ADDIS ABABA UNIVERSITY

FACULTY OF MEDICINE AND SCHOOL OF INFORMATICS

Health Informatics Department

Exploring the Application of Geographic Information System in Health Organizations Working on HIV/AIDS Prevention Programs in Ethiopia.

A Thesis Submitted to the School of Graduate Studies of Addis Ababa University in Partial Fulfillment of the Requirements for the Degree of Masters of Science in Health Informatics

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June, 2010

Addis Ababa, Ethiopia

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DECLARATION

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

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Date of Submission: June, 2010

Dedication

This thesis work is dedicated to my mother Tsega Haile and my little Daughter Soliana Girma.

Acknowledgements

First of all , I would like to express my heart felt thanks and appreciation to my advisor Dr. Million Meshesha for his invaluable comments and suggestions starting from the development of the research proposal up to the preparation of this research thesis.

Next, I would like to thank the department of Health Informatics for its financial support in the preparation of my thesis.

My deep appreciation and thanks also goes to all organizations working on HIV/AIDS prevention, care and treatment programs participated in this survey and provided full information with their full cooperation.

Last but not least I would like to thank my wife Sr. Genet Getachew, my colleagues Dr. Jemal Aliy, Mr. Surafel Mamo and Mr. Solomon Mengistu for their unreserved support during conducting this thesis work.

Abstract

***Background**: Understanding issues ranging from medical epidemiology to healthcare access requires a comprehensive understanding of their geography. In health organizations, GIS provides powerful tools for geographic and spatial analysis, and it allows visualizing data that may have gone unnoticed in spreadsheets, charts, and other reports. Despite the availability of a number of functionalities of GIS technologies with convenient cost, their applications to the health sector in preventing HIV/AIDS is not explored.*

***Objectives:** To assess the extent of GIS applications and identify barriers to its adoption, diffusion and utilization in HIV/AIDS prevention programs.*

***Methods:** Organization based survey was carried out in Addis Ababa between March and May; 2010.The study participants are organizations working on HIV/AIDS programs at national level. The study employed quantitative and qualitative methods. The data are entered, cleaned and analyzed using SPSS version15 statistical software.*

***Result**- Current GIS use among organizations working on HIV/AIDS prevention programs, 18(26.9%) are using GIS technology for program planning and management. Lack of GIS awareness (42.9%), GIS skill (18.4%) and clear GIS strategy (16.3%) are major barriers to the adoption and utilization of GIS among organizations included in the study. Lack of GIS skill (OR=0.07, 95 % CI (0.01, 0.71)) and awareness on GIS use (OR= 0.15, 95% CI (0.04, 0.48)) found to have associations with the current use of GIS in an organization.*

***Conclusion**- The study discovers that the uptake of GIS technology in the HIV/AIDS prevention programs is very low. The main reasons identified are Lack of GIS awareness, skill, strategy and poor data sharing experience among organizations. To improve the adoption and use of GIS in the health sector, I recommend organizations to create GIS awareness, develop GIS skill and enhance data sharing with and within the health sector, and investigate further the adoption and use of GIS technology in the health sector in general.*

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Acronyms

GIS:	Geographic Information System
AIDS:	Acquired Immune Deficiency Syndrome
HIV:	Human Immuno Deficiency Virus
NGO:	Non Governmental Organization
GPS:	Global Positioning System
ICT:	Information Communication Technology
PLWHIV:	People living with HIV
CDC:	Communicable Disease control
FMOH:	Federal Ministry of Health
WHO:	World Health Organization
FP:	Family planning
ESRI:	Environmental System Research Institute
TB:	Tuberculosis
VCT:	Voluntary Counseling and Testing
PMTCT:	Prevention of Mother to Child Transmission
ART:	Anti-Retroviral Treatment

CHAPTER ONE

INTRODUCTION

1.1 Background

Since the 1990s, interest in geographic information systems (GIS) has increased within the public health, and the use of GIS techniques has become increasingly more common in public health practice [13]. By definition, GIS can be regarded as an automated system for the capture, storage, retrieval, analysis, and display of spatial data [1].

A strict definition of public health is difficult to pin down, as it is used in different ways by different groups. In general, public health differs from personal health in that it is (i) focused on the health of populations rather than of individuals, (ii) focused more on prevention than on treatment, and (iii)operates in a mainly governmental (rather than private) context[31].

Public health data contains an inherently large amount of information that may not be readily understood by naive person. The ability to represent the geographic information that can be linked to other public health data in a map would enhance the following. First, decision-making abilities of planners. Second, determination of pockets of need within areas and aid in allocation of funding. Third, decrease the response time to disease outbreaks.

In the current model of GIS in the Public Health Sector, there is a distinct separation between the health specialists, who are experts with distinct public health datasets, and the GIS technicians, who are experts in GIS functionality [27].For effective GIS use, information transfer between the GIS expert and the health specialist must become a two way street. GIS functionality must be provided in a way that is readily understandable to the health specialist. For this to happen, the health specialist must

effectively communicate information regarding data security, data use, patient information and other health-related uses that may not be known to the GIS expert. Rather than blindly creating a map that the health specialist asks for, the GIS expert would better also know background information that could enhance any GIS analysis performed. Maps created with this increased knowledge of health data would be both more useful and more desirable to the health specialists.

Health mapping refers to the activities, techniques and tools that are used to link geography or location as the common factor that pulls health community data together [30].The health map generally aims to create cartographic representation of the environmental setting, the distribution of diseases and the health services. The real value of health mapping emerges when maps are linked to disease control and prevention efforts.

World Health Organization (WHO) has been using mapping techniques coupled with surveillance to monitor the global health situation and present it through user-friendly and modern tools such as geographic information systems. Public health mapping utilizes the technology of geographic information systems to add value to information for public health planning and decision making. Mapping enables professionals to understand complex spatial relationships visually, and as planning has an element of informed prediction, mapping can be a powerful tool for forecasting and trend analysis [6]. WHO has developed a computer-based system called HealthMapper [30] to address critical surveillance information needs across infectious disease programs at national and global levels. The Health mapper has been designed to simplify access and use of GIS and mapping technologies in public health.

1.2 Statement of the Problem

In many African countries GIS adoption, diffusion and utilization of spatial technologies has proceeded at relatively lower rate. A little attention has been paid to improve current situation along the line of flexible approaches and efficient organizational frameworks. The implementation of GIS has been restricted by numerous factors such as financial, political, technical, technological, educational, organizational, and human behavioral, etc. The most common explanation of GIS unsuccessful stories was covered under umbrella of financial, technical and staffing obstacles [29].

A careful assessment of data gathered over the last four years suggests that, in Ethiopia, the prevalence of HIV/AIDS has stabilized, with adult HIV prevalence estimated at 2.2% in 2003/04 and 2.1% in 2006/07[3].The rural epidemic appears to be relatively widespread but heterogeneous, with most regions having a relatively low prevalence of HIV, but a few demonstrating adult prevalence greater than 5%. HIV prevention services; antiretroviral treatment and HIV-related care and support services are freely provided through government programs. The national response for HIV/AIDS is the sum of the collective efforts of many actors, notably the government, multilateral and bilateral partners, international and local NGOs Associations of people living with HIV (PLWHIV), Faith-based organizations and the like(3).

In the fight against HIV/AIDS, GIS technology has been used in several different ways, including for spatial analysis of HIV/AIDS epidemiology, locating high risk populations and prevention services, and understanding barriers to access care services among people with HIV/AIDS [20]. Tekalign [22] tried to show the use of GIS technology in HIV/AIDS prevention programs planning and evaluation in Addis Ababa by developing prototype using GIS as a tool. His work was focused on mapping the HIV susceptibility

areas and service distribution in Addis Ababa. However, Tekalign did not examine to what extent Organizations, working on HIV/AIDS prevention, care and treatment interventions programs are using geographic information technology in any of the ways mentioned above for their planning and decision making purpose.

Understanding the extent of GIS use for planning, decision making and evaluating HIV/AIDS intervention programs and identifying the potential barriers for adoption of the technology by organizations working on HIV prevention programs are very crucial for successful implementation of GIS technology in an organization.

This in turn brings about better planning, management and equitable allocation of resources to prevent and control HIV/AIDS in the population.

Hence, the aim of this study is to assess the extent and challenges of application of GIS for HIV programs management among organizations working on HIV/AIDS prevention programs

1.3 Research Questions

This thesis aims at finding answers to the following questions.

- How is the current situation of GIS use in HIV/AIDS prevention program areas?
- Why organizations working on HIV/AIDS are not using GIS technology in their planning, monitoring and evaluating prevention programs?

1.4 Research Objectives

1.4.1 General Objective:

The general objective of this research was to assess the Application of GIS among Organizations working on HIV/AIDS prevention programs in their service planning ,monitoring and evaluating activities.

1.4. 2 Specific objectives:

The specific objectives of this study are:

- To assess the extent of GIS application among organizations working on HIV prevention programs.
- To identify challenges in implementing GIS technology in organizations working on HIV prevention programs.
- To forward concluding remarks and recommend further research areas.

1.5 Rationale for the study

Exploring the current use of GIS and identifying the organizational challenges in the health sector is very important to understand the status of GIS technology use and barriers to its application in planning, monitoring and managing HIV prevention and control programs. Based on the findings important recommendations can be made to improve the use and awareness of GIS for analysis and integration of HIV related spatial information to enhance equity and evidence based decision.

1.6 Scope and Limitation of the Study

The study focused on exploring the extent of GIS use and identifying determinants of its use and is limited to organizations working on HIV/AIDS preventions programs at national level. There are some limitations related to this research. Firstly, limitation related to those organizations which did not fill the questionnaire for various reasons that made the non- response rate

more than 10%. Secondly, limitation related to the study design by which one can not ascertain whether the dependent variables are responsible for the change in the dependent variable i.e. it is difficult to establish cause and effect relationship.Thirdly, the study did not develop a prototype to demonstrate the use of GIS for planning, monitoring and evaluating program performance due to time constraint.

1.7 Significance of the Study

Although this research is primarily meant to fulfill academic requirement, it can serve as foundation for further study on how to fully use GIS technology in the health system to capture, store, spatially analyze and disseminate health related data for evidence based decision making.

CHAPTER TWO

2. LITERATURE REVIEW

2.1. Geographic Information System (GIS)

An information system is an arrangement of people ,data,processs, information presentation, and information technology that interact to support and improve day-to-day operations in business as well as support the problem solving and decision making needs of management and users[33]. As it is cited in the work of [32],Ken Duker defined GIS as " a Special case of information systems where the database consists of observations on spatially distributed features, activities or events, which are definable in space as points, lines or areas. A geographic information system manipulates data about these points, lines and areas to retrieve data for Ad hoc queries and analysis".

Since the 1960's computers have been used for manipulating spatial data by geographers and geologists. The word geographic means that location of data items are known and can be calculated in terms of longitude and latitude (24).

A geographic information system is an organized collection of computer hardware and software, geographic and tabular data, and personnel and knowledge designed to capture, store, manipulate, update, analyze and display spatial data [2]. GIS draws on concepts and ideas from many different disciplines as diverse as cartography, cognitive science, computer science, engineering, environmental science, architecture, public policy, statistics and surveying [11].It is relatively new and fast developing methodological approach that is designed to look at geographic and spatial data [25].

GIS can be viewed as a software package, the components being the various tools used to enter, manipulate, analyze and output data. The components of a GIS include computer system (hardware and software), spatial data, data management and analysis procedures and people to operate the GIS [11]. Spatial data are data characterized by information about position, connections with other features and details of non-spatial characteristics. Spatial data are represented as either layers or objects which must be simplified to points, lines or areas before they can be stored in the computer [11].

2.2. GIS functional Capabilities

GIS definitions usually focus on what tasks a GIS can do rather than what it is. GIS functional capabilities follow the standard GIS definitions; therefore, GIS can bring together the elements necessary for problem solving and analysis **[**5**],** such as data capturing, data storage, data retrieval, data display and data integration.

2.2.1. Data Capturing

Data can be input into the GIS from existing external digital sources. When no data exist for a project, the base data must be assembled from other studies, public domain datasets, and /or images. In addition, GIS can capture new map data directly; this means either the user can scan the map and input it into the GIS or trace over map's features using a digitizing tablet and enter them into the GIS map database. Global Positioning System (GPS) can be used to obtain locations of point features on a map [1].

GPS is a space-based radio positioning system designed to provide suitably equipped users with highly accurate positioning, velocity, and time data. GPS and GIS together have permanently altered the relationship between field data collection and data analysis. Data collected in real time can be analyzed the same day and acted upon immediately.

2.2.2. Data Storage

GIS can store both map and attribute data. Attribute data are usually stored in a relational database management system contained within the GIS and accessed by a spreadsheet or query-driven user interface. For storage, map data must be encoded into a set of coordinates so that the geometry of the map is available for query. Image maps are usually stored as gridded arrays. Line maps are encoded by any one of several systems, but usually by using both the coordinate information and encoded topology, so that the relationships between points, lines and areas, such as the adjacency of regions or the connectedness of lines, are known in advance.

GIS has the ability to link relational databases to geographic objects [24]. Geographic objects can be displayed in three ways line, point or polygon. There are two fundamental approaches by which spatial components represent geographic information: the Raster and the Vectors model. Briefly, the vector model represents real objects by points and lines, which define their boundaries. The raster model represents space by regular subdivision into cells or pixels. The location of geographic objects or conditions is defined by the row and column position of the cells they occupy [24].

2.2.3. Data Retrieval

Data records in GIS can be retrieved in one of two ways. The relational database manager allows searching, reordering, and selecting on the basis of a feature's attributes and their values. GIS also allows spatial retrieval. The user could select all clinics by region, by their latitude, or by their distance from the capital. In addition, combining searches for retrieval is possible.

2.2.4. Data Display

Display functions include predominantly the making of maps. Tools must exist for constructing many types of maps, such as contours, symbols, shading or choropleth, and sized symbols. Formal map display often follows a series of more temporary map images, usually without a strict map composition, and the result of a test, an analysis, or a query.

Visualization, which means the presentation of data in graphic form, is used as a convenient and effective way to communicate complex information. Information system (IS) exploits and explores the different ways in which the display of geographic information can be presented. Humans have the ability to interpret and understand complex spatial relationship visually; if the same information were displayed in the form of tables and numbers it would be hard to understand [24].

2.2.5. Integrating Data

In health organizations, GIS provides powerful tools for geographic and spatial analysis. It allows visualizing data that may have gone unnoticed in spread sheets, charts, and other reports. By integrating database operations, such as query and statistical analysis, with geographical and spatial visualization, one can be able to predict, plan and recommend interventions and strategies with confidence [24].

GIS can be used to handle and geographically integrate large amounts of information from different sources, programs and sectors. GIS can eliminate the duplication of effort involved in data collection across an organization, and hence substantially reduce the cost involved in it. It serves as a common platform for the convergence of multi-disease surveillance activities, and each data record has to be georefenced to a desired level of accuracy [1].

2.3. Spatial Analysis and GIS

Spatial analysis is a term used to describe analytic processes applied to georeferenced data. Analysis in GIS takes the form of many functions using a combination of different sets of data to get different results, which lead to a completely new set of data and information. The ability to handle and compare multiple features of the same geographic location and their attributes in one system to develop different scenarios is asset to the technology [6]. Some of the most common and fundamental GIS functions by which data can be analyzed are the following:

- Recoding, this is briefly the rearrangement of classes logically manageable and coherent lists.
- Overlay, which is simply placing one coverage over the other in an attempt to find spatial relationships between and among features.
- Buffering, this is basically an operation that gives a desired and stated distance outward from the selected feature creating a buffer.
- Network analysis, which makes useful and numerous operations on a road, river, railway networks and site suitability selection that used to extensively in land planning.

2.4. GIS Software

There are a number of GIS software packages available for users such as ArcGIS, Healthmapper, MapInfo, and Epimap. The first three GIS softwares are described briefly below.

ArcGIS: Is a long lived, fully function GIS package that has been ported to the microcomputer, the workstation, and the mainframe. It is used to automate, manipulate, analyze, and display geographic data. The software incorporates hundreds of sophisticated tools for map automation, data conversion, database management, map overlay and spatial analysis,

interactive display and query, geographic editing and address geocoding [32].

HealthMapper: HealthMapper was developed by WHO with the initial objective of building a system for mapping Guinea worm disease. Its particular focus is on the African countries. The original objective later expanded for meeting the needs of other control programs such as malaria, HIV/AIDS and other diseases. It provides a basic set of geographic information system functions, mainly those for mapping and displaying thematic maps [34].

MapInfo: Although MapInfo GIS retrieval and analysis functions are few than those of full blown GIS packages, it includes a link to the basic programming language via a language called mapbasic.This development environment permits the creation of customized applications extending MapInfo built-in functionalities and allowing use of a common graphical interface[32].

2.5. Applications of GIS in the Health Sector

GIS applications show the power and potential of such systems for addressing important health issues at the international, national, and local levels. Much of that power stems from the systems' spatial analysis capabilities, which allow users to examine and display health data in new and highly effective ways. Spatial analysis refers to the ability to manipulate spatial data into different forms and extract additional meaning as a result [5].

Most health and human service problems facing the world today exist in a geographic context. Understanding issues ranging from medical epidemiology to health-care access requires a comprehensive understanding of their geography [1].

2.5.1. GIS in Disease Mapping and Spatial Analysis

Describing disease epidemiology typically has three elements: Time, Place, and Person. Describing the outbreaks and the spreads of communicable disease therefore explicitly includes a spatial component [27]. The representation and analysis of map of disease-incidence data is a basis tool in the analysis of regional variation in public health. The development of methods of mapping disease incidence has progressed considerably in recent years. The map of addresses of cholera victims related to the locations of water supplies by john Snow in 1854 is the earliest example of disease mapping [27].The main areas of application can be broken down into: Disease mapping, Disease clustering and Ecological analysis.

The objective of analysis is to provide the true relative risk of a disease of interest across a geographical area. Disease clustering, on the other hand, is important to assess whether a disease map is clustered and where the cluster is located. The analysis of disease incidence around a putative source of hazard is a special case of cluster detection. The ecological analysis focuses on the geographical distribution of disease in relation to explanatory covariates, usually at an aggregated spatial level.

Though most research has focused on temporal analysis ignoring the spatial dimensions of the HIV/AIDS epidemic, spatial analysis is an important tool to monitor the epidemic, predict future treatment demands and target areas for public health interventions [19].

2.5.2. GIS in Communicable Disease Prevention

Prevention comprises all measures and strategies of health protection and promotion, which ensure that communicable diseases do not occur. The success of preventive measures depends on identifying the existence and location of a population at risk, spatially allocating preventive actions, and ensuring accessibility to these preventive measures for those at risk.

In South Africa, an investigation using GIS demonstrated that there exists a substantial heterogeneity of HIV prevalence among pregnant women and that this heterogeneity closely correlates with the distance of the women's homestead to primary and secondary roads[27]. It was seen as a starting point for the development of more precise prevention strategies to reduce the spread of HIV infection.

2.5.3. GIS in Communicable Disease Surveillance

Surveillance is a continuous and systematic collection, analysis and interpretation of data on infectious diseases. This is essential for planning, implementing and evaluating intervention measures and programs for the prevention, identification and control of infections.

Since the beginning of 1990s, the Centers of Disease Control (CDC –U.S.A) have carried out several GIS based analyses covering the occurrence of infectious disease due to environmental factors [27]. Modern software facilitates the development of complex application for the WWW in the field of GIS and database technology. The web can be used to generate complete maps interactively. The online monitoring of the spatial distribution of disease is of increasing interest to public health.

2.5.4. GIS in Communicable Disease Control

Control comprises all the measures that are necessary to identify an increasing number of infections with the same pathogen as well as the specific causes. It includes measures that are directed at the cause and prevent the infection from spreading or recurring. In United States of America, North Carolina, a GIS was used in an out break of shigella sonnei infection in a single community [27]. A database consisting of demographic, temporal, and home address information was used. Through simultaneous examination of temporal and spatial distribution of the 59 identified cases, a focus of infection in a single housing was identified. Targeted Education

among residents of the neighborhood was associated with prompt control of the epidemic.

2.5.5. GIS Application in Planning Health Infrastructure and Maintenance

For health care planners and mangers it is important to explore ways by which health care delivery can be improved. It is important to analyze and understand the real patterns of health seeking as opposed to the theoretical catchment area [2].

Access to health care describes people's ability to use health services when and where they are needed [28]. GIS is being used to create better measures of geographical access and analyze geographical inequalities in access as well as those patterned along social and economic lines. Measuring geographical access can be either area-based or distance based [27]. Area-based measures for areas like countries, towns, or states. The ratios of population need services available. Measures like physician to population ratio are used to describe disparities in access to physicians across a region or a country. The distance based measures focuses on the distance or travel time or cost between the population and health service provider eliminates the limitation of the area-based measure.

Although several studies analyzing geographic variations in HIV have been conducted [15, 16], only one published study that applied GIS to the analysis of HIV [19] and provided some evidence for an ecological relationship between transport accessibility and HIV prevalence.

2.5.6. Displaying Performance Indicators

By linking the database of the health information system with a digitized map showing catchment areas of the health facilities, supervisors can easily spot performance outliers in their districts. Since both data and maps can

be aggregated at the health center, district, provincial, and national levels, each level of decision-makers can be provided with a thematic map that corresponds to their decision needs.

2.6. Innovation, Adoption and Diffusion

Computerized technology and geographic information system are increasingly used in developing countries (29).International aid organizations have been instrumental in providing initial financial and technical support for the introduction of GIS technology. However the diffusion of this technology is fraught with the same problem as are associated with the transfer of computerized technology in general.

The innovation decision process theory which is developed by Rogers is one of the most well known research theories on the adoption of innovations [29]. The innovation-decision process is a mental process through which an individual or an other decision-maker unit passes [29].The adoption process can be divided into five distinct stages: Knowledge, persuasion, decision, implementation and confirmation.

- Knowledge: potential users must learn about the innovation.
- Persuasion: potential adopters must be persuaded in support of the new technology
- Decision: when potential users know about the technology and are persuaded they decide to adopt and use the innovation.
- Confirmation: potential users seek reinforcement of an innovation-decision already made through confirmation or may reject the decision to adopt the innovation.

The decision of Adoption of GIS by an organization involves interaction between complex sets of personal, organizational and cultural interests [26]. Further, adoption does not necessarily lead to successful utilization

resulting in benefits. They suggest that diffusion should be an umbrella concept encompassing the process of awareness raising, adoption, implementation, routinization and utilization and an evaluation of the outcome.

According to Hall et al. [17], even if the uptake of GIS software in the developing world has been increasing, there is no published documentation on the adoption and successful implementation of GIS technology over time in developing countries. In the early 1990s, GIS implementation in developing countries has not moved much beyond the experimental stage for technical barriers and other reasons such as social, economic and political[18].

2.7 Determinants of GIS Diffusion and Use

Budic [29] have derived a framework from the empirical work on GIS implementation in developing countries that includes the concepts of context, management and infrastructure. The researcher of this thesis has adopted this framework (Shown in figure 2.1) to assess the factors influencing the implementation and use of GIS in organizations working on HIV/AIDS prevention programs.

The infrastructure includes personnel factors, data, technology, organization and finance. The contextual factors grouped into organizational, sectoral and wider context whereas the management part comprises activities that guide and control the process of technological introduction, organizational change and long-term system use and maintenance.

2.7.1 Personnel Factors

This factor manifests itself primarily in staffing support for the development and use of GIS.GIS implementation occurs through individuals, and

shortage of professionals or computing staff is one of the most frequently cited obstacles. Committed, empowered and enthusiastic individuals make GIS implementation happen and keep it sustainable. Access to training is the key to build local knowledge and in-house expertise. In addition, motivations and career opportunities keep professional sable and loyal.

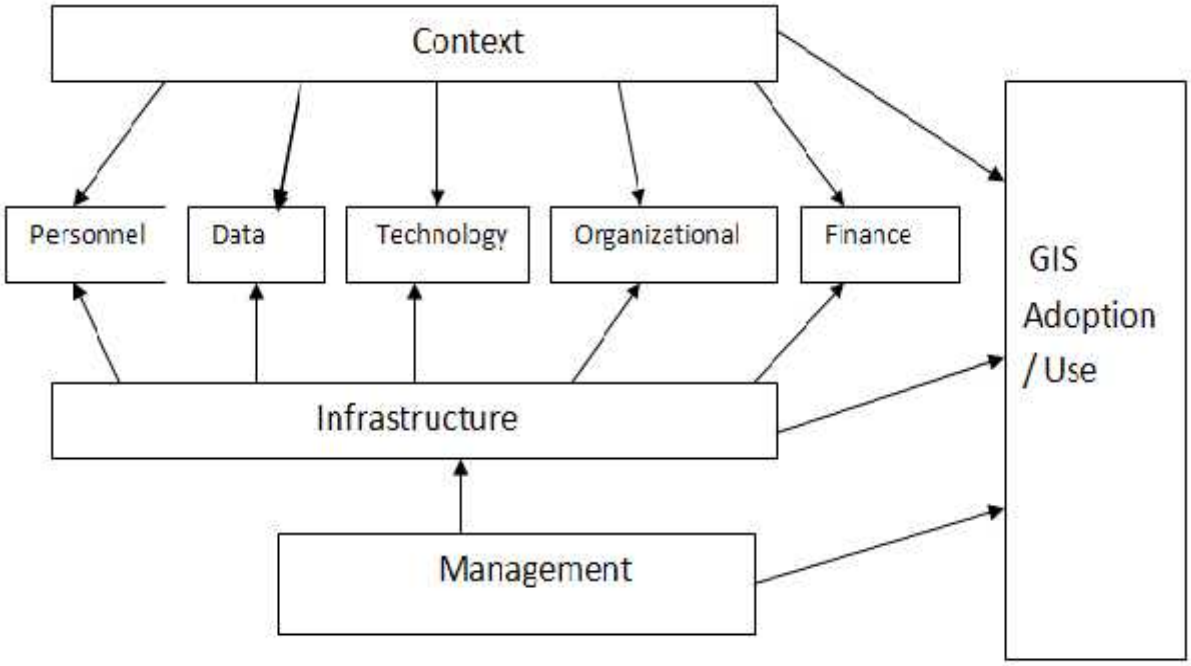


Figure 2.1. A Conceptual framework (adopted from Budic .etal. [29]).

The availability of spatial data enables or inhibits GIS diffusion. Development of base maps, application of affordable methods of database update and the presence of an overall data management strategy are all crucial aspect of the process of GIS implementation.

2.7.2. Technological Factors

Access to hardware and software needs to be secured. Reliability of equipment is more important than the latest feature it has. It is difficult to

obtain equipment and exchange or upgrade parts from remote locations. However, with the advent of World Wide Web, GIS applications and upgrading services are easier to obtain by users and decision makers.

2.7.3. Organizational/Institutional Factor

Organizational factor Is probably the most complex determinant of the process and success of GIS diffusion. An organization is a stable system of individuals who work together to achieve common goals through a hierarchy of ranks and a division of labor [26].Stability is achieved by a high degree of structure imposed on communication patterns through creation of the formal and informal organizational settings. Both formal and informal organizational settings are relevant. Different political and administrative structures (centralized decentralized) requires different implementation approaches. Approaches range from top-down (centralized) to locally driven (bottom-up). The resulting GIS setups may vary from focused to dispersed and from independent to corporate. The balance of power and dominant vision of key stakeholders strongly influence the diffusion process and the outcomes. Organizational stability and relationship with external environment, overall institutional awareness may determine the levels of GIS diffusion and use.

2.7.4. Finance

Finance is also frequently mentioned as an inhibitor of GIS implementation. Funding can be unpredictable and cost overruns are not uncommon. Limiting reliance on external funding in order to minimize dependency on donor's project cycle is one way to sustain GIS development efforts.

2.8. Related Works

A GIS survey entitled 'The use of geographic Information system (GIS), Geocoding and Confidentiality Guidelines in STD Programs' was conducted

in U.S.A in 2004 by Out Come Assessment through Systems of Integrated Surveillance (OASIS) Project work group. The use of GIS among surveyed program areas was 58%. And the study identified major barriers to GIS implementation. The main factors were lack of training, budgetary and staffing constraint.

Budic and etal. Conducted a research on Diffusion of GIS in Botswana in 2003 and concluded that shortage of trained staffs, lack of reliable and standardized data and absence of a national institution in charge of GIS implementation are the main obstacles to a broader diffusion of the technology in Botswana [29] .

In Ethiopia, there are few research works related to exploring the application of GIS in HIV prevention programs planning and management. Dagne [21] and Tekalign [22] have explored the potential use of GIS to identify suitable areas for establishing public health facilities and Mapping HIV prevalence and risk factors in Addis Ababa respectively. The Researchers concern was in suggesting potential areas for applying GIS. To the knowledge of the researcher, however, there is no attempt that examines the status of GIS usage and challenges in the various organizations engaged in HIV/ AIDS prevention programs.

Therefore, this study is aimed at assessing the extent of GIS use, the types of application areas that are being addressed using GIS and the factors that are influencing levels of its uptake in health organizations working on HIV prevention programs.

CHAPTER THREE

3. METHODS

3.1 Introduction

In this study, the researcher used both quantitative and qualitative methods of data collection. Using a cross sectional study design, all organizations working on HIV prevention programs at national level are included in the study. The major findings from the data collected using both methods are analyzed, interpreted and discussed accordingly.

3.2 Study area

This study is conducted in Addis Ababa which is the capital city of Ethiopia, and the centre of political, social and cultural activities of the country. Addis Ababa was selected as study area because the head office of more than 97% of the organizations working on HIV prevention programs at national level are located in the capital.

3.3 Study Design

A cross sectional study design is used to identify the extent of use of GIS and the challenges in adopting it by organizations working on HIV prevention programs at national level. The data are collected using both quantitative (questionnaire) and qualitative (using in- depth interview, observation and document analysis) methods.

3.4 Study Population

The study populations were those organizations (Governmental and Non Governmental) which are working on HIV/AIDS prevention care and Treatment programs with head office in Addis Ababa. The study populations were taken from all organizations running HIV/AIDS intervention programs

in Ethiopia including governmental, international and local Non-governmental organizations.

3.5. Sample Size

A total of 88 organizations working on HIV/AIDS prevention program areas at national level (involving two or more regions) are identified. Among this, two organizations' head offices are located out of Addis Ababa. Therefore, the study excluded these two organizations and the remaining 86(both user and non-user) organizations are considered as study population. Using a Single proportion formula, with assumption that the proportion of GIS use among organizations is 50% (as there is no previous study that tells the proportion of GIS use in this country), the minimum sample size required for this study with out including 10% non-response rate is 384. However, this number is larger than the actual number of the organizations available as study population (86).Thus the researcher included all the organizations in this study for the quantitative method. The respondent, who actually represents the organization to fill the self-administered questionnaire, is the director or department head or GIS unit leader of the organization.

For the qualitative study, three the organizations (two from users and one from non-user) are selected purposively.

3.6. Sampling Procedures

In this study both quantitative and qualitative methods are used**.** For quantitative data collection, organizations working on HIV/AIDS prevention programs in Ethiopia are identified .Those organizations whose head office is located in Addis Ababa are included for collecting data using the quantitative technique, self administered questionnaire.

The qualitative data collection method is used to supplement the data obtained using the quantitative method in order to meet the stated specific objectives.

Both users and non-user are interviewed as the researcher thoughts that the situations among GIS user might be different from that of GIS non-user organizations.

3.7. Data Collecting Instrument

For the quantitative method, the self administered questionnaire is used for the quantitative part of this study. The issues included in the questionnaire are categorized into two parts the organization's and the respondent's general information and current status of GIS use of organizations are included in the first part of the questionnaire (see annex A) whereas issues specific to GIS user's and non-users are included in the second part. The questionnaire is adopted from a study that used the it to assess the use of GIS in national health services, U.K. [7].

In addition, open ended in depth interview guide is used for the qualitative study. The main issues that are addressed in the in-depth interviews are why organizations decided against GIS use and how organizations use geographic information system. Document analysis and observations also used in this study.

3.8. Data quality Management

To achieve data quality, the questionnaire was first prepared in English and then translated to Amharic, and again back to English to check for consistency. In addition, the structured questionnaires were pre-tested in organizations working on the same program a week before starting the actual data collection and the results were used for modifying questions included in the questionnaire. Based on the comment given by respondents questions that are confusing were removed such as questions related to geocoding.

3.9. Study Variables

The study undertaken statistical analysis using dependent variable and independent variables. Current GIS use is the dependent variables and the following are the independent variables. The independent variables are derived from the personnel, technological, organizational and finance factors described with the conceptual framework depicted in figure2.1.

Variables related to Personnel factor: GIS skill, GIS technology awareness, Insufficient, variable related to Data: lack of data, Variables related to technology: lack of hardware, lack of software, variables related to organizational factor: type of organization, GIS strategy, No demand and No priority and variable related to Finance: finance.

3.10. Ethical Consideration

In Addition to a formal letter submitted to each organization under the study to obtain their co-operation, all the organizations respondents were asked to read the cover page of the self administered questionnaire(see Annex A) that reassured them for the confidentiality of the information the respondents provided and it was purely meant for research purpose. They were also given chance to ask anything about the study.

3. 10. Operational Definitions

- Use of GIS: The Application of GIS one or more functionalities for planning, monitoring or evaluating HIV/AIDS prevention programs.
- Awareness of GIS: The level of understanding about geographic information system and its use among decision makers and public health practitioners in the health sector.

3.11. Data Analysis Procedures

Quantitative data are entered and analyzed using SPSS version 15 statistical software. Errors related to inconsistency of data are checked and corrected. The univariate analysis such as percentages, proportions, ratios, frequency distributions and appropriate graphic presentations such as bar chart are used for describing data. Bivariate analyses are performed to identify whether the independent factors have any association with the current use of GIS (dependent variable).

3.12. Dissemination of Research Finding

The study is undertaken for the partial fulfillment of the Degree of Masters of science in Health informatics, from the Department of Health informatics, a joint program held by Faculty of Public Health and Faculty of Informatics, Addis Ababa University. The plan of disseminating the findings of this research includes Department of Health Informatics and concerned organizations that potentially would benefit from the study outcome. The findings of the study will get published in relevant scientific journals as appropriate.

CHAPTER FOUR

4. DATA ANALYSIS, FINDINGS AND INTERPRETATION

4.1. Result of the Quantitative Study

Eighty three percent (71) of the total governmental and non-governmental organizations working on HIV/AIDS prevention program areas responded to the study. Four of the organizations answered only some part of the questionnaire and thus excluded from analyses. Thus, the total number of organizations used for analysis is sixty seven (67).

4.1.1 Current Use of GIS

The organization types of the respondents were governmental, International NGO and local NGOs. The International NGOs accounts for 67.2 percents of the total organizations engaged on HIV/AIDS Prevention programs.

The governmental organizations accounts for 4.5% only. The job description of the respondents ranges from the most frequent Program assistant (37%) to GIS specialists (3 %)

Table 4.1.1 Current use of GIS (May 2010) by governmental and non-governmental organizations located in Addis Ababa, Ethiopia

Organization Type	Current GIS Use		
	No	**Yes**	**Total**
Governmental	1()	2()	3()
International NGO	33()	12()	45()
Local NGO	15()	4()	19()
Total	49 ()	18()	67

As it is shown in Table 4.1, only 26.9 % organizations working on HIV/AIDS prevention program areas are currently using GIS. Among those using GIS, 12 are international NGOs, 4 are local NGOs and 2 are governmental in organization type.

The proportion of current GIS use among organizations working on HIV/AIDS prevention is low when compared to a similar study conducted in U.S.A. (12) with 58% of GIS use among Sexually transmitted diseases prevention program areas. The majority of those currently using GIS are the Non-governmental international organizations by type.

4.1.2. GIS Non-User

In the second part of the questionnaire, the first four questions are to be filled by only organizations which do not use GIS technology. The questions are related to the organizations awareness of GIS technology in HIV/AIDS program planning and management, reasons for not currently using GIS technology and the likelihood of GIS use in the future by their organization.

Table 4.1.2 shows reasons for not Using GIS for HIV/AIDS prevention programs planning and management.

Reasons for Not Using GIS	Frequency	Percent
Not Aware of GIS use for their work	24	49.0
No Demand	13	26.5
Not Priority	9	18.4
Lack of Staff	3	6.1
Total	**49**	**100.0**

Lack of awareness (49%), absence of demand (26.5%) and little or no priority (18.4%) were the three important reasons stated by the respondents for their organization not using GIS currently.

More than half of the respondents (77.6%) among those organizations do not use GIS are aware of the GIS technology application in managing and planning health sector prevention programs. The sources of information are media, university study and previous organizations where the respondents were working for. The remaining 22.4% of the respondents that do not use GIS are not aware of it.

In Addtion, respondents also asked to mention factors barrier to GIS Adoption.

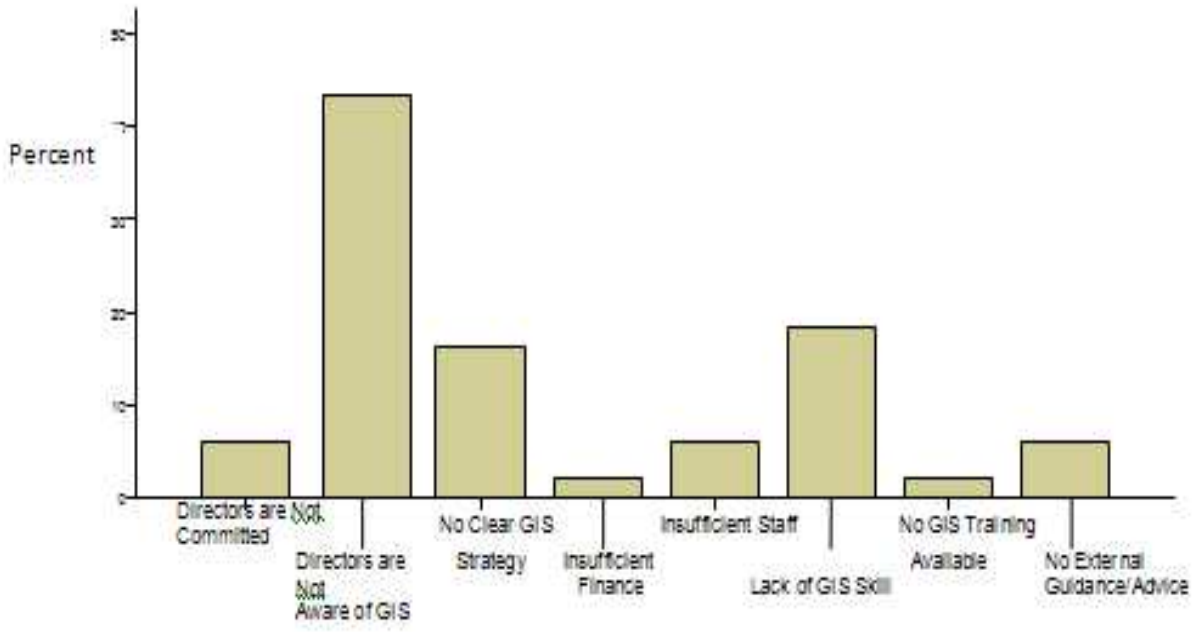


Figure4.1 Factors preventing or hindering GIS use.

The above Figure4.1 presents summery of respondents' suggestion on factors preventing GIS use. The major factors which prevent their

organizations from using GIS were Lack of organizational GIS awareness (42.9%), lack of GIS Skill (18.4) and lack of clear GIS strategy (16.3). The other constraints were Lack of director's commitment, insufficient staffs and absence of external advice or guidance on GIS use.

Among the 49 organizations, 21(42.9%) stated that the future adoption of GIS is less likely and about 16(32.7%) believed that the adoption of GIS in their organization in the near future is unlikely. Only 2 respondents (4.1%) affirmed that GIS adoption by their organization in the future is likely.

The organizational awareness of GIS use in HIV/AIDS prevention program planning and management among non-users in this study is little when compared to those organizations currently using GIS. The main barrier to the adoption and use of GIS among non-GIS user is lack of awareness of GIS use for their organizations followed by lack of GIS strategy and GIS skill. Therefore, creating awareness can lead to have GIS strategy, developing necessary GIS skill and eventual use of GIS technology in that organization by increasing the likelihood of future GIS adoption.

4.1.3. GIS User

Among 18 organizations which were using GIS during the study period, the majority 44.4% have been using GIS technology for the last 1 to 5 years followed by five organizations which started using it for less than a year. Only an organization has used GIS for more than ten years.

According to the respondents' answer to the question about who perform the GIS functionalities in their organization(See figure 4.2), 50% of the organizations responded that the GIS related jobs were performed by HIV program officers and only 28% of organizations' GIS job were done by GIS specialist. The remaining 22% accounts for staffs with IT and other background such as Statistics.

Figure4.2 The type of staff who performs GIS tasks in organizations using GIS.

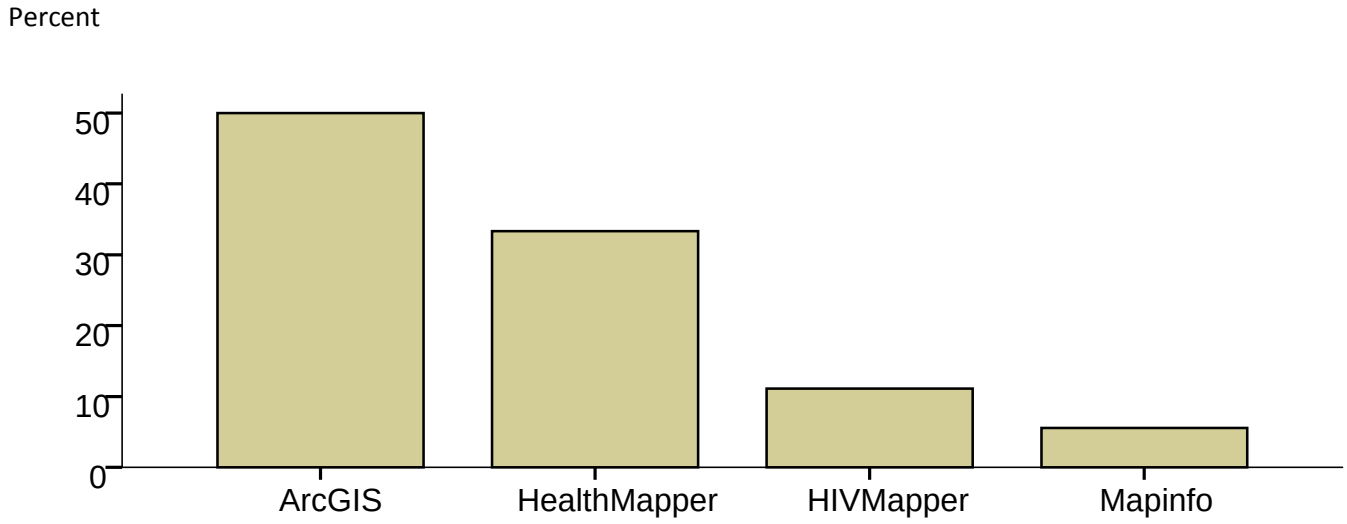


Most of the organizations among those using GIS, perform their GIS related activities with HIV program staffs who do not have university level proper training on GIS.This may in turn limit the organization's use of various functionalities of GIS which are important to produce information that help decision makers to plan and manage their program based on evidence.

Fourteen organizations are using GIS in HIV program areas. This accounts 77.8% of the organizations using GIS. The remaining 16.7% and 5.6% organizations use GIS in HIV plus TB and HIV plus FP program areas respectively.

As shown in figure 4.3, 50 % of GIS users use ArcGIS software to carryout their GIS activities where as 33%, 11.1% and 5.6 % used Health mapper, HIVmapper and mapinfo respectively.

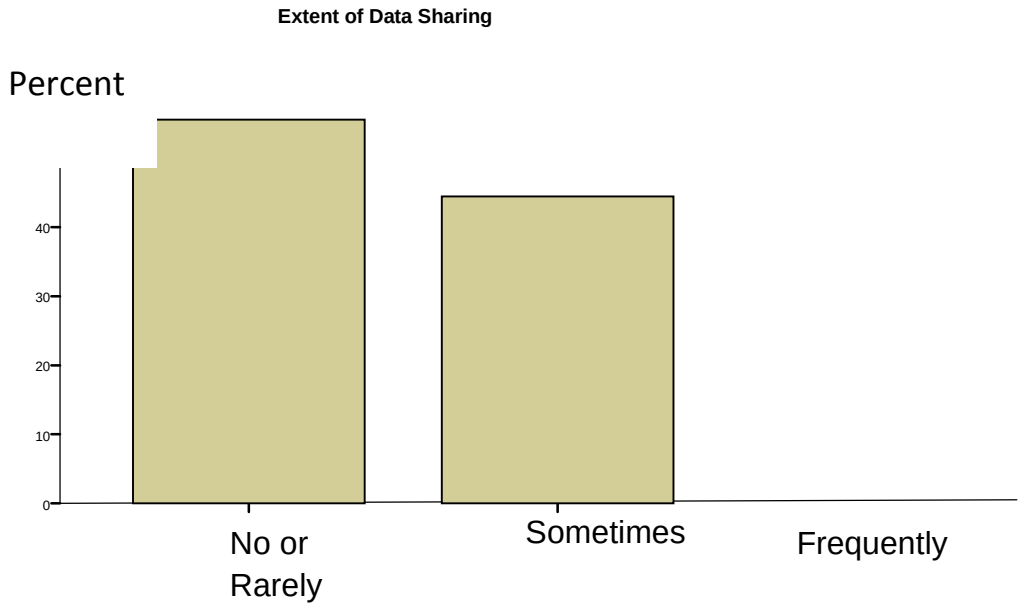
Figure4.3 GIS software used by organizations currently using GIS.



Despite WHO effort to customize the GIS software with ESRI and provide the Health mapper for free, still larger number of GIS users in the Health sectors use ArcGIS for their GIS activities. This might be due to inadequate awareness creation and training on how to use the software application or related to the functionalities it supports.

Regarding data or information sharing among organizations working on HIV prevention program areas, 44.4% of organizations have some data sharing between them and other's organizations. More than half (55.6%) of the organizations using GIS states that either they never share data or is very rare. As figure4.4 depicts, no organization indicates regular data sharing among other organizations.

Figure4.4GISExtentofdatasharingamong the study organizations



According to the above findings data sharing among the organizations is little or absent. The major reasons mentioned by the respondents are lack of policy on data sharing, lack of knowledge about the type of data the other organizations have and issue of confidentiality.

Based on the above findings, the data sharing practice among organizations working on HIV/AIDS program is not to the level so that organizations can use data already produced by other organizations for their own purpose without spending resources and hence avoids duplication of efforts.

The use of GIS in the study organization vary from monitoring performance which is indicated by 14 organizations out of 18 to Evaluating HIV treatment service demand(4). In general, assessing health needs, examination of HIV incidence, Determining catchment areas and targeting resources are also mentioned as use or application areas of GIS in the study organization.

Related to factors that are indicated as hindering further use of GIS technology in organizations already using GIS, respondents answer is showed in table 4.3.

Table4.1.3 GIS use expansion hindering factors among current GIS users

Hindering factors	Frequency	Percent
Directors are Not Aware of GIS	2	11.1
No Clear GIS Strategy	5	27.8
Insufficient number of Staff	4	22.2
Lack of GIS Skill	5	27.8
No Spatial data in Appropriate format	1	5.6
No External Guidance/Advice	1	5.6
Total	18	100.0

As Shown in the above table 4.3, absence of clear GIS strategy (5 or 27.8 %) and lack of GIS skill (5 or 27.8 %) in an organization are most frequently mentioned

hindering factors. Insufficient number of staffs (4 or 22.2%) is also an important hindrance indicated by the respondents.

The major hindering factors for further use of GIS are lack of GIS strategy, GIS skill and insufficient staffs in the organization. GIS implementation occurs through individuals and shortage of professionals or computing staff, lack of data management strategy and availability of spatial data are factors that enable or inhibit GIS diffusion. The findings of this study, from questionnaires' data analysis and the interview, are similar to those factors stated as inhibiting factors in a literature reviewed during the adoption of the conceptual framework used in this study.

4.1.4 Bivariate Analysis

Factors affecting the adoption and use of GIS technology in organizations (independent variables) were examined one by one using binary logistic regression to test for any association with the dependent factor of this research 'current use of GIS'. The Explanatory variables (independent) used in this study are Directors commitment, lack of GIS strategy, financial insufficiency, lack of spatial data, lack of Hardware/software and GIS use Awareness. Each independent variable are categorized and become dichotomous (with yes or no possible values). The null hypothesis of each independent variable in this study assumes that a unit change in the independent variable is not responsible for any changes in current use of GIS among organizations working on HIV prevention programms.

Table 4.1.4 Binary Logistic regression out put on current GIS use among Organizations working on HIV prevention programs by selected variables.

Factors	Current GIS use		Crude OR(95% CI)
	Yes (#)	No (#)	
Directors commitment			
Yes	9	28	1.33(0.45, 3.94)
No	9	21	
GIS Strategy			
Yes	13	34	1.15 (0.35, 3.79)
No	5	15	
Financial Insufficiency			
Yes	13	32	0.72 (0.22, 2.37)
No	5	17	
Lack of GIS skill			
Yes	14	48	0.07 (0.01, 0.71)
No	4	1	
Lack of Spatial Data			
Yes	11	31	0.91 (0.3, 2.77)
No	7	18	
Lack of appropriate Hardware/Software			
Yes	9	22	1.23 (0.42, 3.62)
No	9	27	
Awareness			
Yes	6	38	0.15 (0.04, 0.48)
No	12	11	

As it is shown in table 4.3, the crude OR for directors commitment is OR=1.33(0.45, 3.94). Since the 95% confidence interval include 1, the data is not sufficient to reject the null hypothesis stated above. Thus, the odds of using GIS by those organizations with directors having commitment are the same as that of those organizations without directors' commitment. Similarly, for the other independent variables such as clear organizational strategy for GIS implementation (OR=1.15, 95% CI (0.35, 3.79)), Financial insufficiency (OR= 0.72, 95% CI (0.22, 2.37)),Lack of spatial data (OR=0.91, 95% CI (0.3, 2.77))and Lack of appropriate hardware/software (OR= 1.23, 95% CI (0.42, 3.62)), the null hypotheses are not rejected as their respective confidence interval includes 1.However,for the independent variables, Lack of GIS skill in an organization (OR= 0.07, 95 % CI (0.01, 0.71)) and GIS awareness (OR= .15, 95 % CI (.04, .48)), the null hypothesis is rejected as the 95%CI does not include 1. Thus, as organization's awareness on GIS use and GIS skill increase, the odds of using GIS in their organization also increases by fifteen and seven percent respectively.

4.2 Result of Qualitative Study

For the qualitative methods, three organizations are purposively selected. Among this one organization is from non-user while the other two are from GIS users. The qualitative study is primarily to supplement the quantitative study. The results are broadly categorized into two thematic areas: barriers to GIS use and the data sharing practice among organizations working on HIV prevention program areas.

4.2.1 Barriers to GIS use

During in-depth interview , all the organizations stated that lack of GIS skill, strategy and and awareness on its use for planning, monitoring and evaluating HIV prevention programs mentioned as the major factors that prevents GIS use among the study organizations. In particular to lack of GIS

skill, one respondent of International NGO explained the existing GIS skill availability as below.

> *"of course we have been using GIS since some years back for monitoring ART services in the country which is mainly mapping aggregated data of Cases following ART clinic, defaulters and deaths by regions and the maps that we are producing are not by GIS specialist."*

This finding consistent with the findings of the quantitative study and hence serve as supplementary information that indicates there are some organizations which are GIS users but complaining lack of GIS skill in the institution as hindering factor for further use of GIS functionalities in their program planning and monitoring.

4.2.2. Data Sharing

The exchange of different datasets or data among organizations studied using qualitative method is limited to of attribute dataset or information dissemination based on the organization's need to disseminate information. The main reasons mentioned by mentioned by the respondents during interview are: confidentiality issue of patient level information, lack of knowledge about the data type the other organizations has , difficulty in identifying what dataset they need for GIS analysis in addition to what they have and lack of policy that enforce organizations to share data among organizations.

With this regard, a respondent from Federal HIV/AIDS prevention and Control organization (FHAPCO), said

> *"The constraints we have in my department for further use of GIS are many. The most important one is the difficulty of getting data. Data sharing among organizations particularly with the governmental organizations that owns relatively larger number of health datasets is extremely poor".*

4.3 Discussion

This study has tried to assess the extent of GIS use among organizations working on HIV prevention program areas. It has also tried to identify factors which influence the adoption and use of GIS in the health sector particularly for HIV prevention programs.

The diffusion and use of GIS in governmental and nongovernmental organizations working on HIV /AIDS prevention programs is still in its infancy. Awareness of GIS use in the HIV prevention program planning and management in both governmental and nongovernmental organizations is low. For GIS to fulfill its potential contribution to evidence based decision making, the awareness of the decision makers should raise as they facilitate or hinder the adoption or expansion of GIS in organizations as awareness is directly related to increase in need of GIS products or services.

The use of GIS in HIV prevention programs were limited to some functionality of GIS specifically mapping to visualize the prevalence of HIV in relation to the distribution of voluntary counseling and testing(VCT), prevention of mother to child transmission(PMTCT) and Antiretroviral treatment(ART)(HIV prevention and treatment) service providing facilities. Other application areas such as spatial analysis of determinant factors of HIV incidence, accessibility analysis of Health care facilities, equitable distribution of limited resources, targeting proper interventions and the like were not used by the current GIS users.

There is shortage of GIS trained/ specialists in most of the study organizations. Many organizations GIS systems are performed by HIV program officers with some GIS task exposure and limited bases. Lack of staff with GIS skill was one of the barriers for adoption or further expansion of GIS use in the study organizations. Hiring GIS staff is crucial for future implementation of GIS in the health sector. Training on GIS at all level and

computer literacy is required for long term GIS use. Peculiar to the health sector, the decision makers need to specify their requirements to the GIS specialist in order to produce report or map or model that satisfy the information need of the decision makers. Identifying areas of GIS application in the health sector areas and looking for appropriate data set should be performed by public health practitioner and GIS specialist.

The lack of spatial data and poor data sharing practice among the study organizations are other major factors for preventing GIS use by those organizations. Some of the organizations notes the lack of knowledge concerning what type of data the other organization have as a reason for low spatial data sharing among themselves. In addition, GIS application influenced by the way geographic information is collected, stored and distributed among organizations. Therefore, it is difficult to share data among organizations because of differences in classification systems used to organize the geographic information.

Access to hardware/software was factor mentioned least by the organizations as a barrier for further expansion or new adoption of GIS technology. Rather the complexity of the GIS software to understand and use for the purpose they want. WHO has customized GIS software for the public health practitioner in order to make the system more user friendly and one can use it with out special training on GIS. However, as it was done little in introducing such system to the health care by Federal Ministry of Health (MOH) and other responsible bodies, the customized software are not used effectively in the health sector.

Variability in software application used by organizations in this study is important for understanding the GIS functionality used in the HIV prevention program. This study indicated that Environmental System Research Institute (ESRI), I.e. ArcGIS is the primary GIS software application used by HIV prevention programs (50%). If training or license

agreements were implemented, it would be advantageous to focus on software used by the majority of programs. The Health Mapper, a GIS soft ware customized and available for free to be used in the health sector by WHO, was not a choice in many of the organization those are using GIS in this study. This clearly indicates that GIS training and awareness creation should have been done in parallel with customizing the application for the health sector.

Most of the organizations using GIS currently in this study are international NGOs funded by foreigners and are mainly projects and pilots which are not operational systems. The financial constraint identified in this research as a barrier may worsen when the funding agencies stop financing the project for one or the other reasons. Thus, the FMOH has to take the initiative to build operational GIS systems for planning and managing health programs in general and HIV prevention programs in particular.

Regarding the managers/Directors commitment, few managers of the organizations see the benefits of GIS tools. However, many of them are not clear with the contributions of the application of GIS to the general improvement of information management of their organization. The other factor identified in this research is lack of GIS strategy (16.3%) which was incriminated as a factor that prevented organization from using or further use of GIS. The role of having GIS strategy is mainly to reduce and deal with the GIS diffusion and use in the organization [29]. A national GIS strategy at the Federal ministry of health (FMOH) is not developed and is essential in this regard because it will compel organizations to not only avoid the duplication of effort but rather to adhere to the same GIS standards of data collection, data structure and organizations, data storage and a good arrangement for the exchange of data.

Study Limitation: this study focused on examining the use of GIS in HIV prevention program areas. It does not include other health related

intervention program areas such as Tuberculosis, Malaria, malnutrition etc. the other limitation of the study is that it does not demonstrates the various functionalities of GIS software in the spatial analysis of health data in planning and monitoring disease preventions and control activities.

Strength of the Study: this study is of the first in its type. As to the knowledge of the researcher, there is no such study that attempt to assess the extent of GIS in HIV prevention program areas. It has also deployed both quantitative and qualitative methods of data collection and analysis that supplement each other.

CHAPTER FIVE

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

This study is meant to examine the extent of GIS use among organizations working on HIV prevention program areas and to identify barriers for uptake of GIS technology in the health sector.

Quantitative methods with self-administered questionnaires and in depth interview are employed in the survey. The data are cleaned and analyzed with SPSS soft ware. The analysis gives an insight in the extent of the use of GIS and major barriers to its implementation in the study organizations. The GIS use among the study organization is low. Most of the organizations currently using GIS are international NGOs for monitoring their programs performance. Unawareness of GIS technology, lack of GIS skill, absence of organizational strategy for GIS implementation, complexity of the software and lack of GIS training were major factors identified as barriers to GIS adoption and use. Majority of GIS application users were international Non Governmental organizations. Majority of the organizations among GIS users employ GIS technology for monitoring performance, assessing health needs, examining HIV incidence and targeting resources.

There was no data sharing practice among majority of the organization as they don't know what data is owned by whom and having no policy to support it. The bivariate analysis showed that the organizational current use of GIS is dependent on the organization's awareness on the use of GIS technology.

5.2 Recommendations

Based on the concluding remarks of this study and with the objectives of promoting GIS use among non-users and sustaining GIS use among those currently using for planning and monitoring HIV/AIDS or health related programs, the researcher recommends the following.

- The health sector should improve the uptake of GIS technology to store and analyze spatial data which is unique to GIS through developing GIS strategy.
- GIS training and awareness creation program should be organized and conducted regularly for public health officers and decision makers to increase awareness and demand for spatial analysis of health data.
- The free GIS software HealthMapper should be further simplified and made user friendly in order the public health practitioners to use it for mapping, and other spatial analysis.
- Health organizations should develop not only employee with GIS skill but also public health practitioner that can identify the information need of the organization and type of analysis to be made.
- The health sector with other sectors should formulate and implement a policy that guides the spatial data sharing and standardization of data formats.
- Further research should be conducted on diffusion and utilization of GIS technology in the health sector as this study is limited to HIV prevention program areas.

References

1. T. Najafabadi, Applications of GIS in Health Sciences, Shiraz E-Medical Journal, 10(4), 2009.
2. T.Lippeveld, R.Saverborn, and C.Bodest, Design and Implementation of Health Information System, pp213-223, WHO, 2000.
3. F D R E, Report on Progress Towards Implementation of the UN Declaration of Commitment on HIV/AIDS, Federal HIV/AIDS Prevention and Control Office, Addis Ababa, Ethiopia, March 2008.
4. Republic of Zambia, Assessment of the Health Information System in Zambia,Ministry of Health Department of Planning & Development Monitoring & Evaluation Unit, Compiled by the Ndeke HouseLong Acres, LUSAKA, April 2007
5. Keith C. Clarke, Epidemiology and Geographic Information Systems: Emerging Infectious Diseases, Center for Disease Control, 2(2): pp85-92, April-June, 1996.
6. Najeeb Al-Shorbaji, Use and Potential of Geographic Information Systems for Health Mapping in the Eastern Mediterranean Region, PhD thesis, WHO/EMRO.
7. G. Higgs, Darren P. Smith and Myles I. Gould, Findings From a Survey on GIS use in the UK National Health Service: Organizational Challenges AND Opportunities, Health Policy 72:pp105–117, 2005.
8. Frank C. And David l., The Application of Geographical Information Systems to Important Public Health Problems in Africa, International Journal of Health Geographic, 2002.
9. R. Foley, Assessing the Applicability of GIS in a Health And Social Care Setting: Planning Services for Informal Carers in East Sussex,

University of Brighton,Brighton BN2 4GJ,UK, Social Science & Medicine, 55:pp79–96, 2002.

10. H. Zeug, Potential analysis of GIS Utilisation in Water Supply Management By Aid Agencies, Cranfield University at Silsoe,Master's Thesis, Cranfield University, 2006.

11. I. Heywood, S.Cornelius and S.Carver, an Introduction to Geographic Information System, Preason Education Limited, 2002.

12. Jennifer M.etal, Assessment of Geographic Information Systems and Data Confidentiality Guidelines in STD Programs, Public Health Reports, Supplement 2 / Volume 124, / 2009.

13. Gatrell, A.C. Geographies of Health: An Introduction. Blackwell Publishing, Oxford, United Kingdom, 2002.

14. F.Tanser and D. le Sueur, The Application of Geographical Information Systems to Important Public Health Problems in Africa, International Journal of Health Geographics , 1:4, 2002.

15. Killewo J, Dahlgren L and Sandstrom, A Socio-Geographical Patterns of HIV-1 Transmission in Kagera Region, Tanzania. SocSci Med, 38, pp:129- 34, 1994.

16. Amat-Roze JM Geographic inequalities in HIV infection and AIDS in sub- Saharan Africa. Soc Sci Med, 36:pp1247-56, 1993 .

17. Hall, G. B., Feick, R. D. & Bowerman, R. L. (n. a.): Problems and prospects for GIS-based decision support applications in developing countries. Report.

18. Taylor, D. R. F., GIS and developing nations. In: Maguire, D. J.,

Goods child, M. F. & Rhind, D. W. (Hg.) Geographical Information Systems: Principles and Applications, 71–84, Longman, London, 1991.

19. Tanser and eta.l, D , HIV Heterogeneity and Proximity of Homestead to Roads in Rural South Africa: An Exploration Using a Geographical Information System, Trop Med Int Health, 5:pp 40-46, 2000.
20. Rushton, G. Public health, GIS and Spatial Analytic Tools. Annual Review of Public Health, 24(1): pp43-46, 2003.
21. Dagne M., Integrated Spatial And Multidimensional Visualization Model of Primary Health Care in Addis Ababa, Addis Ababa University, Msc. Thesis, 2009.
22. Tekalign Z. The Use of Geographic Information System Technology For HIV/AIDS Prevention Planning, Evaluation And Surveillance in Addis Ababa, Ethiopia, Addis Ababa University, Msc. Thesis, 2006.
23. HTTP://W.W.Cliftnotes.com/wilyCDA/CliffsReviewTopic/, Accessed on November 23, 2009.
24. Muhallab M. The Potential role of GIS in Development and Application of Urban Indicators, The Case of Housing in Khartoum, Sudan, Msc Thesis,2001.
25. Nathan D. and Britany A. Utilizine Geographic Information System (GIS) to Influence State Policy, Philadelphia, 2005. Conference.
26. Tai on C. and Ian P. Williamson, A model of the Decision Process for GIS Adoption and diffusion in a Government Environment, Journal of Urban and Regional information systems Association, Vol 11,1999.
27. Ravi M. and Massimo C., GIS in Public health practice, CRC Press, U.S.A. ,2004.

28. Sara L. McLafferty, GIS and Health Care, Annual Review of Public health, vol 24, pp 22-42, Down loaded by University of California,Los Angeles 2007.

29. Branco I. Zorica N. Budic and Horatio G., Diffusion of GIS Technology in Botswana, IDPR 25(2), 2003.

30. WHO, Health Mapper, A WHO Information and Mapping Application for Public Health, 2008.

31. HTTP://WWW.WIKIPEDIA , Accessed on May 3, 2010.

32. Keith C. clarke, Getting Started with Geographic Information Systems,

4th edution,Pearson education,U.S.A.,2003.

33. Pan American Health Organization, Epidemiological Bulletin, 25(4), 2004.

34. Http://www.Whitten ,Accessed on June 30,2010.

Annex A

Addis Ababa University

Faculty of Medicine and Informatics

Department of Health Informatics

Questionnaire on Exploring the Application of GIS in HIV Prevention Programs and Awareness of Public Health Professionals towards Its Use.

This self administered questionnaire is prepared by the researcher to obtain information on the extent of use of geographic information system by organizations working on prevention, treatment and care of HIV/AIDS and to identify challenges and opportunities for its use in the management of resources in such organizations. The information you provide is confidential and will be used only for postgraduate masters thesis in health informatics department (Addis Ababa University).

Part I

I. **General Information**

1. Name of the Institution .....

2. Position of the Respondent .....

3. Address .....

4. Academic Qualification (please mention the highest class/degree/diploma)……

5. Number of years of work Experience……

II: **Current Geographic Information System (GIS) Use**

6. Does your organisation currently use GIS, or has it used GIS in the past?

Yes, currently use GIS ☐ No, but has used GIS in the past ☐

Never used GIS ☐

7. How would you describe the current status of GIS in your organization?

Fully operational GIS ☐ Partly operational GIS☐ Temporally stopped using GIS☐ Permanently ceased using GIS ☐ Never used GIS☐

8. Why does your organization not make greater use of GIS? Please tick all that apply

No demand for increasing the use of GIS ☐ Work time constraints☐

Insufficient financial resources to fully implement systems ☐

GIS software does not meet requirements ☐ Insufficient training / M guidance ☐ Insufficient staff resources to fully implement systems ☐

Lack of digital data ☐

9. What mapping materials are in use at your organization?

Manual Drawn Sketch☐ Paper Map ☐ Digital Maps & Georeferenced ☐

Atlas ☐ Satellite /Arial image ☐

10. Listed below are selections of GIS uses. Please tick those which are operational in your organization, or are planned for implementation during the next 12 months.

Use	Operational	Planned
Data capture (GPS reading, Georeferencing , digitizing)		
Integrating data(Spatial and Non spatial)		
Data manipulation & Visualization		
Producing maps		
Modeling data		
Geographically based analysis		
Analysis of statistical data		
Making forecasts		
Producing reports		

- If your organization uses GIS, please rate how each of the following **hinders** its use.

- If your organization does not have GIS, please rate how each of the following has **prevented uptake.**

  For each statement tick a box if appropriate and leave blank if you have no opinion.

	Severe Problem	Major problem	Minor Problem	No problem At all
Directors of your organization aren't committed to GIS	☐	☐	☐	☐
Directors of your organization aren't aware of value of GIS	☐	☐	☐	☐
There is no clear GIS strategy	☐	☐	☐	☐
There are insufficient finances to fully implement GIS	☐	☐	☐	☐
There are insufficient staff resources to fully implement GIS	☐	☐	☐	☐
There is no designated person to maintain a GIS	☐	☐	☐	☐
There is no work time available for individuals to use GIS	☐	☐	☐	☐
There is a lack of GIS skills within the organization	☐	☐	☐	☐
There is no GIS training available for employees	☐	☐	☐	☐

The GIS software is inappropriate	☐	☐	☐	☐
The hardware is insufficient	☐	☐	☐	☐
There is a lack of digital data in appropriate formats	☐	☐	☐	☐
Data confidentiality restricts use	☐	☐	☐	☐
There is no external guidance / advice provided	☐	☐	☐	☐

Part II If your organization is not GIS user, please continue to provide answer for the questions below otherwise go to the "GIS user" part.

I. GIS Non user

12. Have you ever heard of the use of GIS in the health sector?

Never ☐ Heard about it but not in detail ☐ I am aware of it ☐

13. What was the source of Information?

Media ☐ University Study☐ Other organization☐ Other☐

I am not aware ☐

14. What do you think the possible reasons that your organization is not using GIS?

Not Aware of GIS ☐ No Need ☐ lack of staff ☐

No budget ☐ Not priority ☐ Other ☐

15. How do you rate the likelihood of starting to use GIS in your organization

with in a year?

Very likely ☐ likely ☐ less likely ☐ unlikely☐

II. GIS User

16. When do you think GIS was first used in your organization?

During last 12 months ☐ 1-5 years ☐ 6-10 years ☐ More than 10

years ☐ Not Used ☐

17. How long have 'you' been using GIS?

Less than 6 months ☐ 6-12 months ☐ 1-5 years ☐ 6-10 years ☐

More than 10 years ☐

18. Who perform the GIS functions?

GIS specialist staff ☐ HIV program Staff ☐ Other (specify) _____

19. Which GIS software packages that are used within your Organisation**?**

Mapinfo☐ ArcGIS ☐ HealthMapper ☐ HIVMapper☐ EpiMap ☐

20. In which program areas your organization is using

GIS?.....

……

21. Please provide a description of the principal datasets used in your organisation for GIS purposes. Please specify if you already have access, or plans to access and use.

	Datasets	Already used	Plan to use
1.			
2.			
3.			
4.			

22. Please provide a description of the extent of sharing data.

Name of organization sharing data	Frequently	Sometimes	Not at all

23. What prevents your organisation from exchanging geographical information with other agencies? Please tick all that apply.

No policy towards exchanging data ☐ Inappropriate data formats ☐

Confidentiality constraints ☐ Resource constraints ☐

Not aware of data held by other organizations. ☐ Inappropriate media, hardware and software ☐

Other (please specify) ……

24. What uses and applications have you made of GIS over the last 12 months?

Please tick all that apply.

Monitoring performance ☐

Assessing health needs for the establishment of health services for local populations ☐

Epidemiological research (examination of patterns of HIV/disease incidence) ☐

Producing health/HIV profiles of local populations ☐

Determining Health facility catchment areas for local services ☐

Planning the distribution (location) of health facilities/ART clinics ☐

Targeting resources towards local population groups ☐

Analyzing HIV/AIDS related Service referral patterns ☐

Evaluating demand for HIV prevention and Treatment services ☐

Evaluating demand for other HIV/AIDS related services ☐

Thank you