate health related publications from some health institutes which are found in Addis Ababa. Other stakeholder and health institutes are not reached due to time and the complex nature of health resources. The data collection process through interviews was difficult to conduct because of some respondents' low motivation and lack of cooperation to be interviewed and due to time constraints. These limitations may be solved after the framework is applied and user acceptance testing is made.

The WNDC framework is proposed to limited number of organizations because of time constraints, which is another limitation of this study.

CHAPTER SEVEN: RECOMMENDATIONS FOR FUTURE WORK

A pilot web-based framework is proposed in this study for health related publications. But, health resources are very vast and complex.

There are lots of untouched technological advancements in the web service that can be added to the current system. Integration of this system with other web-based health applications within and across health institutes and adding other features like web reporting and analysis tools should be addressed.

As a future research, the WNDC framework can be integrated with other models like web 2.0. Web 2.0 is the move toward a more social, collaborative, interactive and responsive web. It helps users to collaborate and share information online in ways that was not possible before on the World Wide Web, therefore, creating interactive environments with this WNDC deserves attention and shall be explored further.

Moreover, a web crawling is a program that automatically scans context and meaning of the content from the URLs of different websites on the internet. This system needs to have a crawler which searches for health related publications, validates and adds URLs into the collections of the publications database so that users can have data enriched application which is center for multiple local, national and international publications.

Since the numbers of respondents were very limited and selected to the purpose, detail statistical reliability was not the concern of this study. The aim was to develop a descriptive assessment to design a WNDC framework and to show its applicability as a solution to integrate health publications in different health institutes. Hence, statistical analysis of the results is left as a future study.

Finally, the researcher acknowledges that further research work and memorandum of agreement for sharing resources among inter-related institutes is needed for proposed framework.

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Appendices

Appendix-1: Use case Scenarios

Functional Requirement Use Case Name: User Login	
Use Case	UC001
Description	This use case handles the access to the system. If the user has no access with the username and password he has provided while registering with the system.
Primary Actor	User or the Customer
Trigger	The user or the customer writes username and password. Then s/he then logons into the system and make privileged information.
Pre-condition	the user must enter a valid User Name and a Password
Failed End conditions	Duplicate user name is not allowed in the system application.
Action	User clicks on the log-in button.
Main Scenario	User types the URL of the site on the browser which in turn opens the main page. In the main page of application, user gets 'Log-in' button. Application then checks whether the user name is unique in the system, if not then user is popped up with error message that "user already exist". After entering the unique name the user is finally logged in the application.
Post-condition	If the username and password are valid, the system verifies username and password that the user is able to view the information available on the system.
Success Scenarios	Opens page of a selected room in that other user names and their messages can be seen. the user can enter into the system

Functional Requirement Use Case Name: Register User	
Use Case	UC002
Description	This use case handles the access to the system. If the user has no access (that is, is unregistered), he/she will be directed to a registration page.
Primary Actor	The main actors are new users who have not registered to this system and do not have a valid user account. (Customer, member, physician, administrator)
Trigger	User types application on URL of the browser.
Pre-condition	Not available
Failed End conditions	Duplicate user name is not allowed in the system application.
Action	User clicks on the "create a user account" button.
Main Scenario	A1. The user accesses the system and chooses the new user register function to create a user account. A2. The system displays a registration form, including Email address, name and password A3. The user fills out the registration form, and submits it. A4. The system verifies the submitted information. If the data is valid, the system returns the confirming information to the user, shows the user a welcome message, the user account, and the password.
Alternate Scenario	B4. If user account already exists in the system, the system shows an error message. Then the system displays the registration form, and the user goes to step A3. C4. If the user's password does not match when reentered, the system shows an error message. Then the system displays the registration form, and the user goes to step A3.
Success Scenarios	Opens page of a selected room in that other user names and their messages can be seen. the user can enter the system
Post-Condition	After a new user is registered to the system successfully, the user can use the user account and password to login the

Functional Requirement Use Case Name: Register User	
Non Functional Requirement	system and perform other tasks. Error message should be clear to the users. When the user is asked to refill out the form, the correct data that the user submitted last time should be there.

Functional Requirement Use Case Name: Edit-Personal-Information	
Use Case	UC003
Description	This functionality allows the user to manipulate their personal information.
Primary Actor	The main actors are users who have valid user accounts. (Customer, member, physician, administrator)
Pre-condition	The account of user must exist User must logged in the system
Failed End conditions	Duplicate user name is not allowed in the system application.
Action	User clicks on the Edit a user button.
Main Scenario	After the user has logged in, s/he will choose the option "Edit Personal Information". System displays his current profile and Users will be able to see their information such as name, address, e-mail, phone number. User makes required changes. System updates the changes into the database. System informs the user that the changes have been made.
Alternate Scenario	1a. User requests profile deletion. 1. System asks him for confirmation. 2. User confirms. 3. System informs the user about his account deletion.
Post-Condition	User has successfully edited his profile.

Functional Requirement Use Case Name: Login/Logout	
Use Case	UC004
Description	This use case describes the scenario that shows how the administrator of the system logs into and logs out the system.
Primary Actor	Administrator
Trigger	The administrator of the system logs into the application with the administrator username and password.
Pre-condition	The user is logged in to logout and logged out to login.
Action	User clicks on the logout/login button.
Main Scenario	User instructs the system to the logout/login him/her out/in using the 'the logout/login link. System clears his session, logs him/her out and redirects to the login page. When login into the system, session is established.
Post-Condition	User successfully logs out of his/her account.

Functional Requirement Use Case Name: request new password	
Use Case	UC005
Description	A user has forgotten his password and requests a new one.
Primary Actor	registered user
Pre-condition	The user is not logged in
Failed End conditions	User provides unknown email address: There is not user with the provided email address
Main Scenario	1. User opens the start page in his browser 2. The user selects “I forgot my password” 3. The user provides his email address 4. The system checks if there is a user with the provided email Address in WNDC 5. The system sets the password of this user to a randomly generated new password 6. The user sends an email to the given email address containing the new password 7. The system displays a message that a new password has been sent to the provided email address
Post-Condition	A new password is generated for the user with the provided email address and an email containing a new password is sent to this email.

Functional Requirement Use Case Name: Search article	
Use Case	UC006
Description	This functionality helps to facilitate search for resources. Search will be based on various categories such as article/ publication title, Author, or typing the keyword. This function is performed by all the actors in the system.
Primary Actor	The main actors are all users. (Customer, member, physician, administrator)
Pre-condition	Search page
Failed End conditions	. The system displays "The article doesn't exist" message
Action	User writes search key in the search text button and presses the "go" button
Main Scenario	1. User selects the 'Search' link from the initial home screen. 2. System displays the search screen. 3. User enters the keywords they are searching on. 4. System searches all the items matching the given keywords and displays a list of the matching items. 5. User reviews the available items and selects the one they like. 6. System sends a request to the owner of the selected item, informing them that the user would like to borrow this item and here use case ends
Success Scenarios	User gets what s/he wants to get.
Post-Condition	The user gets article information from the system

Functional Requirement Use Case Name: submit Article	
Use Case	UC007
Description	This functionality allows members and content contributors, and administrators to add published Articles and journals to the WNDC.
Primary Actor	Members, content contributors, administrators.
Pre-condition	The account of Members, content contributors, administrators must exist and they must login
Action	Members, content contributors, administrators writes user name and password and clicks on the login button
Main Scenario	1. Member, content contributor, Author logs into the system 2. Member, content contributor, Author selects the upload/contribute Article link. 3. Member, content contributor, Author fills up required forms and submits an article for consideration 4. The administrator logs into the system 5. The administrator selects the article and checks for criteria and details of the Article submitted. 6. The administrator approves/disproves article 7. If approved, content will be added to the data center.
Alternate Scenario	
Success Scenarios	Member, content contributor, Author, and aadministrators are able to add article to data center.
Post-Condition	Article is added to data center .

Functional Requirement Use Case Name: Update Information	
Use Case	UC008
Description	User will be able to update user/system information when needed.
Primary Actor	User (administrator/member)
Pre-condition	User is logged into the system.
Action	User clicks on the update button.
Main Scenario	User Updates Publication and his/her own personal information User correct or fills in missing information. User closes the form and the system is updated.
Alternate Scenario	A. user tries to update some access limited information. A.1. Only a member/administrator is allowed to update information.
Success Scenarios	The user gets updated information.
Post-Condition	The system contains valid and updated data.

Appendix-2: Class Diagram Notation

UML Class Diagram Notation			
No	Term	Description	Notation
1	Association	A relationship between two classes or objects	
2	Inheritance	Relationships defined as "is a" and "is like"	

Appendix-3: Assessment Tools

Questionnaire to be filled by Institute workers

This questionnaire is administered by a graduate student of the department of health informatics at Addis Ababa University. The purpose of the questionnaire is to collect data on a thesis entitled "A Web-Based National Data Center Framework to Integrate Health Related Publications in Ethiopia".

The data is needed purely for educational purpose and your response to the questions will be kept confidential. Finally, I would like to express my heartfelt thanks for taking your time in completing the questionnaire.

Direction

- No need to write your name
- Put "X" mark in the box where alternative answers are given
- Use the codes from the table in filling out Demographic Data.

I. Area Information:

Organization:_____

II. Demographic Data

Serial Number of interviewee_____(to be given by interviewer)

Gender :---------- Age: ----------

Level of education: ---------- Type of occupation: ----------

Questions

1. Do you have any computer literacy?
    a. Yes b. No
2. If "Yes" in question #1 above, which computer skills do you have? (you can choose more than one)
    a. Computer basics like Ms-office
    b. Email and Internet
    c. Advanced applications
    d. A, B

e. A, B, C

3. Is there Internet access in your office?
    a. Yes b. No
4. If "Yes" in question #3 above, for what applications you use it? (you can choose more than one)
    a. Email service
    b. As a source of information browsing
    c. Data sharing
    d. A, B
    e. A, B, C
5. Do you use and/or read health related publications?
    a. Yes b. No
6. If "Yes" in question #5 above, would you mention few of them?

    _____ _____

7. If "Yes" in question #5 above, where you get them from? (you can choose more than one)
    a. from in office
    b. from the Internet.
    c. from library
    d. A,B
    e. A,B,C
    f. B,C
8. Does your office have its own health related publications?
    a. Yes b.No
9. If "Yes" in question #7 above, in what format are these publications?
    a. Hard copy
    b. Soft copy
    c. In Hard and Soft copy
10. Where are these publications kept? (you can choose more than one)
    a. On the website
    b. In a local computer
    c. In a library
    d. In office shelf

Interview Questions for ICT Department, MOH and, Institute Managers

Questions

1. What ICT infrastructures are available in your institutes?
2. Do you have health related publications that are available in your institutes?
3. Where are these resources kept?
4. Does your organization have its own website
5. Does this website have any health related publications?
6. What types of publication formats are used?
7. How do you organize your publications? [e.g. chronological, theme, hierarchy, story...]
8. What are other several health publication websites you read/ know? (Local Or International)
9. How would you see about designing a central data center with a common website that integrates all health related publications together?
10. What are those additional services that this system should provide in addition to publications?

Appendix-4: Analyzed Qualitative Data Set

Respondent ID	Q#	**Response Notes**	**Code**
ICT9	1	Computer LAN	ICT infrastructures
ICT7	1	Database, LAN, Website, drop box, HMIS	
ICT8	1	HMIS, Internet, Website	
IM2	1	Internet	
IM3	1	Internet, Database	
IM4	1	Internet, Network	
IM6	1	Internet, LAN, drop box	
ICT6	1	Internet, website, computer	
ICT4	1	Internet, website, database, computer	
IM5	1	Internet, website, HMIS	
ICT6	1	Network (LAN), iNternet	
IM1	1	Webex, SharePoint, internet	
ICT1	1	Website, Database	
ICT2	1	Website, Internet and video connectivity	
ICT3	1	Website, internet and video connectivity	
IM7	1	website, Database, HMIS	
IM8		Networking, Internet	
ICT1	2	yes	Availability of related publications
ICT7	2	no	
IM2	2	No	
IM7	2	no	
ICT2	2	yes	
ICT3	2	yes	
ICT4	2	yes	
ICT6	2	yes	
ICT6	2	yes	
ICT8	2	yes	
ICT9	2	yes	
IM1	2	yes	
IM3	2	yes	

Respondent ID	Q#	**Response Notes**	**Code**
IM4	2	yes	
IM5	2	yes	
IM6	2	yes	
IM8	2	no	
ICT9	3	in LAN, Local computer, hard copy	Place where publications are found
ICT2	3	In local computer	
ICT3	3	In local computer	
IM6	3	In local computer	
ICT1	3	In local computer, in Website	
IM4	3	In local computer, Shelf, Library	
IM1	3	In local computer, website (Hard copy, soft copy)	
ICT6	3	In website, local pc	
IM3	3	local computer	
ICT8	3	local computer, Website (soft and hard copy)	
ICT4	3	local PC	
IM5	3	local computer, shelves	
ICT7	3	lot applicable	
IM2	3	Not applicable	
IM7	3	not applicable	
IM8	3	not applicable	
ICT6	3	website, shelve, library, local computer	
ICT9	4	no	Availability of website
IM2	4	No	
IM3	4	no	
ICT1	4	yes	
ICT2	4	yes	
ICT3	4	yes	
ICT4	4	yes	
ICT6	4	yes	
ICT6	4	yes	
ICT7	4	yes	
ICT8	4	yes	
IM4	4	yes	
IM5	4	yes	
IM6	4	yes	
IM7	4	yes	
IM8	4	yes	
IM1	4	yes, www.epha.org	