DOKUZ EYLÜL UNIVERSITY
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

# EXAMINING THE FACTORS RESPONSIBLE FOR THE VARIATION IN ACCESSIBILITY TO HEALTH CARE FACILITIES IN TAMALE, GHANA

By
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July, 2017

İZMİR

# EXAMINING THE FACTORS RESPONSIBLE FOR THE VARIATION IN ACCESSIBILITY TO HEALTH CARE FACILITIES IN TAMALE, GHANA

**A Thesis Submitted to the Graduate School of**
**Natural and Applied Sciences of Dokuz Eylül University**
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**Science in City and Regional Planning**

**By**

**Zulaihatu HAMIDU**

**July, 2017**

**İZMİR**

**M.Sc THESIS EXAMINATION RESULT FORM**

We have read the thesis entitled **"EXAMINING THE FACTORS RESPONSIBLE FOR THE VARIATION IN ACCESSIBILITY TO HEALTH CARE FACILITIES IN TAMALE, GHANA"** completed by **ZULAIHATU HAMIDU** under supervision of **PROF.DR. K. MERT CUBUKCU** and we certify that in our opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Science.

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**EXAMINING THE FACTORS RESPONSIBLE FOR THE VARIATION IN ACCESSIBILITY TO HEALTH CARE FACILITIES IN TAMALE, GHANA**

## ABSTRACT

One of the current issues of discussions in recent times is on rapid population growth in the coming years and its accompanied consequence that are expected to take place in urban cities of developing counties and not in rural communities. Rapid population growth often occurs with its accompanied consequences rendering parts of cities not conducive for a living. To curb this accompanied consequence of population growth, analysts came out with a good number of critical socio-economic issues that needs to be addressed ahead of the expected growth. These include attainable sanitation measures, adequate healthcare facilities and schools, different sources of income, sufficient open space for recreations etc. Among these critical socio-economic issues, is adequate and accessible healthcare facility, which many suggest should be given the greatest attention, for health is so important that it is sometimes equated to wealth of the people. Literature reviewed portrays that most researchers in measuring accessibility to healthcare facilities, concentrated on socio-economic factors of the inhabitants and geographical distance factors without much assessment of the spatial structure of the city. This necessitated the research that is to examine the factors responsible for the variations to healthcare facilities in an urban city of Tamale in Ghana, using Arc Map online data and data from Tamale Municipal Planning Unit and Tamale Health Directorate. The healthcare facilities are categorized as government and private and according to hierarchy. The data is analyzed using methods of spatial analysis such as (1) Voronoi diagrams to illustrate the catchment area of each healthcare facilities; (2) Network analyst to estimate the service areas of government and private healthcare facilities; and (3) Graph-theory-based centrality indices to estimate levels of accessibility to each of the government and private healthcare facilities.

The results reveal that the spatial distributions of healthcare facilities do not meet the needs of the population distribution. Also, there are major differences in accessibility levels of spatial distributions of public and private healthcare facilities. Healthcare facilities should be located at central parts of the city where there exist concentration of populations to have access to these facilities.

**Keywords:** Accessibility, health care facilities, population, Tamale

**SAĞLIK TESİSLERİNE ERİŞİMİ FARKLILAŞTIRAN FAKTÖRLERİNİN İNCELENMESİ:**
**TAMALE (GANA) ÖRNEĞİ**

# ÖZ

Son zamanlarda gündeme gelen tartışmalardan biri, önümüzdeki yıllardaki hızlı nüfus artışı ve onun eşlik ettiği sorunların, kırsal toplumlarda değil, gelişmekte olan şehirlerde olması beklenmektedir. Hızlı nüfus artışı, eşlik eden sonuçlarla birlikte, şehirlerde yaşam kalitesini düşürebilmektedir. Bu açıdan ele alındığında, nüfus artışının ortaya çıkardığı problemlerin çözümü için pek çok sosyo-ekonomik konunun ciddiyetle ele alınması gerekmektedir. Bu konular arasında, yeterli ve nitelikli konut, sanitasyon, yeterli düzeyde ve sayıda sağlık ve eğitim tesisleri, farklı gelir kaynakları, rekreasyon için yeterli açık alan gibi konular da bulunmaktadır. Bu başlıklarda, sağlık tesislerinin yeterliliği ve erişebilirliği yaşamsal düzeyde önemlidir. İlgili literatür incelendiğinde, araştırmacıların çoğunun sağlık kuruluşlarına erişilebilirliğinin ölçülmesiyle ilgili olarak, mevcut mekansal yapının fazla önemsenmeden ele alınmış olduğu görülmektedir.

Bu çalışmada Tamale (Gana) kentinde bulunan sağlık tesislerine erişimi etkileyen faktörler incelenmiştir. Kamuya açık veri tabanları ile Tamale Belediyesi ve Tamale Sağlık Bakanlığı'na bağlı birimlerden elde edilen veriler ile coğrafi bilgi sistemleri temelli bir veri tabanı oluşturulmuştur. Çalışmada özel ve kamuya ait sağlık tesisleri ayrıştırılarak incelenmiştir. Çalışmada her bir sağlık kuruluşunun hizmet alanının tespiti amacı ile (1) Voronoi diyagramları oluşturulmuş, (2) ağ analizleri yapılmış ve (3) sağlık tesislerine olan erişebilirlik düzeylerinin tespiti için Grafik Teorisi temelli endeks değerleri hesaplanmıştır. Elde edilen sonuçlar, mevcut sağlık tesisleri dağılımının hizmet verdileri nüfusun dağılımının ihtiyaçlarını karşılayacak biçimde gerçekleşmediği, ayrıca özel ve kamuya ait sağlık tesislerinin dağılımında önemli farklar olduğunu ortaya koymuştur.

**Anahtar Kelimeler:** Erişilebilirlik, sağlık tesisleri, nüfus, Tamale

**CONTENTS** **Pages**

M.Sc THESIS EXAMINATION RESULT FORM ........ ii
ACKNOWLEDGEMENTS ........ iii
ABSTRACT ........ iv
ÖZ ........ vi
LIST OF FIGURES ........ ix
LIST OF TABLES ........ xii

**CHAPTER ONE - INTRODUCTION ........ 1**

1.1 Problem Statement ........ 3
1.2 Justification ........ 5
1.3 Scope of Study ........ 6
1.4 Relevance of the study ........ 6

**CHAPTER TWO - REVIEW OF LITERATURE ........ 8**

2.1 Accessibility ........ 8
2.2 Understanding Accessibility and Accessibility Measures ........ 9
2.3 Urban Health Accessibility ........ 14
2.4 Urban Spatial Form and Its Representation ........ 20
2.5 Location Allocations ........ 23
2.6 Structure of healthcare in Ghana ........ 26
2.6.1 Primary Health Care (PHC) ........ 29
2.7 Conceptual Framework for the Study ........ 29
2.8 General Conclusions Derived from the Literature Review ........ 29

**CHAPTER THREE - BACKGROUND OF STUDY AREA AND DATA ........ 32**

3.1 Profile of Tamale Metropolitan Area ........ 32
3.1.1 Location and Size ........ 34

3.1.2 Demographic Features .......... 35
3.1.3 Age specific death rates .......... 36
3.1.4 Tamale Metropolitan Health Administration .......... 37
3.2 Data .......... 38
3.2.1 Research Design .......... 38
3.2.2 Sources of Data .......... 38
3.2.3 Techniques for Data Collection .......... 39
3.2.4 Health Facility's Distribution .......... 39
3.2.5 Graph Representation .......... 41
3.2.6 Data Compilation of Study Place .......... 44
3.3.7 Government/Private Ownership of Health Facilities .......... 47

**CHAPTER FOUR - ANALYSIS AND RESULTS .......... 48**

4.1 Spatial Analysis along the Network .......... 48
4.1.1 Events along Network .......... 49
4.1.2 Event on network .......... 49
4.1.3 Application of the Voronoi Diagram in Estimating Catchment Area of Healthcare Facilities .......... 50
4.1.4 Catchment area of Government Health Facilities derived from the Voronoi diagram .......... 52
4.1.5 Catchment Area of Private Health Facilities derived from the Voronoi Diagram .......... 54
4.1.6 Catchment Area and Count of Building derived from the Voronoi Diagram according to Government and Private .......... 55
4.1.7 Sum of Length and Count of Building for Government and Private Health Facilities derived from the Voronoi Diagram .......... 57
4.2 Spatial Network Analyst .......... 59
4.2.1 Closest Analysis .......... 59
4.2.2 Service Area of Healthcare Facilities .......... 64
4.3 Network Centrality Indices .......... 69
4.3.1 Reach Index .......... 69

4.3.2 Gravity Centrality Index .......... 70
4.3.3 Betweeness Centrality Index .......... 71
4.3.4 Closeness Centrality Index .......... 71
4.3.5 Straightness Centrality Index .......... 72
4.3.6 Results of Executed Analysis of Network Centrality on the Data of the Tamale Metropolitan Area .......... 73

**CHAPTER FIVE - DISCUSSIONS AND CONCLUSION .......... 81**

**REFERENCES .......... 86**

**LIST OF FIGURES** **Pages**

Figure 2.1 Administrative Levels of Ghana public health service ............................ 27
Figure 2.2 Functional (service distribution) levels of public healthcare in Ghana .... 28
Figure 2.3 The conceptual framework of the study ................................................ 30
Figure 3.1 Map of Ghana locating regional divisions.............................................. 33
Figure 3.2 Location of Tamale Metropolitan area within the Northern Region ........ 34
Figure 3.3 Reported age specific death rates by sex ................................................ 37
Figure 3.4 Arial photograph of the built environment and Graph representation...... 43
Figure 3.5 Spatial Distributions of Healthcare Facilities. ........................................ 44
Figure 3.6 Spatial Distributions of Private Health Facilities .................................... 44
Figure 3.7 Spatial Distributions of Government Health Facilities............................ 45
Figure 3.8 Network presentation of Tamale Metropolitan Assembly........................ 45
Figure 3.9 Building Data of Tamale Metropolitan Assembly................................... 46
Figure 4.1 Voronoi diagram for government healthcare facilities............................. 50
Figure 4.2 Sum of lengths of streets and count of buildings of government first hierarchy of health facilities derived from the Voronoi diagram............ 51
Figure 4.3 Sum of length of streets and count of buildings of government second hierarchy of health facilities derived from the Voronoi diagram............ 51
Figure 4.4 Sum of length of streets and count of building of government third hierarchy of health facilities derived from the Voronoi diagram............ 52
Figure 4.5 Voronoi Diagram for private healthcare facilities................................... 53
Figure 4.6 Sum of length of streets and count of building of private first hierarchy of health facilities derived from the Voronoi diagram ............................... 53
Figure 4.7 Sum of length of streets and count of building of private third hierarchy of health facilities derived from the Voronoi diagram ............................... 54
Figure 4.8 Voronoi diagram for government and private health facilities................. 55
Figure 4.9 Sum of length and count of building of government/private facility under first hierarchy facilities derived from the Voronoi diagram ................... 55
Figure 4.10 Sum of length and count of building of government/private facility under third hierarchy facilities derived from the Voronoi diagram .................. 56

Figure 4.11 Sum of length and count of building of government and private facilities ........................................................................................................ 57
Figure 4.12 Shortest routes from buildings to government facilities......................... 59
Figure 4.13 Closest buildings of government first hierarchy of healthcare facilities 60
Figure 4.14 Closest buildings to government second hierarchy of healthcare facilities ........................................................................................................ 60
Figure 4.15 Closest buildings to government third hierarchy of healthcare facilities 60
Figure 4.16 Shortest routes from buildings to private facilities................................ 61
Figure 4.17 Closet buildings and sum of routes of private first hierarchy of health facilities ........................................................................................ 62
Figure 4. 18 Closest buildings and sum of routes of private third hierarchy of health facilities ........................................................................................ 62
Figure 4.19 Closest buildings to government and private healthcare facilities ......... 63
Figure 4.20 Buildings in the service areas of government healthcare facilities......... 64
Figure 4.21 Non-service buildings of Government healthcare facilities ................... 65
Figure 4.22 Buildings in the service areas of Private healthcare facilities ................ 66
Figure 4.23 Non-service buildings of private healthcare facilities ............................ 67
Figure 4.24 Reach centrality indices, government first hierarchy of health facilities 72
Figure 4.25 Reach centrality indices, government second hierarchy of health facilities ........................................................................................ 72
Figure 4.26 Reach centrality indices, government third hierarchy of health facilities ........................................................................................................ 72
Figure 4.27 Reach centrality indices, private first hierarchy of health facilities ....... 73
Figure 4.28 Reach centrality indices, private third hierarchy of health facilities ...... 73
Figure 4.29 Closeness centrality indices, government first hierarchy of health facilitie ........................................................................................................ 74
Figure 4.30 Closeness centrality indices, government second hierarchy of health facilities ........................................................................................ 74
Figure 4.31 Closeness centrality indices, government third hierarchy to health facilities ........................................................................................ 75
Figure 4.32 Closeness centrality indices, private first hierarchy of health facilities . 75
Figure 4.33 Closeness centrality indices, private third hierarchy of health facilities 76

Figure 4.34 Gravity centrality indices, government first hierarchy of health facilities ........................................................................................................ 76
Figure 4.35 Gravity centrality indices, government second hierarchy of health facility ........................................................................................................ 77
Figure 4.36 Gravity centrality indices, government third hierarchy to health facilities ........................................................................................................ 77
Figure 4.37 Gravity centrality indices, private first hierarchy to health facilities ..... 78
Figure 4.38 Gravity centrality indices, private third hierarchy to health facilities .... 78
Figure 4.39 Comparison of closeness, gravity and reach indices according to government and private Facilities. .......................................................... 79

**LIST OF TABLES** **Pages**

Table 3. 1 Population Size .......... 40
Table 3. 2 Health Facility's Distribution .......... 45
Table 3. 3 Ownership Hierarchy Matrixes of Health Facilities .......... 46

# CHAPTER ONE

# INTRODUCTION

One of the current issues of discussions in recent times is about the rapid population growth in the coming years and its accompanied consequence that is expected to take place in urban towns of developing counties and not in rural communities. Montgomery (2009), and United Nations (2004), affirm the fact that the world as a whole is expected to witness a population growth of about 2.5 billion until the year 2050; this additional population is expected to be absorbed by urban towns and cities of developing countries. Montgomery & Ezeh (2005); Weeks et al. (2013) further discover that the rate of population growth in the urban cities is estimated to differ according to the size of the city. Thus, the less wealthy regions of the world is where the population growth will occur, with the most rapid pace of population growth  forecasted to occur in Asia and Africa of which Ghana is not an exception.

Analysis from Chamwada Report (2016), similarly indicate that urban population in Africa increased from about 15% of the total population in 1960 to 40% in 2010. The African population which is currently estimated at 1.2 billion is expected to triple in 50 years to come. The case of Ghana is not anything different from this, specifically as at 1957 when the country attained independence, 70% of the country's population lived in rural areas.

Today 57% of the Ghanaian population lives in urban area and 43% in the rural area. The most important and critical question to ask is, whether the urban cities are planned enough to receive this kind of population growth? The answer is always no! All this movement is triggered because cities in most developing countries are often the main power-engines to national economic growth and development. The cities are where most skilled, highly educated, economically productive persons, specialized services, headquarters of institutions and organizations, quality educational institutions and first class health facilities are found. For this reasons, people in the rural areas migrates with their family to the urban areas where they can have access to these opportunities which are less likely to be found in rural settlements. Although the above mentioned are major advantages associated with cities of the developing countries, there are likely risk to the future development of these cities if pragmatic measures are not kept in place, including those related to healthcare accessibility, housing, governance, provision of water, sanitation, transportation, as well as the inequalities in income and wealth.

Analyst of the Chamwada Report (2016), argue again that to make cities of African countries that are expected to experience rapid urbanization livable for the residents, there is the need to address the following socio-economic issues ahead of the expected population growth and spatial expansion. These critical issues include ensuring;

- ✓ Adequate and accessible healthcare facilities and schools,
- ✓ Adequate, decent and affordable housing,
- ✓ Attainable Sanitation measures,
- ✓ Available and affordable Energy, jobs and different sources of income,
- ✓ Enough open space for recreations etc.

The increasing pace of population growth in these major cities comes with its own benefits and challenges to the cities and the country as a whole. Benefits to the economy of the city in the sense that if a sustained urbanization takes place; where the entire critical infrastructure required is expanded to well serve the growing population without extreme disparities will imply that the growing population will serve as a market to bust various economic activities. However it will be a challenge or a deterrent to the development of the city where the urbanization is not sustained, thus the existence of inadequate as well as stark inequalities in accessing the available service facilities to the growing population. This in most instance results to associated challenges of spatial distribution of resources, affects healthcare accessibility either physically or economically, slum development and rampant social vices etc. Even in the case where the required social service and facilities expansions are being planned for, the challenges as to where best to locate them to equally meet the needs of the underserved populations becomes an issue. Radke and Mu (2000), emphasize that during massive expansion, a key problem to planner is how to allocate public facilities and service in order to optionally serve the increasing population.

Notwithstanding all the rapid population growth likely to be observed in towns and cities of growing countries, either through migration or other factors with its respective consequences, health of the population should be given the utmost attention. Health is much prioritized and so valuable to the extent that it is often equated to wealth of a city. Weeks et al. (2013), state that the wealth of a city, and the country in which the city is found is often equated to the health of the residents. They further indicate that once the inhabitants in the city are mentally and physically healthy they will be more strong to undertake economic activities which will intend increase productivity, while at the same time a place that is characterized by high economic productivity will have the potentials and resources to improve the living standards of the inhabitants. It is also argue that the wealth of a city or country operates in either “global” or “local” level of scale (Weeks et al., 2013). At the global stage, richer places are seen to have healthy people living in it. But at the local stage, there could be likely inequalities of the healthiness of the inhabitants ranging from one part of a city to another.

## 1.1 Problem Statement

The spatial distribution of population in a settlement and their interconnectivity, accessibility to and from the urban cities are important for the delivery of healthcare. Healthcare service would be much affected if the expected population growth in the coming years is projected to be absorbed by urban settlement of developing countries, which already has peculiar socio-economic and geographic distance issues to healthcare accessibility. A study that is targeted at examining the spatial configuration factors that are responsible for the variations in accessibility levels amongst healthcare facilities across the growing Tamale metropolitan assembly area in the northern region of Ghana is necessitated, since healthcare accessibility is one of the critical socio-economic factors that needs to be addressed to make a fast growing city livable and this will as well inform what measures to take in the future to ensure an equitable distribution and access to healthcare facilities across the spatial boundary of the Tamale metropolitan area. Though as evident in the study by Radke and Mu (2000), that it is not possible to have equal access to service facilities in a heterogeneous settlement. However government in providing the needed amenities to its residents must aim to achieve this condition although many private individual who provide services might not even wish to achieve this.

Most of the population growth that is expected to be absorbed by the cities is as a result of migration. This is because city living is becoming a norm for the ever growing proportion of the world's population (Montgomery & Ezeh, 2005). New migrants in the city in most instances settle far from the central business district, where land value is less expensive and accommodation affordable, rendering distances between destinations such as, schools, hospitals, workplaces, offices, and shopping centers longer. This requires more time and money to reach them, leading to a growing dependency on private motorized transport to those who can afford, and other automobile forms of mobility. This situation results in widespread of congestion and traffic in the city center (UN Habitat Annual report, 2006). Pellow (2002), indicate that in most instances the additional population growth in the city either lives in slum localities that is situated in the older city limits, or situated around the expanding periphery where accommodation can easily be found. In either ways Pellow (2002), noted that the rates at which population grow far outpace the ability of the city management in the provision of crucial amenities including schools, health, housing, source of power, recreation and other social services. Though most literature emphasize that rural dweller move to the urban city to have access to facilities that are non-existent in the rural settings and city living becoming a norm, it also notable from other studies that residents in some city slums in most developing cities live in worse and more dehumanized health condition than what is encountered by people staying in rural parts of the same country (UN Habitat, 2006).

## 1.2 Justification

Tamale, which is the case study city, is the capital city of the northern region and the fourth largest city in Ghana. The city has some peculiar characteristics that facilitated it being chosen for this study. Tamale was a sizable city with a smaller population size found in a vast land area. As the years passes by, the city started experiencing population growth with other people from other areas moving in and coupled with natural population growth. As characterized by many cities in the country, it has not been planned adequately to receive growing population, the study will help identify factors to be addressed in ensuring equitable accessibility to healthcare facilities to the residents.

Data from the Tamale metropolitan area indicate that out of all the communities in the metropolitan, about 35% are urban communities, peri-urban communities represent 13% and 52% represents the remaining rural communities. Nevertheless, these communities are still lacking when it comes to critical social and economic needs that include but not limited to healthcare facilities, good road network, schools, and recreational centers (Tamale Metro, 2016). This implies that the rural part of Tamale metropolitan areas depends on the available healthcare facilities of the urban and peri-urban communities for their health needs. Issues of distance to health facilities, affordability with regards to transportation and hospital services now come to play to determine whether access to these healthcare facilities at the urban city is possible or not. The reports also indicate that the proportion of the elderly in Tamale metropolitan area is lower than the Regional and National averages. This indicates the comparatively low life expectancy. The report concludes in this regard by suggesting pragmatic efforts to be made to make primary healthcare delivery more accessible and affordable to the elderly (Tamale Metro, 2016).

Understanding the relationship that exists between the spatial structure of the metropolitan assembly area and the social life specifically to healthcare facility accessibility of the residents is necessitated in making future decisions regarding healthcare infrastructure locations. Since the spatial structure in which healthcare infrastructures is located, its hierarchy and quality influence utilizations.

## 1.3 Scope of Study

The study is grounded around variations in the accessibility to healthcare facilities of the Tamale metropolitan area in Ghana and its urban spatial structure. The spatial structure of the study area may either render healthcare facilities accessible or inaccessible to residents of the study area.

## 1.4 Relevance of the study

Tamale metropolitan area is the only district in the northern region which is predominantly urban. This gives the district utmost advantage as a growth pole in the region, attracting both population and economic development. Thus, the increasing rate of population growth in the metropolitan area requires adequate infrastructural development to enable the accessibility of services and activities to all inhabitants of the spatial area for a sustained development. The study is therefore expected to give an understanding of the spatial structure of the study area in relation to social process of healthcare facility accessibility which, will intern show how best to improve accessibility to healthcare. Again there are quite a number of benefits associated with findings of this study. Which include but not limited to providing enough information to the best location of health care facilities at different part of the Tamale metropolitan assembly area. Also adequate measures can be taken to improve accessibility to non-service area of healthcare facilities with regards to either hierarchy or status of the facility. For instance, there could be a high accessibility to lower hierarchy of healthcare facility which is only for minor health related issues but a low accessibility level to a high hierarchy of healthcare facility which is well equipped for complicated and special health issues. Accessibility can also be improved according to a specific mode or at a particular time of day to a particular destination, once the most common mode of accessing healthcare facility is identified. Individual, household and migrant settlers will know where best to undertake a relocation decision that would enable them have access to healthcare facility. With a good knowledge of the spatial configuration factors that influences accessibility to healthcare facility, location-allocation methods can further be used to locate healthcare facilities that would capture a large proportion of population to have access to it, which will prevent the misuse of resources in establishing new facilities.

Data plays an important part in the analyses and general result of every research activity. However how to collate and have the data at hand often comes with a lot of challenges. This is worse especially in the developing countries where database is nothing to talk about, not forgetting the issues of bureaucracy in the government institutions rendering it cumbersome to retrieve secondary data. Thus, data limitation encountered coupled with constrains of timing and finances compelled the use of what is available. Building data that include the shape, size and height of building is required for the research but this is not available. As such buildings are represented by points for analysis. Even point representation of building is particularly limited to the main town of the city area, however this is not available for the neighboring communities which are administratively part of the study area, and for this reason the study excluded these communities in the analysis.

Chapter two of this dissertation highlights on the review of related literature on variations of accessibility to healthcare facilities. This chapter is divided to major thematic subsections that include accessibility, understanding accessibility and accessibility measures, urban health accessibility, location allocation, urban spatial form and representation, then a description of health care system in Ghana and the conceptual framework of the study. Chapter three gives a clear description of the required data needs as well as the methods used in the data collection and a profile of the study area. Chapter four includes the methods and tools used for the data analysis as well as the results of the analysis. Chapter five concludes the research with a brief discussion on the policy implications of the study.

# CHAPTER TWO
# REVIEW OF LITERATURE

This chapter encapsulates a review of relevant literature with respect to the study topic which provides in-depth knowledge of what has being done so far with regards to related studies and further pursues to acknowledge the literature gap the study seeks to fill. The review is done base on the following important thematic subsection of; accessibility, understanding accessibility and accessibility measures, urban healthcare accessibility, urban spatial structure and its representation, location allocations, healthcare system in Ghana and conceptual framework of the study.

## 2.1 Accessibility

In literature the term accessibility has being defined and described in different forms, but one common thing in all these definitions is that it is generally geared towards the same purpose and understanding. Handy and Clifton (2001), explain accessibility as to reflect the ease of reaching needed or desired activities and thus it should portray the characteristics of the land-use system (specific location of activities ) and the transportation system (how the specific location of activities are linked). This implies that the land-use system that is adopted in locating activities in a zone and the transportations system linking the activities influences to a greater extend the accessibility and inaccessibility of activities. Litman (2016), define accessibility or access to refer to the ease in attaining goods, activities, services, and destinations, which all together are called opportunities. The author also noted that when a good number of opportunities are located near to each other along a street, accessibility tends to increases. And more so when destinations are closer enough together, they can easily be reached by walking (Litman, 2016). Accessibility as the possibilities for interaction and exchange is highlighted in (Hansen, 1959). Aday and Anderson (1981), definition of accessibility to health, describes people's access as the capability to use healthcare services when and where they are actually needed. Litman (2016), state that accessibility should be assessed from various perspectives, including a particular group, mode, location or activity and further reveal that clustering (people and activities together) increases access to common activities, particularly by walking and public transit (Litman, 2016). Aday and Aderson (1974), argue that access is equated to population characteristics (family income, attitude about medical care and insurance coverage) or the delivery system whiles others argue access depends on the utilization rates.

## 2.2 Understanding Accessibility and Accessibility Measures

The accessibility of a geographical location plays a crucial role to the development and underdevelopment of a location in question. Hansen (1959), note that the more accessible a part of a city is to the diverse activities, the greater its growth potential. Residents of an area are often rational in making decision towards locating their place of residence with respect to having ease access to work place and other important social facilities. Hansen (1959), brings to the existence of a residential land use model that tends to explain the process of sharing population growth to small area. Much focused is on residential land use model because majority (80 per cent) of person’s trips is for work, shopping and social purposes. This method is adopted for the estimate of residential growth from 1948 to 1955 for each of the zones in the Washington metropolitan area. In conclusion Hansen (1959), indicate that city planner in their work of addressing accessibility related issues should be able to predict the trickle down effects of actions. For example the construction of an express highway in a zone, reduces travel time and leads to increase in employment in that zone.

Handy and Clifton (2001,) study the reasons that contribute to accessibility at the neighborhood level and a search for options available to planners in measuring accessibility. Another aspect of the study was finding practical or pragmatic accessibility measures, for it is necessary to first make inquiries as to which factors of accessibility is most important to residents. Secondly, what kind of data is available with regards to the mentioned factors or what forms of data can be collated about the factors is important. This is often because most of the factors used by urban planners for accessibility measures may not be the most important factors considered by the residents in issues of accessibility. Thirdly how can the city planners make sense with the available data, for most traditional accessibility measures only give insight as to whether the accessibility is low or high but do not indicate the specific factor coursing this. Finally, it is stated that using the community or a neighborhood as a spatial unit of analysis provides both benefits and challenges. In-depth examination of the characteristics of the neighborhood is enabled at neighborhood level within the immediate environment compared to an analysis that involves a larger geographic demarcation. But accessibility of only the neighborhood provides part of the picture, since most of the inhabitants make use of activities outside the neighborhood boundary.

Measuring accessibility and identifying the factors that affects the ease in reaching activities within a neighborhood or a city is very crucial in understanding the accessibility situation of that particular neighborhood and identifying pragmatics strategies in rectifying the situation. The study of Handy and Clifton (2001), further came out with these main factors to be considered in measures of accessibility. Activity Factors: This basically describes the different characterization of the activity that has an accessibility measurement. Firstly, type of activity can be classified based upon their particular location in a neighborhood. Secondly, Cumulative opportunities measures, gives a tally of locations of a particular activity, resident will always opt for a location of proximity and where there exist variety of activities within same location. Thirdly, relative amount of activity plays a significant role in measuring accessibility; this can be measured using the total numbers of employee and the square size of the activity's buildings. Lastly, what factors attracts residents to an activity in a destination? Humans are rational in making decision as to where to stay and often consider a number of factors such as the variety of destinations found closer or around the neighborhood. These characteristics vary from person to person since they are highly subjective (Handy and Clifton, 2001). The other factors include transport factor, data availability, land use data, transportation data and strategies**.** Given the gap between the required data and available data for accessibility analysis, the authors suggested using strategies in addressing them (Handy and Clifton, 2001).

Handy and Clifton (2001) came out with two interdependent ways that might prove useful: one is a city-wide approach using existing data and GIS to assess the accessibility of the entire community and the other way involves a neighborhood-specific approach of creating a detailed accessibility database. In the final conclusions the authors made it clear that, it is necessary to identify the factor that improves accessibility and examine the relative importance to the inhabitants.

The accessibility measures presented in the study of Bhat et al. (2002) is aimed to be applied for a countrywide transportation planning, and for other planning activities such as for measuring the current accessibility situation of a place and as an alternative way to assess the conditions before and after project execution in a zone or place. The research was triggered in finding an appropriate and accurate accessibility measure to assess the effectiveness of transportation projects by transportation planner. Thus a measure that goes beyond the traditional measure which concentrates on not only the ease to movement but rather a measure that encapsulates both transportation and land use accessibility measures within a zone is needed (Bhat et al., 2002). Most accessibility measures gives details at a disaggregate levels, but this study targeted the aggregate level over combination of four aspect. The four aspects are: purpose of the trip, mode of travel, time-of-day, and spatial level (Bhat et al., 2002). Bhat et al. (2002), further reveal that accessibility measures have mainly two components, one relate to the activities which is known and called attraction. Attraction measures include the number of employees, amount of sales or square feet of space. The second component describes the ease of having access to activities. Thus the impedance factor that include the distance to the destination, the amount of time it takes to the attraction or the cost involve in travelling to the attraction. A third factor has been quite recently being used by researchers. That is; data about the user group, this data is often not included in the measures of accessibility, but instead it is used to select attractions and impedance data to include in the calculation of the accessibility measures. The aggregation methodology explored in the study was the Multinomial Logit (MNL) model. This model was selected because it is flexible to behavioral structures and allows aggregation without further model estimation. The model is applied to Dallas/Fort Worth data set with fifteen maps representing different aggregation scenarios. Three maps of accessibility measured at a disaggregate level and one map measured at aggregation over one dimension is conducted. The result of the trip purpose of shopping, social-recreation and work, using high way mode and peak travel time was as expected, as the distance from the central business district increases the accessibility reduces. In conclusion Bhat et al. (2002), argue transportation professional to incorporate more information beyond the traditional mobility measures.

Handy & Niemeier (1997), mention that accessibility is determined by the land use pattern and the transportation system of a given place, they further state that accessibility level of two people living in same neighborhood may differ, as peoples' wants and tastes vary. The authors indicate that transportation planners often try to address accessibility issues by targeting only the transport system ignoring the larger context of land-use. On the other hand land-use planners in tackling accessibility issues focus on the activity patterns in isolation of the links connecting these activities. Thus, the concept of accessibility as defined in the above that includes land use patterns and transportation systems has hardly been translated into performance measures by which policies are evaluated and thus has had little practical impact on policies. The purpose of their research was therefore to bridge the gap between the academic literature and the practical application of measures and provide a framework for the development of accessibility measures. A case study that measure accessibility for a nonwork choice at a local scale is conducted. The research was to test the assumption that pre-World-War-2 neighborhoods have better accessibility to shops and services than the newer postwar neighborhoods. Two paired communities of one old and new was selected from the San Francisco Bay Area. A gravity-based measure of local accessibility is calculated by using existing data available from the Metropolitan Transportation Commission on intra zonal travel times and amount of employment by type in each zone. Service, retail and other employment are used as a measure of the opportunity for non-work activities. Based upon the gravity based measure of accessibility the older community has much higher levels of local accessibility than the newer communities. However it did not portray the nature and cause of the difference. A more detailed study was done where land-use pattern is evaluated through maps and the types of establishments. Commercial development was defined as pedestrian oriented. The study conclude that newer community did not have pedestrian-oriented commercial activity instead strip malls are located at the intersection of major arterials, in contrast post war communities had a linear strips of pedestrian-oriented commercial activities and as well as activities located within residential areas. This difference is clear using the maps of each community. Using coverage, thus the percentage of each area that is within a quarter mile of a super market or convenient store, the older community has higher coverage than the newer community.

The work of Litman (2016), provides guidance on how to apply different types of accessibility analysis in planning. Litman (2016), gives descriptions of the facts which influence peoples' ability to have access to destinations and assessments of methods in improving accessibility. The author also indicates that a good number of factors affect accessibility. These include:

1. A motor vehicle travel condition such as an automobile travel speeds and affordability affects accessibility in one way or the other.
2. Quality of modes either by walking, cycling, public transit, delivery services speeds, also have an impact on accessibility levels.
3. Factors of the transport network connectivity that comprises the density of streets and roadway connections, quality of connections between modes of walking and cycling to public transport stations, further improves accessibility.
4. Land-use proximity factors which involve the creation of density and land mix with distances between destinations are all reasons affecting accessibility either positively or negatively depending on the existing situation (Litman , 2016).

The difficulties associated in collating data from walking and biking modes in measuring accessibility have made way for the over dependence on auto vehicle modes of accessibility measures which often does not give a complete nature of accessibility in a given neighborhood where all the modes of walking, biking and auto vehicle are used (Litman, 2016). Litman (2016), mention that conventional planners tend to assess transport system performance mainly on automobile travel conditions using indicators such as roadway level-of-service, traffic speeds and vehicle operating costs. So in most cases other modes of accessibility, such as walking and cycling, are either left unnoticed or ignored. This tends to support mobility on automobile over other modes of transport. Litman (2016), claims that land-use planners in many instances focus on geographical availability (distances between activities), and that transportation planners focus on mobility, particularly on vehicle journeys. The main purpose of communication specialists is the quality of telecommunications (such as the access of households to telephone, cable and internet services) and finally social service planners focus on accessibility options for certain services (such as the ability to access certain services) in medical clinics and recreation centers. However, each of the above categories of planning analysis is generally done in isolation. This could imply that in addressing a particular aspect of accessibility to either a group, mode, geographical location etc. can have a negative impact on the other. For an effective accessibility analysis, the works of land-use planner, transport planner, communication expert, and social planners should be integrated as a whole rather than working in isolation with the view of achieving the goals of their area of specialization. Liman (2016), further discusses how transport facilities and service should accommodate people's special needs. For walking mode, he suggested side walk/path quality, street crossing conditions. For cycling he suggested that land-use condition be available for street riding and parking. Transport cost effectiveness can be improved by lowering user costs and improving affordable modes like walking, cycling and public transit, and bringing more land-use accessibility in urban planning (Litman, 2016). The author concludes by suggesting pedestrian and bicycle improvements to reduce transportation disparities in underserved communities.

### 2.3 Urban Health Accessibility

Arku et al. (2013), examines the social disparities in access to healthcare services in the situation of high urban expansion in a city of Accra in Ghana and how households' health is linked to neighborhood living standards. Data collected for the study is from respondent found in three spatially different residential neighborhoods. These neighborhoods are Labone, characterized by a relatively high income status and good infrastructure; Nima, a contrast of Labone is characterized by poor residents who has inadequate social infrastructure; and Ash Down, an inter-mediate between Labone and Nima . A systematic random sampling strategy is used to select 562 respondents from these three neighborhoods. Face to face interviews of adults above 18 years is conducted in each household. Variables such as demographic, socioeconomic, and housing characteristics are used. It is finally established in the work that poor access to health care services is attributed to households who live in dilapidated housing conditions and have financial difficulty in paying their rents as well as renovation. The study further enlightens the importance of neighborhood in understanding healthcare access in situations of the place in that, health care access is highest in the wealthiest neighborhood of Labone and worst in the most disadvantage neighborhood of Nima.

Healthcare levels of inhabitants of low income levels can be seen in the study of Taylor (1982), which focuses on the dynamics of urban situation in most developing countries. The author highlights that urban situation are broadly categorized into fundamental causes thus the generating factors and manifestation/consequences of the generating factors which together form a chain of interlinks portraying the urban conditions. One of the generating factors in the study is the social factor, which contributes greatly to urban malaise according to the author. Taylor (1982), emphasizes that healthcare and its related social welfare services are inadequate and often regarded irrelevant in most LDCs cities. Health problems are particularly acute in neighborhood inhabited by low income earners and healthcare facilities serving resident of these neighborhoods are mostly inadequate and frequently unsuited to the needs of the people (Taylor, 1982).

Basta (1977) cited in Taylor (1982) establishes that on a average urban health statistics conceal a higher variance than that of rural communities, and further argues that health and nutrition conditions are even worse in low-income urban areas than in the rural settlements from which the migrants came from. With regards to variations of disease infection, tuberculosis is up to ten times higher and infant mortality three times higher in lower-income areas than in the whole city. At the same time coverage of health facilities in these areas are usually four to six times worse in the slum areas than the average published city-wide statistics indicates (Basta, 1977 cited in Taylor, 1982).

Fortney (1990) ultimate purpose was using geographic information system to examine healthcare needs and how health care delivery can be improved. The geography of health services includes the analysis of the spatial arrangement of healthcare services (number, types and locations), how and why spatial arrangements change over time, how people have access to healthcare services, and the effects on their health and wellbeing.

In analyzing the need for health care, population differentiation based on influential geographical differences, age, gender, culture and economic situation (influences health care need, ability to travel for healthcare and type of healthcare services that can easily be accessed) and quality of healthcare services, all calls for healthcare analysis and planning (McLafferty, 2003). McLafferty (2003), highlights geographic information system and its related programs, as powerful tools used to map the spatial disparities and the development of innovative indicators in addressing healthcare need. GIS used to illustrate complicated and complex relationships affecting health accessibility can be seen in the work of Kinman et al. (2000), where household addresses are geographically coded to describe household healthcare needs, and geographical differences in household characteristics to healthcare.

Regarding access to healthcare services analysis; GIS is often used to illustrate geographic variations in accessibility along social and economic lines (McLafferty, 2003). There is a fact that geographic constraints on health services are intertwined with factors based on class, race and ethnicity, and leads to complex patterns of disadvantages. According to the author, measures of geographical health are either area-based or distanced-based. Area-base accessibility is defined within a confined area of jurisdiction such a country, town or city, but distance-based accessibility focuses on direct and indirect distance of travel time or cost between the population and healthcare service providers. It is also possible to use spatial statistical procedures such as kernel density estimation to measure service availability with GIS, but these approaches have not been developed in the healthcare literature (McLafferty, 2003).

Haynes and Fotheringham (1984), emphasizes that the farther a place or activity to people are apart, the lesser the likelihood for spatial interaction. But there are exceptions to the fact that distance can be a barrier for interaction. As described by Folland (1983), given the differences of healthcare services with regard to range, type, and quality of services offered, most people (consumers of health care) are willing to travel farther to obtain their choice of reputable healthcare, so there is a trade-off between distance and facility size or quality.

Geographic variation in utilization; with geographic variation in utilization McLafferty (2003), cited the work of Rushton and West (1999) to elaborate the concept. A study of mastectomy rates in Iowa used GIS and spatial smoothing methods to describe variations at district level (Rushton and West, 1999 cited in McLafferty, 2003). Mastectomy rates differentiated widely in hospital service areas and have high rates in remote communities that are far to the hospitals.

GIS and health service delivery; as healthcare services are assessed and planned, needs, access and utilization issues arise (McLafferty, 2003). How do healthcare policies affect geographic access to health care services? Does the service geographical organization support high quality, effective care? Where services should be located to best meet population needs? (McLafferty, 2003). McLafferty (2003) note that an increasing number of studies have been drawn on GIS tools and data sets to address these questions. GIS-based research on service performance and effectiveness is still in its infancy (McLafferty, 2003), as geographic information needs to be linked to access to health services.

Goodman et al. (1997), tested the influence of distance from residence to the nearest hospital, and the likelihood of hospitalization and mortality. The authors made mention that closer medical care is highly valued by patients and family, since it saves travel time and offers a sense of security. Also from the clinician view point according to the authors, patients close to hospital require less hospitalization. The patients can easily revisit the hospital when the situation gets worse. On the other hand, patients that live far from the hospitals would require high hospitalization. A cross-sectional design is used to study hospitalization and mortality rates in 72 hospital service area from a population in Northern New England (Maine, New Hampshire, and Vermont cities). The health service area is defined using patient-origin and also used to assign zip codes to the patients. Hospital discharge data that includes age and gender and mortality data of the medicare population from the three cities are used. Results of the study reveal that residents in the study area who live farther from the hospital service areas are less likely to be hospitalized for medical illness, in spite of their relatively high geographic access to primary care physicians. The results indicates that adults who have lower health status prefer to live closer to hospitals, and also families who have children with chronic illness are likely move closer to medical facilities, even though these are infrequent causes of hospitalization. Goodman et al. (1997), note that differences in socioeconomic status are unlikely to explain the differences in utilization rates that are observed in his study. The authors note that the consequence of disperse population to medical services are responsible for the highly variable distance to healthcare services. Utilization of any form of services is influence by local availability (Goodman et al., 1997).

Pearce et al. (2005) explores how to measure geographical access to community resources that are related to health. They aim to find out whether particular attributes of a neighborhood or place that people live in have an effect on their health. Neighborhood accessibility is calculated for five main domains of recreational amenities, shopping centre, educational facilities, health facilities and marae (A Maori meeting place). A sub-domain of the main domain, which includes the precise location of facilities, is computed and geocoded in order to ascertain an aggregate measure of the broad domains. For instance, dataset for health sub-domain comprises hospitals locations, which is readily available in a GIS format. Community resource accessibility is calculated for each sub-domain of 38350 census mesh block across New Zealand. Each mesh block is represented by its population weighted centriod and the time taken to each community resource along the road network (distance) using Arc Info GIS. Origin and destination matrix, mean and median travel times are computed and analyzed. The study concludes by indicating that geographical accessibility to community resources varies across the country's urban and rural areas, and even these variations are noticed in the neighborhood level (Pearce et al., 2005). Least accessible community resource is found to be beaches and the most accessible sub-domain is the parks (Pearce et al., 2005).

To answer health care access needs of underserved sub-population within a well-served community, and the usefulness of GIS in illustrating community health access problem is prompted by Phililp et al. (2000),where the community healthcare needs and interventions to improve access is assessed. The study is undertaken in Boone County metropolitan area located in central Missouri with a population of 13000. In 1992, 1995 and 1998, survey of Boone County health situation indicate a high doctor-population ratio in Missouri which led to the establishment of two community health centre in County largest city. The target population is residents below the poverty level. In 1998 another survey is conducted to reassess community health and to highlight the ongoing needs. Three forms of data are used for this study. Firstly, 3314 patient records of the community health centre for 1998 are attained. The records have the home address, number of visits, age, sex, payment method, and household income for each patient. The second data contains the results of the 1998

Boone County health and human services needs assessment. This data is collected from a sample of 2100 adults over the age of 18 who responded to a telephone survey of self-reported health behaviors. The third data contains the geographic information that includes areas, roads, census numbers, zip codes, and the boundary of Missouri Representative Assembly. All data is taken from the Missouri Geospatial Data Service. The resident of each patient and survey respondent was geo coded. Clinic boundaries and census tracts are also geo coded. County health care assessment data all together with patient data base of CHC is combine using GIS maps to define CHC service area and how population inside and outside the service area differ according to demographic and health. Clinic database mapped to patients by census block groups shows a clustering in the initial target service area but weighting household by the number of visits made to CHC, shows a difference in the targeted service areas of 1994, and the actual service area ( Phililp et al., 2000). This is possible through the usage of GIS to make analysis of target and actual access areas and the study also reveals that the socio-economic factors are not enough to conclude on the service area ( Phililp et al., 2000).

U.S Department of Agriculture (1973), show that rural and urban population do not have equal access to health care. This is attributed to the fact that rural areas have inadequate health professional, inadequate physical structure of health care's facilities and the lack of finances to afford health care.

Wang and Luo (2004), use spatial and non-spatial factors to examine accessibility to primary health care. Spatial accessibility factors are defined as geographic barriers that exist between the provider and consumers of healthcare services and on the other hand non-spatial factors are mainly about non-geographic factors such as age, sex, income and social class. A two- step floating catchment area method is executed using GIS to measure spatial accessibility, based on travel time. A factor analysis is applied to measure non-spatial and spatial aspect of accessibility. In conclusion, an integrated method of spatial and non-spatial access factors is derived to identify census tracts that are within the health professional shortage area.

## 2.4 Urban Spatial Form and Its Representation

A number of study explore the ideal way of analyzing and describing complex and complicated spatial interaction of the built environment that will appropriately inform future decisions and research on urban cities. Plans are often used to display the details of a built environment as well as the different land-uses of a geographical location in question. This issue is elaborated in the work of Sevtsuk (2013), where he argues that a plan is the commonly used medium for representing the built environment of a geographical settlement, but this medium comes with its limitations in illustrating the complex spatial interaction between different land-uses of the built environment. Thus a glance of a plan will not explicitly show the inter-relationship within the built environment. He further indicates that every built environment has its spatial order, which determines the different relationship that exists in the various land-uses such as buildings, public spaces and the routes that connects them. These kinds of relationships or spatial patterns in a larger extend influence how a place is good or bad for a particular land-use, and how the different activities influence each other. The inability of a plan to adequately display the explicit information about the interactions that exist in the different land used of the built environment leads to the usage of network-based model. Sevtsuk (2013) States that “In order to represent and analyze such complex spatial relationships, urban designers and planners now use network- based models of the built environment. Unlike traditional plans, network-based representations of urban space encode explicit relationships between the elements of the network, documenting, for instance, how streets are connected to one another, how long the travel times between different districts, buildings, or rooms are, or how many people commute between them.” (Sevtsuk, 2013, p. 147).

Over the years researches have conducted studies to understand the relationship between the spatial structure of human settlements and the social life of the inhabitants. This has been one of the central challenges of the discipline of city planning. The nature of this relationship will inform decisions towards designing a sustainable urban city. One of such research is by Sevtsuk (2010). Sevtsuk (2010), seeks to investigate the retail location patterns in urban settings. The central question that he wants to find answers to is; “Does the spatial configuration of the built environment affect location choices of retail and food service establishments” (Sevtsuk, 2010, p. 5). Thus he is interested in finding out whether the distribution of retailers in a human settlement or a city is affected by the spatial configuration of the built environment. That includes the physical pattern of urban infrastructure, the spacing and sizes of buildings, and the geometry of routes. A case study that focus on Cambridge and Somerville cities in the United States, which are spatially continuous and similar in size is conducted using the location data for individual establishments and employment. Public transit data that includes the route, stops of subways and bus lines in both cities is collated. The spatial distribution of the residents as well as the urban form characteristics such as the road data, building foot print, height and parcel data are used. The study concludes that variations in the reach-to-built-volume are not only as a result of relative location of the buildings with respect to the street network, but also from the relative differences in footprints, heights, and spacing around each building. Thus building volumes, spacing and access to the street network variables are jointly an added advantage and a characteristic of locations with the highest reach-to-built-volume. Also, where building types were fairly uniform, street network plays a key factor in explaining variations in accessibility to volume at the neighborhood scale, building spacing and heights are the primary factors in explaining variations in the district scale. Furthermore, the research also reveals that in considering all stores in the study area as a group, the retail and food service establishments’ location choices are positively related to other retailers’ presence in a neighborhood. The author also finds out that an exogenous land use factor also has an influence. These findings gives a clear understanding of retail location patterns in urban settings of Cambridge and Somerville cities which will help in designing economically, socially, and environmentally sustainable urban neighborhoods even though the conduction of same research using different urban cities might result in different findings.

Tucci et al. (2015) focus on the historical event that leads to changes to the spatial structure of Milan. Tucci et al. (2015), reveals that changes from the period 1737 to 1884 in the city of Milan, Italy is found around two main cross roads, the Decumanus

Maximus (from south-west to north-east) and the Cardo Maximus (from south-east to north-west).This is where a spontaneous development is seen around the axis of the major roads. However changes in the year period 1884 to 2005 are noticed around the castle area of Milan. This explains how central locations that attract population and development in an urban spatial unit can change over time.

## 2.5 Location Allocations

A large and growing literature has investigated that mathematical location models are best in locating facilities with respect to realist objectives. Church and ReVelle, (1974); Rahman and Smith (2000) indicate that locating private facilities is not as cumbersome as in public facilities, since the objective of the location choice analysis for private facility is often clear and understandable. However the location objective of public facilities is difficult to embrace and quantify. Church and ReVelle (1974) highlight the need for surrogate measures due to the difficulty in defining a direct measure of public facility's objectives. Two surrogate measures that have received recent attention in location models are: 1.Total weighted distance or time taken to travel to the facilities. 2. Maximal service distance, a distance or time that a user from the most distant to a facility is willing to travel in order to reach a facility (Church and ReVelle, 1974). Maximal service distance concept is also present in the location set covering problem. "A location set covering problem identifies the minimal number and the location of facilities that ensures that no demand point is farther than the maximal distance from the facility" (Church and ReVelle, 1974,p. 102). The number of facilities in a location set covering problem serves as the cost factor in decision making. In some instance there are so many locations that fall within the requirement, in this situation the solution with smallest maximal distance is selected. It can possibly happen that the distance obtained is larger than the required distance. In this case it is mentioned that the maximal distance that covers almost the entire population or the solution that leaves just a few population out of the desired service distance is selected. "The maximized coverage (population coverage) within the desired service distance by locating a fixed number of facilities is the maximal coverage location problem (Church and ReVelle, 1974, p. 102). A trade-off curve is finally developed showing the maximum possible coverage within a distance for different level of expenditure of the number of facilities. The best pairs of maximal population coverage and number of facilities creates the desired result (Church and ReVelle, 1974).

The measurement of access to social services for household and how to better serve underserved region is the main focus of the study conducted by (Ralke and Mu, 2000). California is experiencing unprecedented population and economic growth and the state's population is projected to increase by 2.4 million in 2020. The question is then how to allocate public facilities and services to adequately serve the growing population. In the quest to address this questions, maximal covering models, which maximize the coverage with a fixed number of facilities and polygon-polygon geometric representation of problem (where the service provider and the population to be served are both represented in polygons) is adopted by the authors. To apply the model, Pacific Gas & Electric Company is chosen as the social service supply. Household population and census tracts levels data are used. In order to assess the quality of service served, it was assumed that all household are being served by each supplier of service. A density surface of household per area is further generated to intersect with a supplier service buffer of 60 miles of radius to obtain the result of household that are served, The results show the existence of areas of over-served and underserved. Teitz and Bart (1968) cited in Ralke and Mu (2000) which state that an existing supply site is replaced with a candidate site to determine if there will be an improvement in the objective results is used. This iteration is done till a supplier location that give the best coverage of the underserved. In conclusion, a polygon-polygon representation of the location allocation substitute model improves allocation of supply and demand although optimizations could not be achieved.

The basic health need which does not reach majority of the populations in most developing countries as a result of poor geographical accessibility of health care facility is the prime focus of the study by (Rahman and Smith, 2000). Location analysis in planning service plays a huge role to the regional development of a place as noted by (Rahman and Smith, 2000). One of such location analysis is the location-allocation modeling. They argue that though mathematical models for location-allocation are said to be difficult, but are proven to be useful in many location-allocation decision-making processes. The main objective of the paper is to examine the role of location-allocation modeling in planning healthcare system and its relevance to developing countries. The authors argue that there is no need to distinct between health development and economic development (Rahman and Smith, 2000). Development of health with other relevant social improvement is necessitated to attain economic goals and similarly economic development is certainly needed to achieve social goals of which health development is inclusive (Rahman and Smith, 2000). Studies and researchers for locating health facilities in most developing countries either consider all the facilities as a single level location-allocation model (SLAMs) or adopts the hierarchy type of health facility (hierarchical location-allocation model) which is often applied at the regional level for most research (Rahman and Smith, 2000).The location-allocation model helps in finding optimal site for a facility location however; this is influence by the ownership. For most private facilities have the objective of maximizing profit but for a public facility objective is often difficult to capture. Thus finding the optimal locations for public facilities such as schools; hospital etc is different from finding the optimal locations for private facilities (Rahman and Smith, 2000). Rahman and Smith (2000) indicate that one of the most popular models for public facility location problems is the p-median problem. It is argue that people always prefer the closest facility, but p-median model does not consider the worst situation of the maximum distance to be travelled to access healthcare services. Different studies show that the usage of facility declines as the distance to have access increases. For this reason it would be better to consider the maximum distance people are willing to travel in location allocation decisions making. Considering this, the location set covering problem (LSCP) would be preferred. It takes in to account the number of facilities and their specific locations and the demand or catchment area of the facility is determined by the maximal service distance that is considered to use a facility (Rahman and Smith, 2000). In developing countries, where it is not possible to provide the required number of healthcare facilities using the maximal distance from demand centre to facility, the maximal covering location problem (MCLP) is advocated where the aim is to maximize the coverage of healthcare service area within a service distance by locating a fixed number of facilities (Rahman and Smith, 2000).

The process of undertaking development planning activities, appropriate decisions and guidelines are needed for locating facilities to ensure that they will provide a wide range of services that would boost the living standards, social and economic development of the population. One of such public facilities is locating healthcare facilities. It has being argued by many researchers that the provision of high-quality healthcare in rural areas is a vital achievement to development planning (Massam and Malezenski, 1991). However, an outstanding issue of rural healthcare planning is the search for appropriate locations for healthcare facilities which will optimally serve the rural under-serve population (Massam and Malezenski, 1991). The study evaluated alternative location centre for healthcare facility in Mpika and Sesheka District of Zambia by the usage computer-based decision support system (DSS) called DINAS (Dynamic Interactive Network Analysis System) to select the most appropriate healthcare centre location. In illustrating the use of DINAS in site selection problem, data sets for the districts of Mpika and Sesheke in Zambia are used .The problem is to select an appropriate location for a new health center from a given set of small healthcare centers. The data is obtained from Massam et al., (1986) cited by (Massam and Malezenski, 1991). For each district, the demand for facilities is described by a population distribution map, which is defined as a set of points, each point representing the location of a village or a population cluster of at least 500 persons. Mpika has a population of 44,500, and this is allocated to a set of 79 points. 84 points allocated to Sesheke which has a population of 47,500. The general evaluation is made on the basis of physical accessibility as measured by direct distance and the size of catchment areas.

### 2.6 Structure of healthcare in Ghana

Health needs of citizens in Ghana is provided by both the government own healthcare facilities and private own healthcare facilities. The government healthcare system is organized hierarchically from the national level to the local level. However the private health system is not organized hierarchically. Two government bodies are responsible for healthcare delivery and infrastructural development in Ghana – the Ministry of Health (MOH) and Ghana Health Services (GHS). Not until 1996, the MOH is responsible for the provision of health service delivery in Ghana. But now, health service delivery is provided by Ghana Health Service. Ghana health Service is the main service provider of the health care system in the country, and works to implement national health care policies, provide health care services and appropriately use resources for health care delivery. Ministry of health is now responsible for policy and monitoring functions (MOH, 2000).

Health administration in Ghana is divided into three levels which are; national level, regional level, and district level. This is further divided into five functional (service distribution) levels of health care.

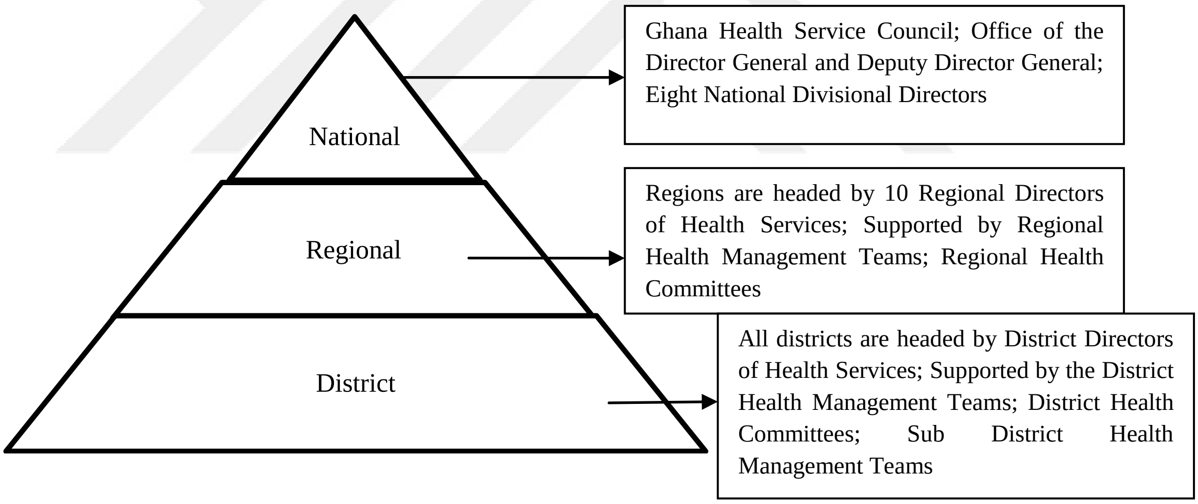



Figure 2.1 Administrative Levels of Ghana public health service (Pehr, 2010)

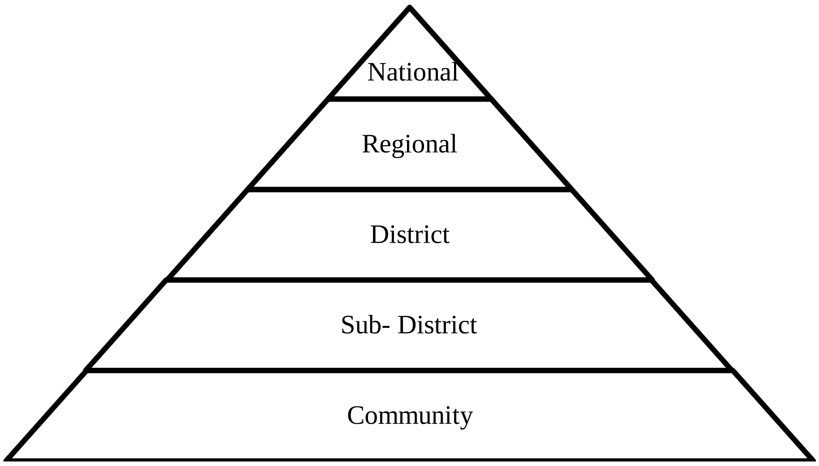



Figure 2.2 Functional (service distribution) levels of public healthcare in Ghana (Pehr, 2010 )

From figure 2.2, the structure of the health system in Ghana is classified according to level of services provided to the patients at the National, Regional, District, Sub-district and Community level. At the Apex of the structure are the national referral hospitals, followed by regional hospitals that are located in the ten (10) regional capitals of the country. Then comes the district hospitals in the district capitals, followed by sub-district health posts/centers and lastly, the community health facilities.

At the regional level of healthcare service, curative services are delivered at the regional hospitals whiles public health services are provided by the District Health Management Team (DHMT), and the public health division of every regional hospital. The Regional Health Administration (RHA) on the other hand provides supervision and management support to the districts and sub-districts within each region (GSS, 2002).

At the district level of healthcare service, public health services are the responsibility of the DHMT and the public health unit of district hospitals. The District health administration (DHA) on the other hand provides supervision and management roles to the sub-districts (GSS, 2002).

At the sub-district level, both preventive and curative services are provided by the health centers, as well as outreach services to the communities within their catchment areas (GSS, 2002).

The introduction of Community-based health planning services (CHPS) have made it possible for basic preventive and curative services for minor ailments to be addressed at the community and household level (GSS, 2002).

### *2.6.1 Primary Health Care (PHC)*

The healthcare system of Ghana is built on the basis of the primary healthcare programs, where the rural communities are the main focus in terms of meeting their healthcare needs. The main purpose of the primary healthcare is to come out with approaches that are targeted at raising the level of health of people in deprived communities. In all countries of operation, it offers strategies to improve fairness in access to healthcare and ensure efficiency in the use of resources. Primary health care covers a holistic view of health that is tackled through a broad whole-of-society approach (World health summary, 2008).

Today, health situation in even the most developed countries, are not meeting the objectives of the primary healthcare. Although incredible improvements have been achieved, people worldwide have still not adequately met their health needs with the existing health systems. (World Health summary, 2008).

## 2.7 Conceptual Framework for the Study

The study took in to considerations the location of healthcare facilities, private and government facilities, as well as the network data set from the network representation of the study area, specifying connectivity rules and attributes required for the network dataset. Connectivity is about defining how the different element of analysis should connect with the network when modeling the network dataset. With the usage of three distinct spatial analyses tools that includes network Voronoi diagram, network analyst and network centrality indices. The healthcare facilities accessibility levels within the network are identified.

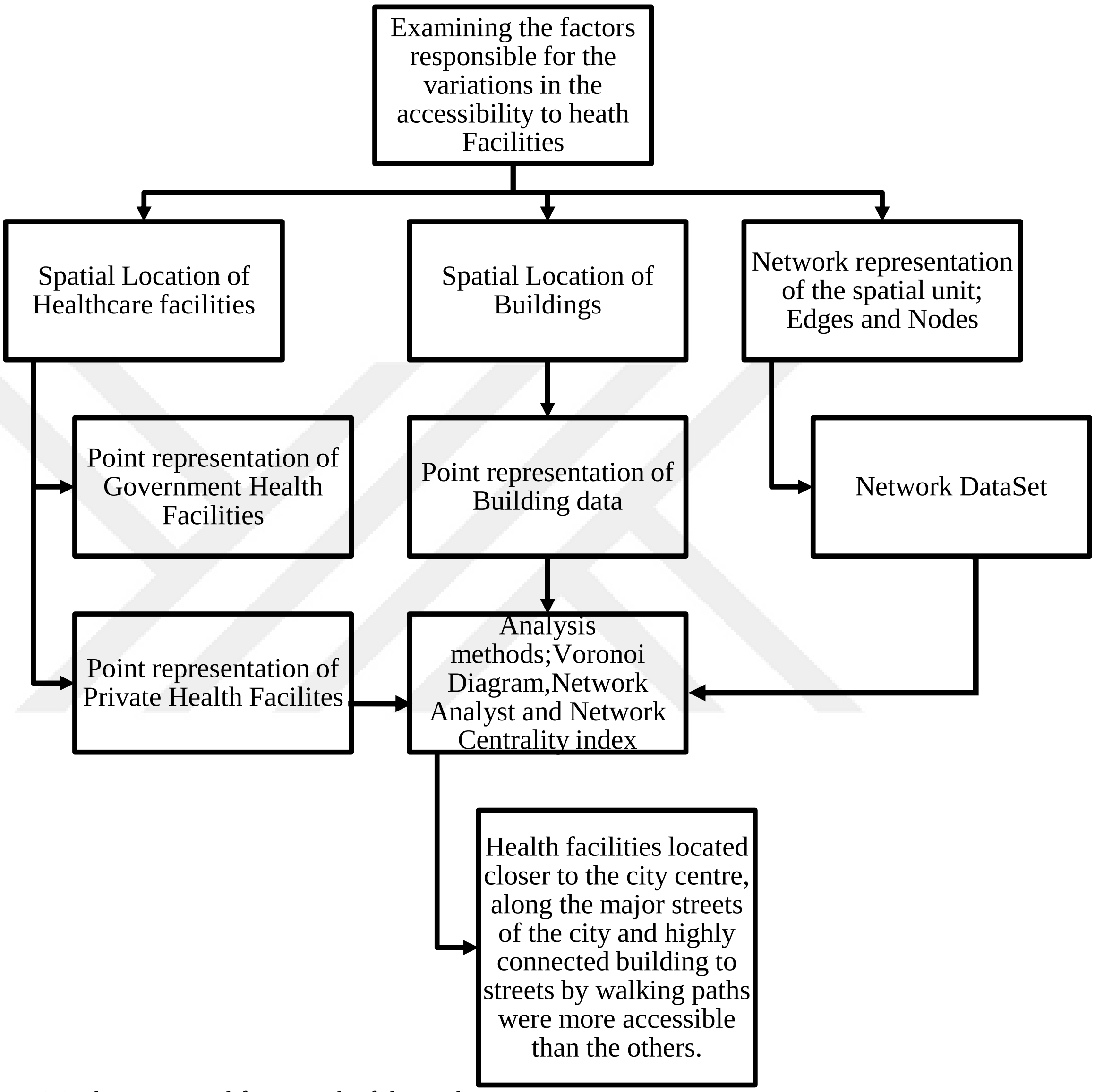



Figure 2.3 The conceptual framework of the study

## 2.8 General Conclusions Derived from the Literature Review

The review of literature outlines several important factors that either enforces or enhances accessibility to health care facilities. In summary of the reviewed literature on the themes of accessibility, accessibility measures, urban health accessibility, urban spatial structure and its representation and location allocations, demonstrates that health accessibility related researches concentrate more on the socio-economic factors and geographical distance factors to the neglect of spatial configuration factors of the urban settlement. Spatial configuration in accessibility analysis is assessed by (Sevtsuk, 2010) where he seeks to find out if spatial configuration of the built environment affects location choices of retail and food service establishments. This research is centered on retail activities but not healthcare facilities. Sevtsuk (2010) concentrates on how the location of retails activity is affected by spatial configuration of the built environment. It gives an understanding of how different land-uses interacts with the built environment and how best variety of activities can be located in the built environment of which health related activities is not an exception.

The review also shows that data on mode such as biking and walking is so difficult to come by or to measure as a result the over dependence on automobile accessibility (Litman, 2016). The importance of using GIS spatial analysis tools in revealing different urban accessibility level is also emphasize by ( Handy & Clifton, 2001; Handy & Niemeir, 1997; Mclafferty, 2003)

This research therefore seeks to use spatial analysis tools to investigate what factors of the spatial unit accounts for the variation in accessibility levels to healthcare facilities. This will enable urban planners to have an idea as where to relocate healthcare facilities in a given built environment that will optimally serve a greater part of the population.

# CHAPTER THREE

# BACKGROUND OF STUDY AREA AND DATA

This chapter entails a brief background of the study area which is the Tamale metropolitan assembly in Ghana. The chapter also contains a description of the data used for undertaking the research. Thus the data sources and data collection techniques applied are presented. Data collection comes with a lot of difficulties because in most developing countries like Ghana, either lacks or have inadequate database for most government and non-governmental organizations. This made the study to take a longer time than expected, since the data has to be reorganized severally to suit the research requirements.

## 3.1 Profile of Tamale Metropolitan area

Tamale metropolitan assembly is found by a legislative instrument (L.I. 2068). Presently it is one of the six metropolitan assemblies in Ghana and the only metropolitan area in the three regions of Northern Ghana, which include: Upper East, Upper West and Northern regions. A metropolitan assembly is defined as a local government administrative unit with a population of 250,000 or more. A municipal assembly is a town assembly with a population of more than 95,000. Finally a district assembly is a group of communities with a population of less than 75,000 and a maximum of 95,000 (District Assemblies in Ghana, 2017). Tamale is the biggest city in the northern region and functions as both the district and regional capital.

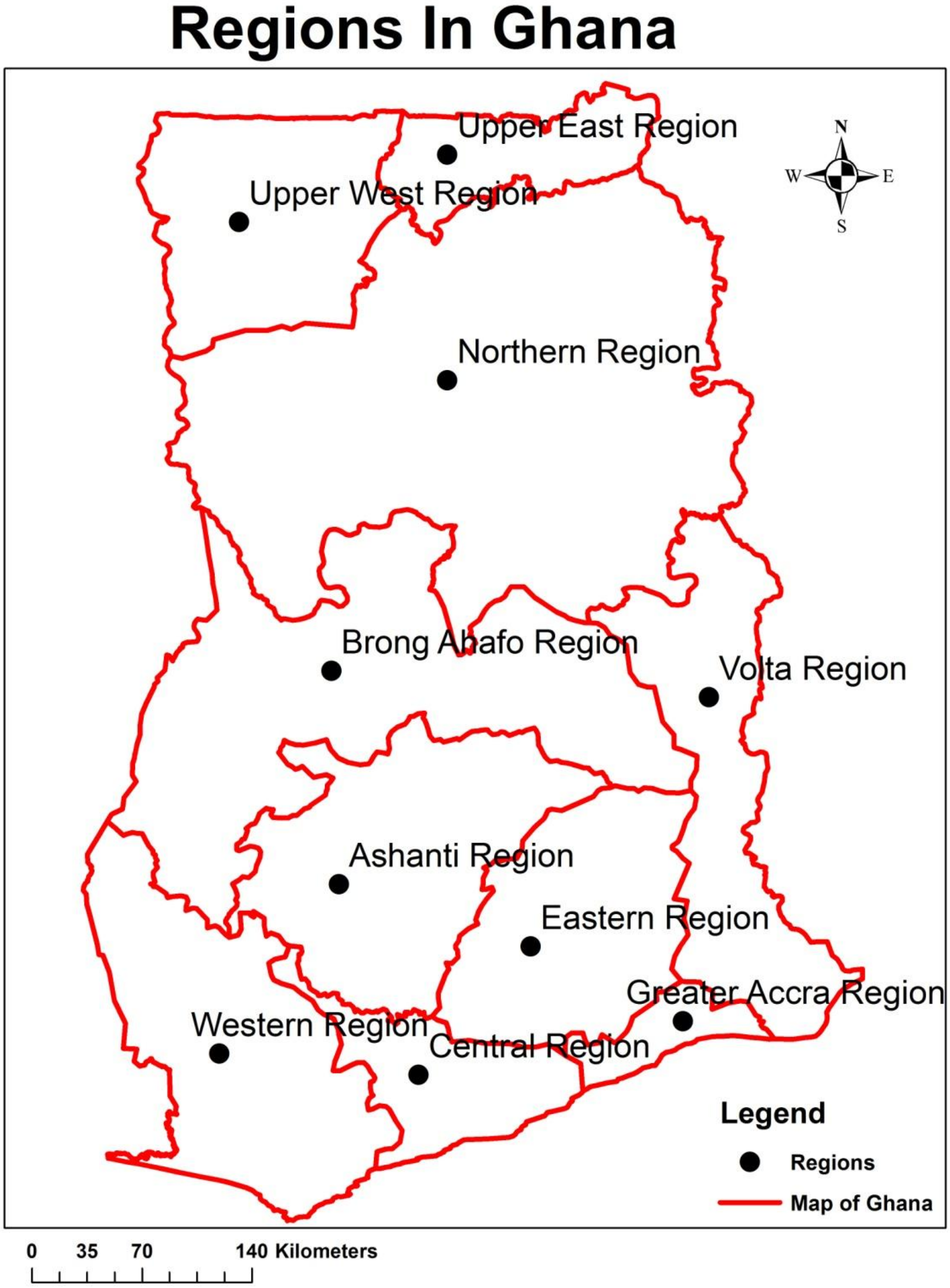



Figure 3.1 Map of Ghana locating regional divisions

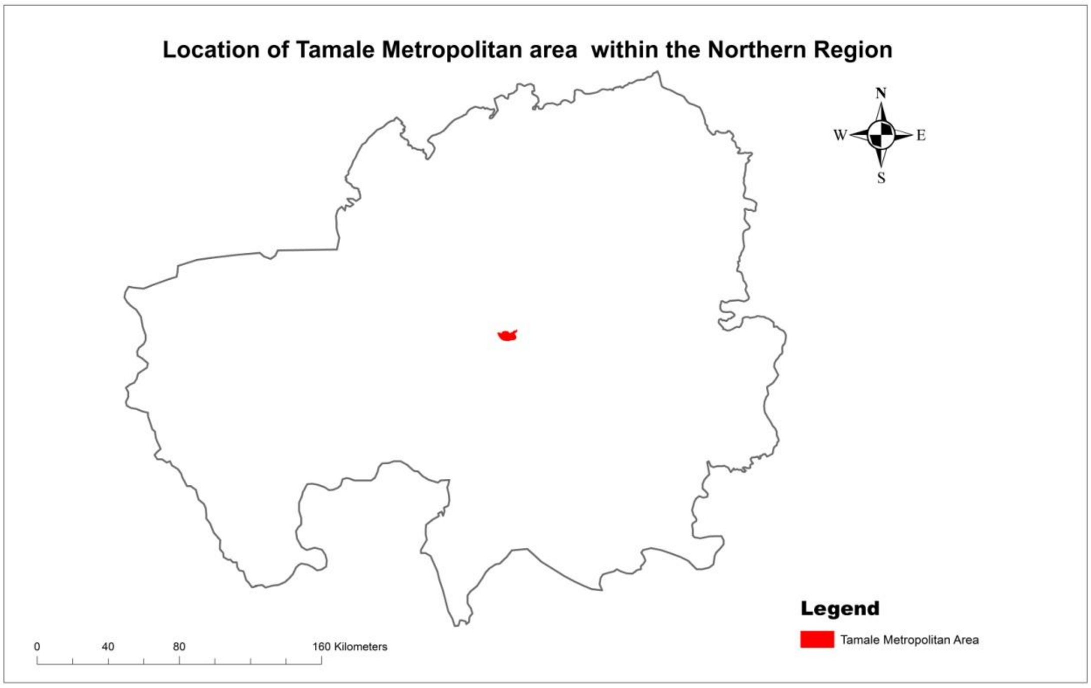



Figure 3.2 Location of Tamale Metropolitan area within the Northern Region

From the map presented in figure 3.1 of the regions in Ghana, it is clear that the Northern region, where the study area is located have the largest land area.

### *3.1.1 Location and Size*

Tamale Metropolitan area is one of the twenty six (26) administrative and political districts, located in the Northern Region of Ghana. Tamale metropolitan areas is centrally situated in the region which shares boundaries with Sagnarigu district (newly created district from Tamale metropolitan area) to the North-West, Mion District to the East, East Gonja to the South and Central Gonja to the South West. Tamale is centrally located in the Northern Region and this makes the metropolitan area serves as a potential market for local goods from agricultural and commercial sectors of the other districts in the region and the southern part of Ghana. It has a surface area of 1011 sq. km. which represents about 13% of the total land area of the Northern Region. Its population density stands at 263 persons per sq. km. (Tamale Metropolitan Planning unit, 2016).

### *3.1.2 Demographic Features*

History has it that the Northern Regions of the Ghana has a vast land size with a small population sizes. The study area began observing high population growth after migrants from other areas came to settle in the Tamale metropolitan area. The metropolitan area currently has a total population of 593,477 according to the (Tamale metropolitan health directorate, 2016). The Tamale metropolitan area is the only district in the Northern region which is typically urban. This implies that the metropolitan area serves as a growth pole for the region attracting both population and economic development in the area. It also has a potential for labour force (skilled and unskilled) for industries. The population age structure of a country with a high fertility such as Ghana is mostly shaped by the effect of mortality. As it is same with the metropolitan area, the population age structures portray a broad base that gradually diminishes with increasing age due to death. The youthfulness of the Tamale metropolitan area's population gives a high potential for human resource development to enhance social economic and political development.

Table 3.1 Population Size

| Indicators | 2010 | 2011 | 2012 | 2013 | 2016 |
|---|---|---|---|---|---|
| Size | 223,252 | 293,881 | 371,357 | 414,584 | 593,477 |

Source: 2010 PHCR

The table 3.1 above gives a description of how the population of the metropolitan area experienced population increase from the year 2010 to 2016.

The age dependency ratio for the Tamale metropolitan area is about 70 dependents for every 100 working population. This means that 1 economic active person has 0.7 dependents (1:0.7).

People in the metropolitan area migrate because of different reasons that include social, economic and other factors. Migrant population of the Tamale metropolitan area stands at 20,321. Ashanti region recorded the highest number of migrants in Tamale metropolitan assembly area with a total migrant of 3,271, followed by the

Upper East and Brong Ahafo regions with migrant populations of 3,114 and 1,848 respectively. The regions that recorded lowest numbers of migrants in the Tamale metropolitan area is the Western and Central with a migrant populations of 505 and 650 respectively.

Majority of the population in Tamale Metropolitan area are Muslims (90.5%), followed by Christians (8.8%) and about (0.2%) are affiliated to other religions. For the total population age 11 years and older, about (42.6%) of them are literate in English whiles (54.8%) of the population are literate in English and other Ghanaian languages. The Tamale metropolitan area has an economically active population of (63.3%) out of the total population. The occupation of populations in the Metropolitan area include service and sales which represents (33.0%) of the working population, craft and related trades workers (21.5), skilled agriculture, forestry and fishery is (17.6%).In almost all the occupations males are more than females except in service and sales where (16.5%) males and (50.3%) females are in to service and sales.

### *3.1.3 Age specific death rates*

Age specific death rates are computed for specific age and sex groups to enable the comparison of mortality rate at different ages over time. Figure 3.3 shows the death rate of the population by sex in the metropolis. The figure shows that from ages 0-14 years, deaths for both males and females falls and starts rising thereafter. The high deaths for females within the child bearing age can be attributed to maternal mortality since this occurs within the reproductive ages of females (Tamale Metropolitan Planning unit, 2016).

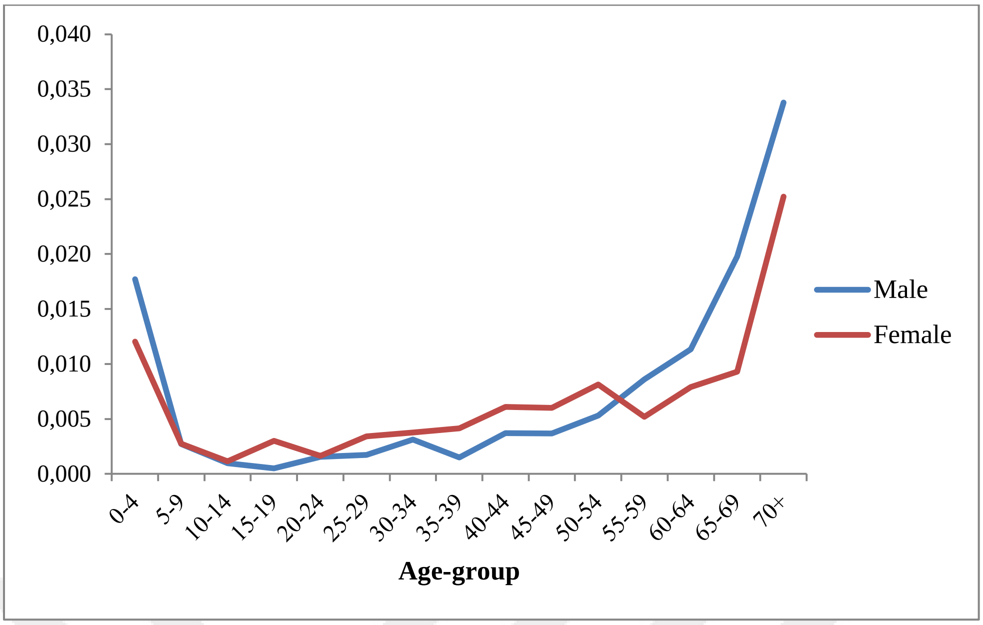



Figure 3.3 Reported age specific death rates by sex (GSS,2010)

### *3.1.4 Tamale Metropolitan Health Administration*

The metropolitan health management team (MHMT) is the body assigned the duty of ensuring that monitoring, planning, supervision, evaluating, training activities are carried out as expected and the co-coordinating of all health programmes in the Metropolitan area. It is also responsible for initiating researches and linking up with other agencies and Non- governmental organizations in health provision. Under the healthcare division, the Tamale metropolitan area is sub-demarcated into four (4) sub-districts, each with a management team known as the sub-district health management team (SDHMT). The four sub-districts are: Bilpela, Nyohini, Tamale Central and Vittin. The SDHMTs is responsible for programme planning and implementation of health activities in their various sub-districts, including conducting integrated static and outreach activities such as immunization, reproductive health, disease control, growth monitoring, health education/promotion and clinical care, Training and supervision of community based health workers such as traditional birth attendants (TBAs), community based surveillance (CBS) volunteers, village health committees. Providing health services at the community level by sub-districts staff supported by TBAs, CBS volunteers (Tamale Metropolitan Planning unit, 2016).

## 3.2 Data

### *3.2.1 Research Design*

The design employed in carrying out this research is that of a case study. Case denotes a spatially delimited phenomenon (Gerring, 2007). Case study gives an in-depth understanding of the natural setting and recognizes its complexity (Punch, 1998). It is also considered as an intensive study of a single case or observation where the main purpose is to shed light on a larger class of cases namely the population (Gerring, 2007). It is argue that in-depth knowledge of an individual phenomenon is more helpful than brief knowledge about a larger number of phenomena (Gerring, 2007).

### *3.2.2 Sources of Data*

Sources of data are either primary or secondary. Primary source are the data that are directly obtained from the respondents such as a survey, interview or focus group discussions. Secondary data sources involve using reading existing observations for research purposes.

The study mainly made used of secondary data since almost all data was from existing sources including ArcGIS online sources, Tamale metropolitan planning unit and health directorate of Tamale metropolitan area. The following data are collated from secondary sources; the profile of the study, health facilities names, facility types, facility ownership, facility location/ community, sub-district and their respective population, Tamale metropolitan map that has the spatial demarcation of the study area and the spatial location of healthcare facilities.

### *3.2.3 Techniques for Data Collection*

A list of the required data in an introductory letter was submitted to the Tamale metropolitan health directorate. The list included: the spatial distribution of health facilities, hierarchy of health facilities, type and ownership of health facilities, sub-district demarcation, and age group population of each sub-district.

Spatial boundary of the study area, spatial location of both private and government healthcare facilities, network presentation of study area and building data are all derived online through the World imagery base map of Arc Map. The spatial boundary and the location of four healthcare facilities were initially obtained in a PDF map format from the health directorate of Tamale metropolitan Assembly. The PDF map data was inadequate, and moreover a digital form of the data was needed. For this reason the file was geo referenced in Arc map and the necessary data extracted. The pdf map data was inadequate because it did not contain the location of all healthcare facilities within the Tamale metropolitan area.

### *3.2.4 Health Facility's Distribution*

Table 3.2 Health Facility's Distribution

| | | | | |
|---|---|---|---|---|
| Sub-District | Health Facility Name | Facility Type | Facility Ownership | Location |
| Bilpeila | Hajj Adams Clinic | Health Center | Private | Baya wire |
| | Bilpeila Health Centre | Health Centre | Government | Bilpeila |
| | God First Maternity Home | Midwife / Maternity | Private | Kpanvo |
| Nyohini | Nyohini Health Centre | Health Centre | Government | Nyohini |

Table 3.3 Health Facility's Distribution Con't

| | | | | |
|---|---|---|---|---|
| Tamale Central | Police Clinic | Clinic | Government | Regional Police Head Quarters |
| | Tamale West Hospital | District Hospital | Government | Zogbeli |
| | Tamale Central Health Centre | Health Centre | Government | Opposite NIB Bank |
| | Tamale Central Hospital | Hospital | Government | Near Police Barracks |
| | SDA Hospital | Chag | Private | Nim Avenue |
| | Rabito Clinic | Clinic | Private | Tamale Post Office |
| | Tamale Central Prisons Clinic | Clinic | Government | Prisons yard |
| | Nutrition Rehab Centre | Rehab. Centre | Government | Nim Avenue |
| | Moshie Zongo Health Centre | Health Centre | Government | Moshie Zongo |
| Vittin | Vitting Health Centre | Health Centre | Government | Vitting |
| | Newlife Clinic | Clinic | Private | Kukuo |
| | Kabsad Scientific Hospital | Hospital | Private | Nim Avenue |
| | Tamale Teaching Hospital | Hospital | Government | Kukuo |

The data from the district health directorate shows that the metropolitan area has 28 healthcare facilities, which include nine private facilities and nineteen government facilities. Due to data limitation the entire Tamale metropolitan area could not be captured in the study. The study is limited to 11 public and 6 private healthcare facilities. Out of the 11 public healthcare facilities three are hospitals, five are health centers and three are clinics. And the private has two hospitals, no health center and four clinics.

Table 3.4 Ownership Hierarchy Matrixes of Health Facilities

| Ownerships/Hierarchy | Government | Private |
|---|---|---|
| 1st Level of Hierarchy | Police Clinic | Rabito Clinic |
| | Tamale Central Prisons Clinic | Newlife Clinic |
| | | Hajj Adams Clinic |
| | | God First Maternity Home |
| 2nd Level of Hierarchy | Bilpeila Health Centre | |
| | Nyohini Health Centre | |
| | Tamale Central Health Centre | |
| | Moshie Zongo Health Centre | |
| | Vitting Health Centre | |
| | Nutrition Rehab Centre | |
| 3rd level of Hierarchy | Tamale West Hospital | Kabsad Scientific Hospital |
| | Tamale Central Hospital | SDA Hospital |
| | Tamale Teaching Hospital | |

The table 3.3 is description of the targeted health facilities according to ownership and hierarchy.

Pertaining hierarchy of the healthcare facilities, the idea of hierarchical classification is based on the primary health ideology of health care. In this study, first level of hierarchy of facilities are considered to be the community based health centers, second level of hierarchy as the health centers, which are often the first referral place from the first hierarchy. Finally the third level of hierarchy as the district hospitals, where tertiary services are provided. Specifically, clinics are considered as the first level of hierarchy, health centre as the second level of hierarchy and hospitals as the third level of hierarchy. Private facilities had no second hierarchy of health facilities.

### *3.2.5 Graph Representation*

Previously, Plans which are the main representations of the built up environment of an urban area brought forth a lot of challenges because it was inadequate for accessibility analysis. This led to the work of Sevtsuk (2013) where he argues that mostly plans are limited in illustrating the complex spatial interaction between different land uses of the built environment. The author further highlights that in addressing the limitation encountered in using plan representations of the spatial units, urban planner have to use network-based model.

The spatial configuration of a built environment can be described through multiple forms of representations, including architectural drawings, images, mathematical, textual, graph and other forms of depictions (Sevtsuk, 2010). For a more explicit and detailed representation of the built environment, graph theory have mostly being used (Keijo Ruohonen , 2013). Conceptually, a graph is formed by vertices and edges connecting the vertices. The usefulness of graph theory cannot be under estimated.

Graphical representations of the spatial configuration of an area allow the description of the geometric relationship between various elements of the build environment in a quantitative manner (Sevtsuk, 2010). Graph representation further enables the usage of computer to calculate meaningful indices for accessibility analysis. Spatial analysis using centrality indices and information enabled the unique virtualization and characteristics of a city structure (Crucitti et al., 2006).

This study aims to represent the buildup environment using the graph theory, where the streets are represented as edges or links, the nodes as the intersection of the links. Buildings of health facilities are represented as points. Formerly most network analysis is limited to links and nodes in their analyses of network without the inclusion of buildings, which are often the major spatial unit of concern. Therefore a third feature which is the buildings has recently been introduced to network based analysis. The Urban Network Analysis tools include a third type of network elements - *buildings*- that are used as the spatial units of analysis for all measures, (Sevtsuk et al 2013).

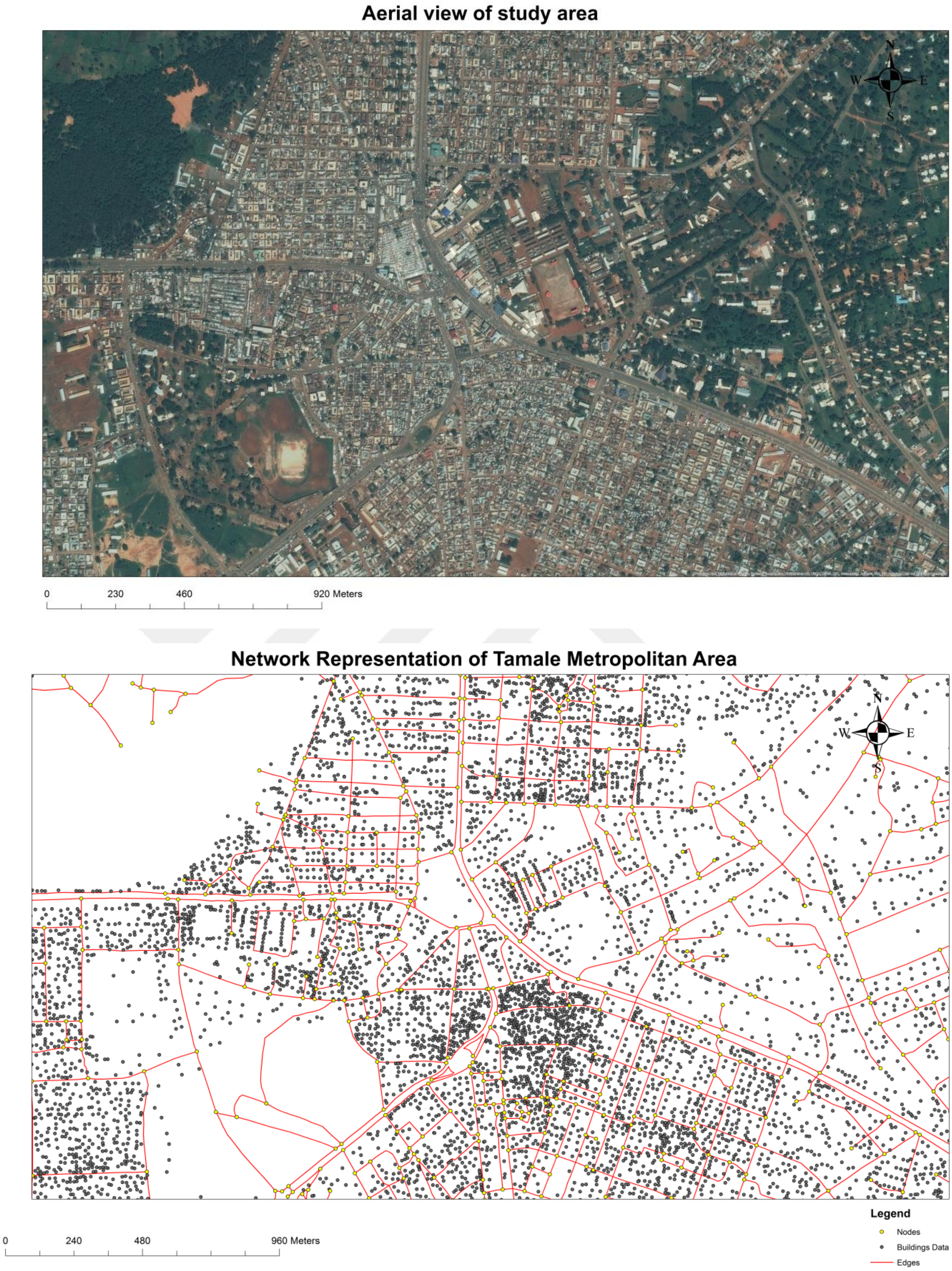



Figure 3.4 Arial photograph of the built environment and Graph representation

The aerial photograph in Figure 3.4 gives a pictorial view of the settlements which do not adequately give a description of the spatial interaction between elements of the study area. Next is the graph theory based network representation of the study area depicting how the streets which are represented as edges and the nodes as the intersections of the edges altogether inter-relates with buildings to affect the accessibility or inaccessibility of destinations.

### *3.2.6 Data Compilation of Study Place*

A PDF file obtained from the Tamale metropolitan health directorate had to be geo-referenced into Arc Map, from which the spatial boundary of the study area is digitized. The PDF map file had the location of four out of 28 healthcare facilities. For this reason Open Street base map as well as World imagery base map where the other healthcare facilities location is found was used to locate the entire healthcare facilities found in the study area. The specific locations of the health facilities are represented as points. The streets network of the study area is digitized into edges and nodes using Arc map. The building locations is  represented as points in this study due to lack of building data from the Tamale Municipal area database, and as well as time constrains of digitizing each building shape in a polygon form .

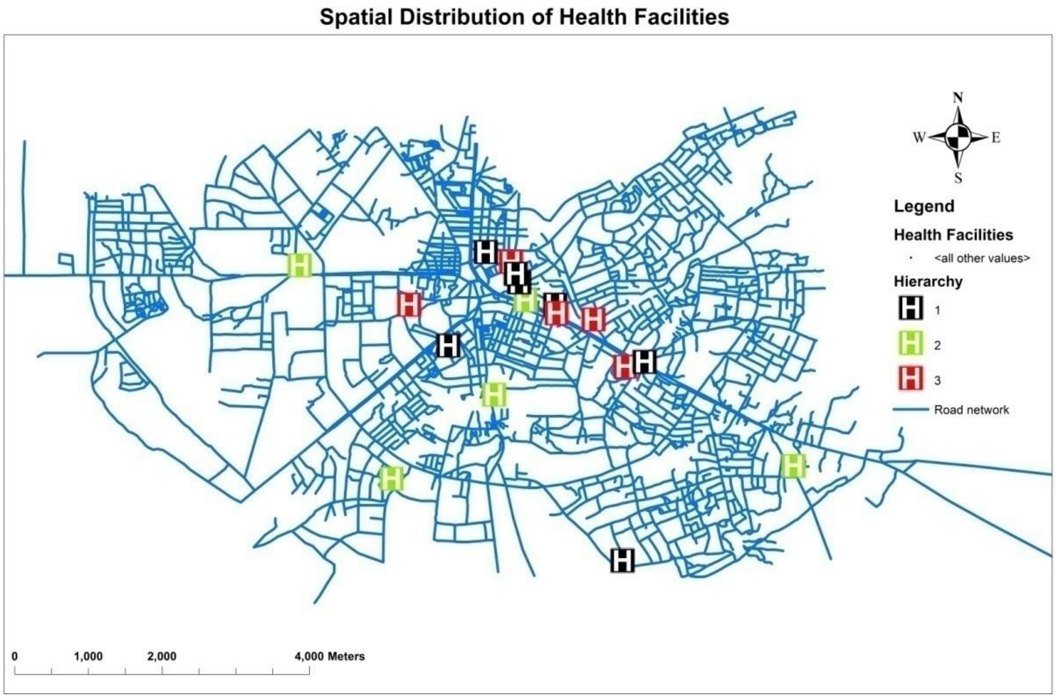



Figure 3.5 Spatial Distributions of Healthcare Facilities.

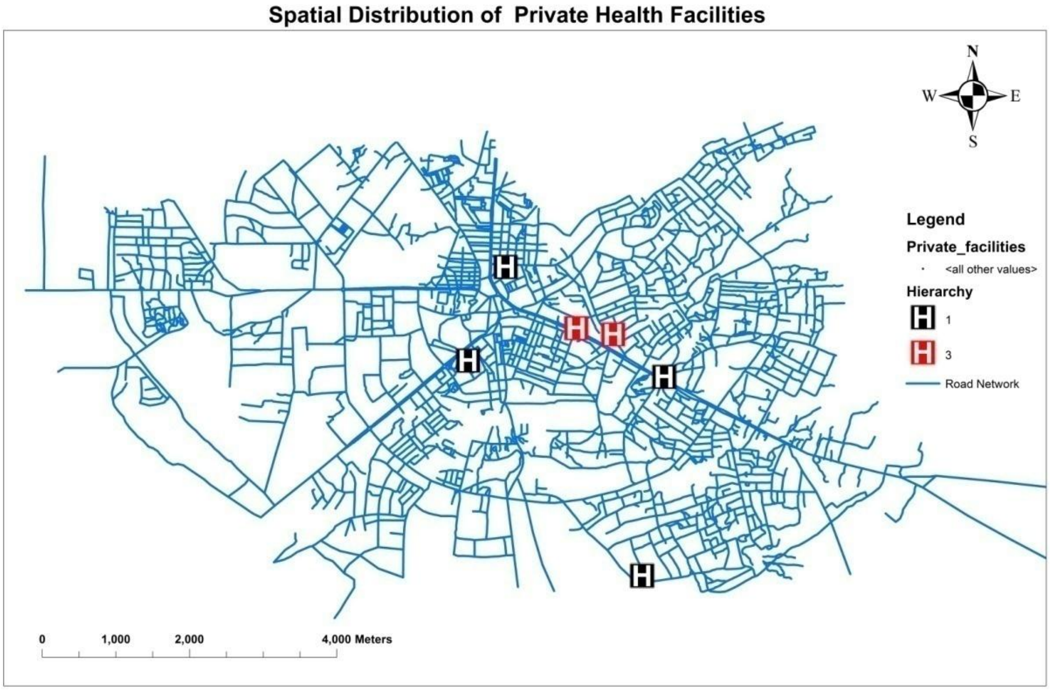



Figure 3.6 Spatial Distributions of Private Health Facilities

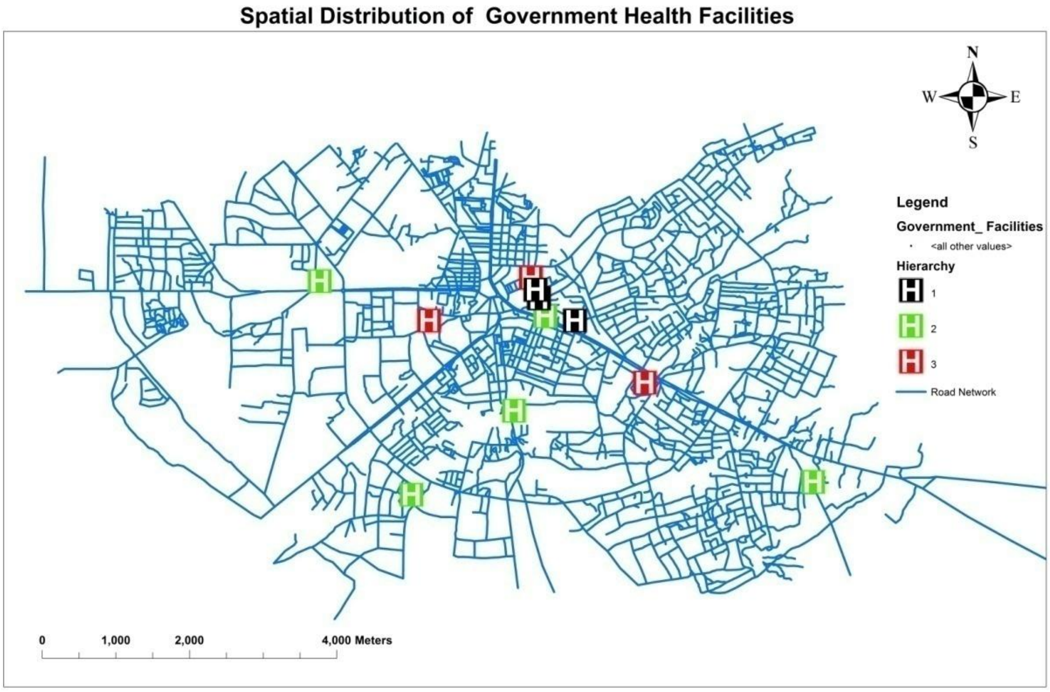



Figure 3.7 Spatial Distributions of Government Health Facilities

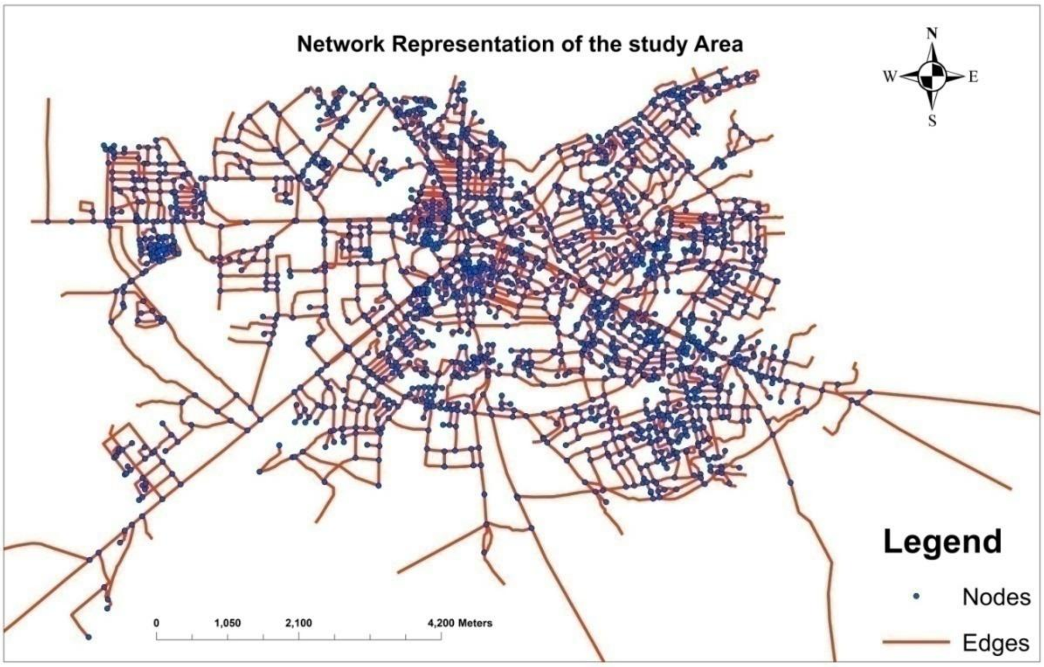



Figure 3.8 Network presentation of Tamale Metropolitan Assembly

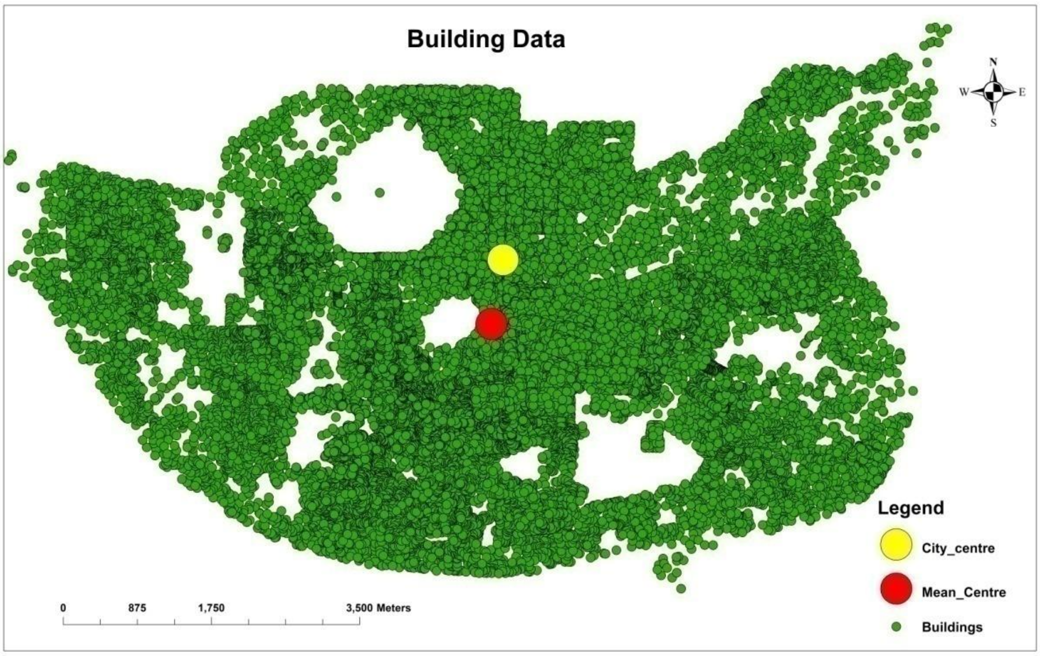



Figure 3.9 Building Data of Tamale Metropolitan Assembly

The above is the representation of buildings as points. The data can be said to be a true representation of the study area because the actual centre of the city as shown in the map with yellow circle and the mean centre of building as represented with the red circle are very close to each other.

### *3.3.7 Government/Private Ownership of Health Facilities*

The digitized healthcare facilities are represented by point and further categorized based on ownership. Ownership classification is either private or government healthcare facility. The study is limited to 17 healthcare facilities, out of which six (6) healthcare facilities are privately own either by an individual, group of individual or religious bodies. Private healthcare facilities mode of management and how service is delivered to residents varies across. Government health facilities on the other hand are those healthcare facilities own by the public. The healthcare system care in Ghana is based on the primary health system upon, which the 11 government healthcare facilities are operated.

# CHAPTER FOUR
# ANALYSIS AND RESULTS

This chapter gives a clear understanding of the data analysis techniques, tools and methods used for analyzing the data described in the preceding chapter and finally present the results of the executed analysis. A good number of methods are adopted for this study and one among them is the spatial analysis of events that are found along-network of a spatial unit. From the review of literature of spatial analysis along network, it is revealed that there are two forms of this kind of spatial analysis. That is an analysis of events that occurs on the network, example of this event is road accidents. The other is the analysis of events that occurs along the network, this include for instance the location of facilities such as beauty solons, student hostels, restaurant, schools and hospitals that are often located along streets (Okabe and Sugihar, 2012). This study focuses on the analysis of events that are along network thus the locations of healthcare facilities along the road network of Tamale metropolitan assembly area. Another method used is the network analyst tool that estimated the closest buildings to healthcare facilities and service areas, and the last method is the graph-theory network centrality indices tool.

## 4.1 Spatial Analysis along the Network

From our day to day activities we realize that a great number of events we encounter are mostly affected by networks, such as car accidents on the streets, location of restaurants, salons shops, super markets and grocery alongside streets. These are called network-constrained events Yamada and Thill (2007) cited in (Okabe and Sugihara, 2012). The authors argue that originally planar spatial analysis is supposed to analyze events on a plane. The inappropriateness of the planar spatial methods in analyzing event along network made Okabe and Sugihara (2012), to come out with spatial analysis along network that takes into consideration events on and alongside a network. This method uses distance as a variable and considers shortest-path distance in analyzing either event on or along the network.

The literature also found out that it is easy to calculate the Euclidean distance of a plane than shortest distance of a network, the difficulty of computing the shortest distance has however being reduced due to the usage of geographical information systems (GIS) that makes it easy to manage network data and to calculate shortest-paths (Okabe and Sugihara, 2012).

#### *4.1.1 Events along Network*

In analyzing events along the network, Okabe et al. (2008), determine the service areas of parking lots in Kyoto using the Voronoi diagram on a network. Using events along network method for example again, Myint (2008) examines schools, banks, churches and restaurants distributions in Norman City, Oklahoma. Sevtsuk (2010), similarly applied this method in understanding how retail and food establishments in two communities of Massachusetts is distributed. He argues that most service areas of facilities are responsive to network design.

#### *4.1.2 Event on network*

There exists literatures about on-the network spatial analysis executed many years ago, notable among them is that of (Snow, 1855). The history of scientific quantitative network spatial analysis can be traced from John Snow’s study that was undertaken centuries ago (Snow, 1855). John Snow’s cholera map was called a diagram of the topography on the outbreak of cholera. Snow (1855) illustrates the severe outbreaks of cholera that occurred around Broad Street and Golden Square in London in the mid-nineteenth century. To locate the source of the infections, Snow (1855), demarcated the area where a Broad street pump is the closest pump among 13 water pumps around the area concerned with regards to shortest-path distances along streets. After identifying that almost all the victims of the cholera outbreak are found in the demarcated area, the author concluded that the cause of the victims’ illness is as a result of the contamination of the water from the Broad Street pump. This is also because all the deaths that occurred were living within a shortest distance to the pump. Snow called the demarcated area as the cholera area (Snow, 1855). In recent days, the area is a Voronoi sub-network of the network Voronoi diagram (Okabe et al., 2000).

### *4.1.3 Application of the Voronoi Diagram in Estimating Catchment Area of Healthcare Facilities*

Network spatial analysis uses shortest path distance on networks which needs heavy geometrical and topological computation. Spatial analysis along network (SANET) toolbox plugged in of GIS makes it easy to perform network spatial analysis with detailed data such as point representation of location on or along a network.

Requirement to execute a Voronoi diagram;

- ✓ Spatial analysis along network toolbox extension is required in Arc map to enable the execution. An application form for the request of the key for activation is filled and sent to the SANET GROUP. The key for activation is sent through email.
- ✓ In order to present the data to suit spatial network analyses along or on a network the network representation of the study area is subjected to connectivity. Thus specifying how the network dataset should connect with the other elements of analysis.
- ✓ The SANET tool has twelfth different sub-division for different purpose of analysis. One of the sub-division in the list tools is the Voronoi diagram tool. This tool is opened and the connected network shape file is loaded as well as the generators which are the location of the healthcare facilities. The result is the generated Voronoi diagram for each generator. As depicted in figure 4.1

Network Voronoi diagrams, are use to estimate the catchment area of a service facility. For a given set of generators for instance a number of service facilities are represented by points in a given network of streets. A sub network is generated for each point using the shortest distance to each generator. Shortest distance is shortest possible path from one destination to the other. In this study, the catchment area of the healthcare facilities is estimated using the network Voronoi Diagram. Catchment area represents the service area each healthcare facility serves with a given settlement. The healthcare facilities which serve as the generators are represented as points in the digitized network of the study area. Using shortest distance a sub network is generated for each healthcare facility explicitly showing the possible catchment area. The spatial joint analysis tool is further used to assign buildings to the generated catchment network for each health facilities. The analysis is done separately for the government and private facilities.  The Dbf file of each analysis is open in Micro soft excel and using the pivot table to appropriately sort and analyze the result. This was further displayed in graphical forms. The following are therefore the analysis according to themes.

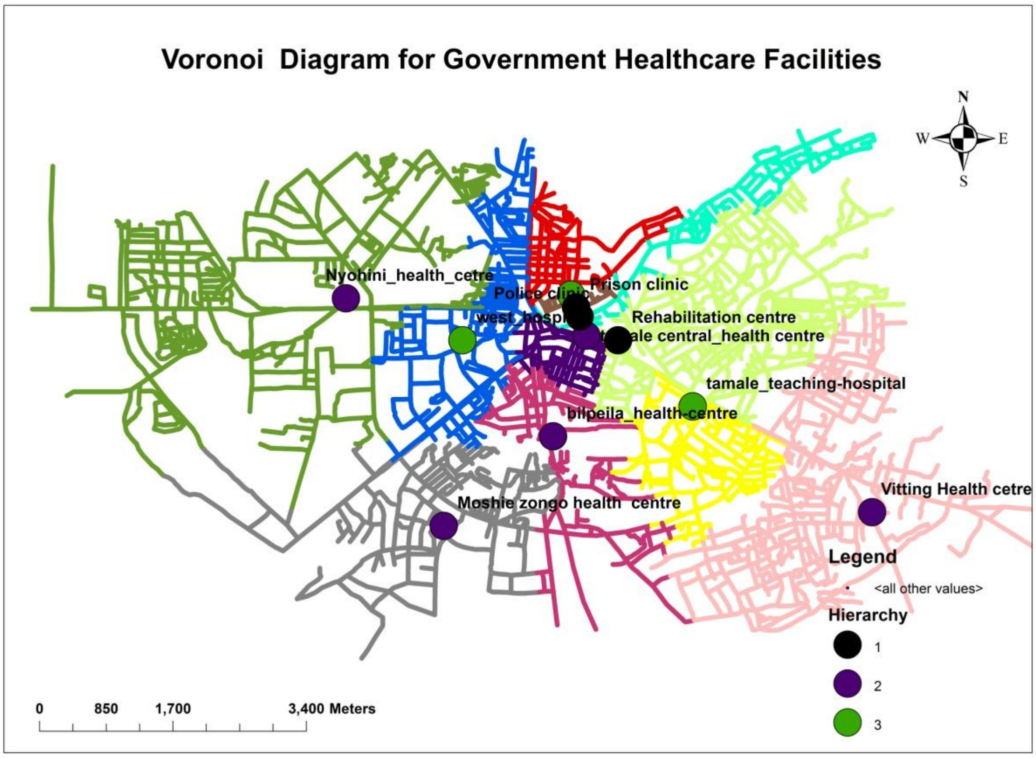



Figure 4.1 Voronoi diagram for government healthcare facilities

From figure 4.1, the different colors of the small circles represent the hierarchy of government healthcare facilities and the different colors of sub networks represent the limits of the catchment area of each health care facility.

### *4.1.4 Catchment area of Government Health Facilities derived from the Voronoi diagram*

Figure 4.2, figure 4.3, figure 4.4, are graphs comparing catchment areas among government healthcare facilities according to hierarchy, from first to third hierarchy derived from the Voronoi diagram.

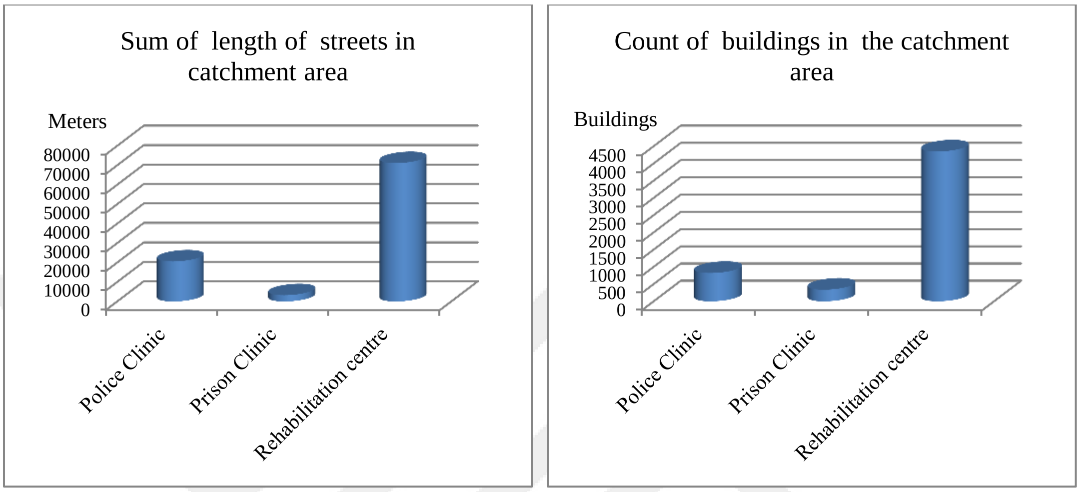



Figure 4.2 Sum of lengths of streets and count of buildings of government first hierarchy of health facilities derived from the Voronoi diagram

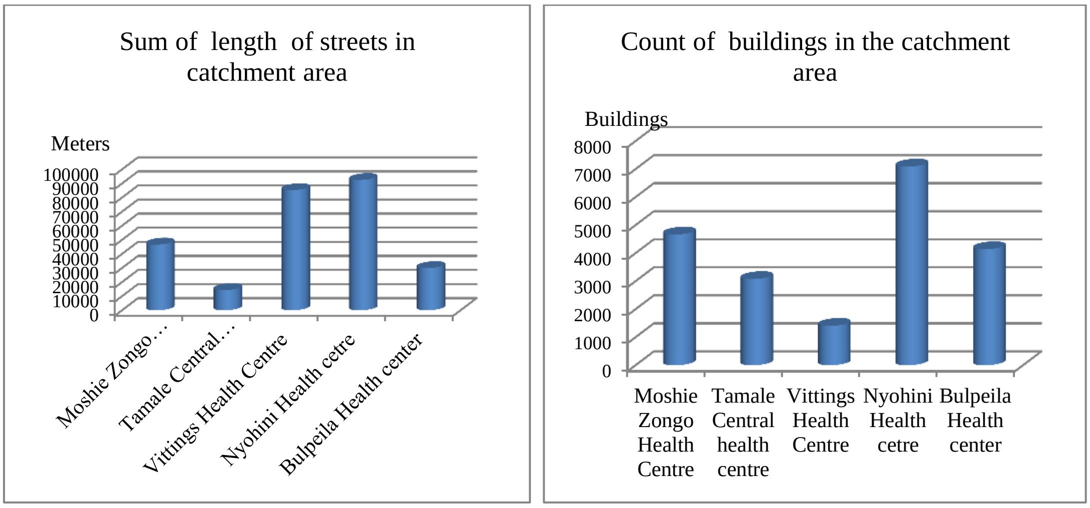
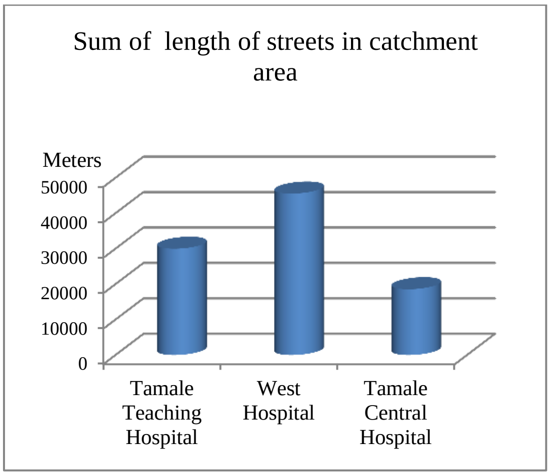



Figure 4.3 Sum of length of streets and count of buildings of government second hierarchy of health facilities derived from the Voronoi diagram



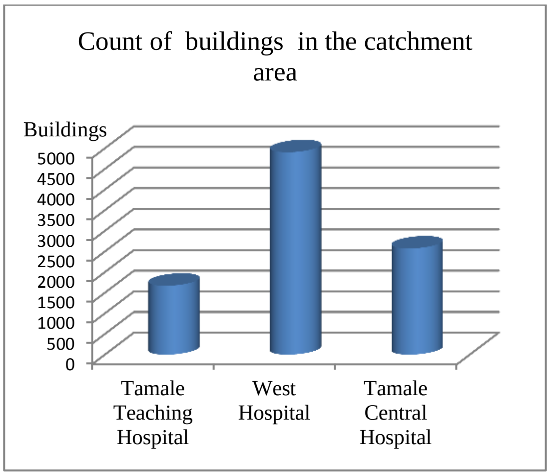




Figure 4.4 Sum of length of streets and count of building of government third hierarchy of health facilities derived from the Voronoi diagram

Results of the government healthcare facilities of the Voronoi diagram analysis, portrays from figure 4.2, that rehabilitation centre had the maximum count of buildings and sum of length of streets in its catchment area. Nyohani health centre had the highest count of buildings and sum of length of streets connecting the buildings in the catchment area as shown in figure 4.3. For figure 4.4, West Hospital among the other facilities of third hierarchy had the maximum count of buildings within its catchment area and the highest sum of length of streets connecting the facility in the catchment area.

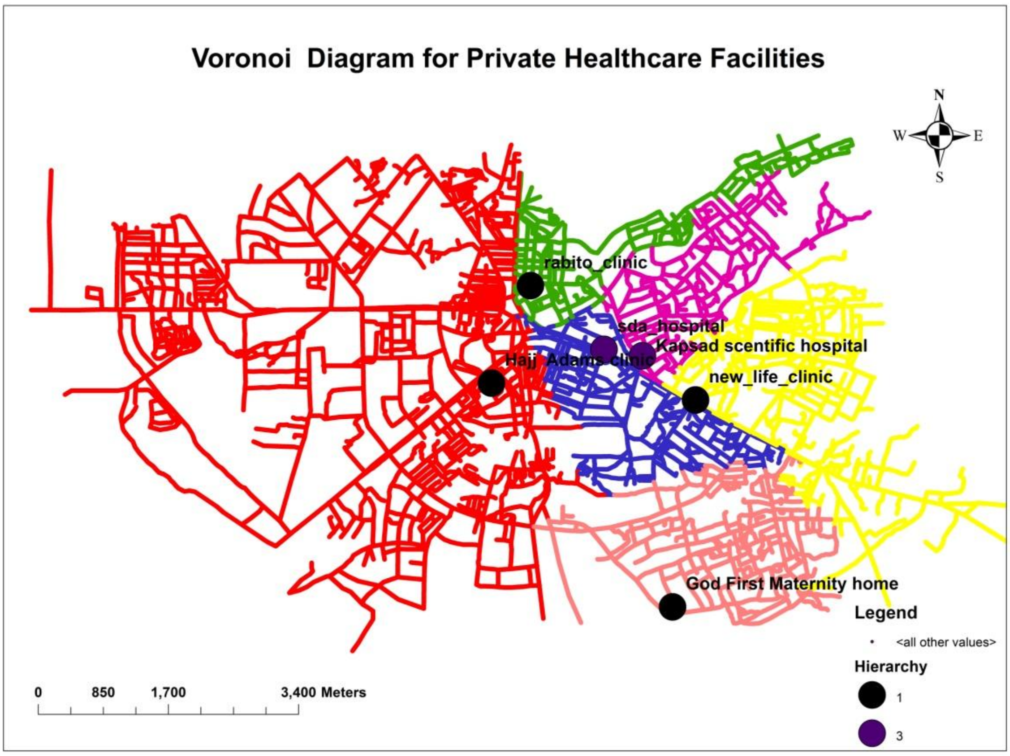



Figure 4.5 Voronoi Diagram for private healthcare facilities

### *4.1.5 Catchment Area of Private Health Facilities derived from the Voronoi Diagram*

Figure 4.6 and figure 4.7 includes graphs of catchment area among private facilities according to hierarchy.

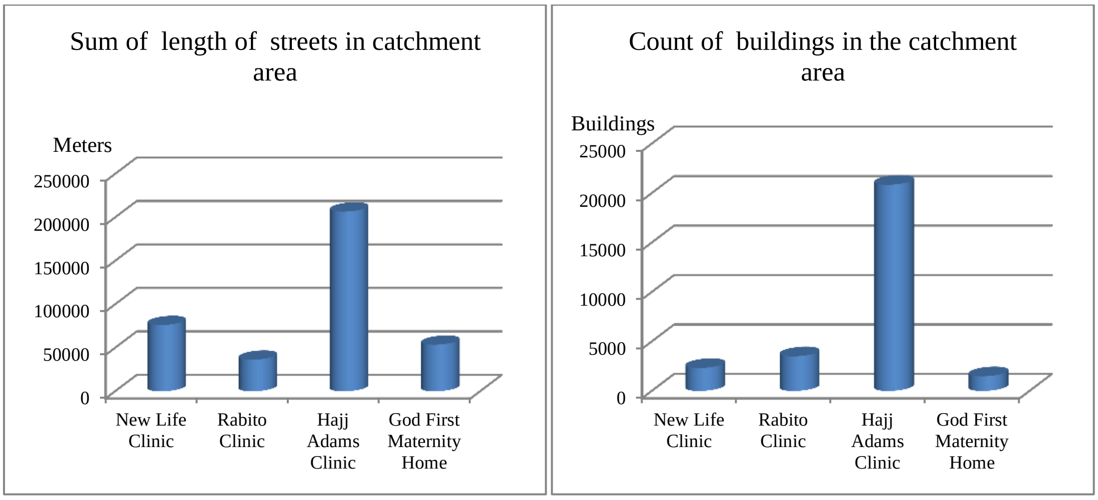



Figure 4.6 Sum of length of streets and count of building of private first hierarchy of health facilities derived from the Voronoi diagram

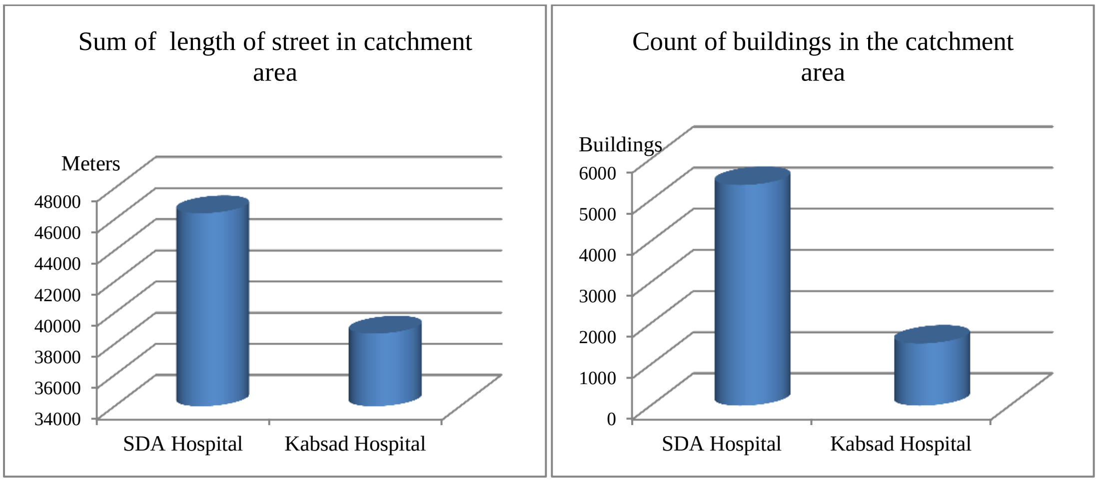



Figure 4.7 Sum of length of streets and count of building of private third hierarchy of health facilities derived from the Voronoi diagram

Result of the private healthcare facilities shows from figure 4.6, that Hajj Adam clinic has the highest sum of length of streets and count of buildings within its catchment area for the first hierarchy of facilities. Figure 4.7 shows that SDA Hospital has the maximum count of buildings within its catchment area and sum of length of streets connecting to the facility for the third hierarchy of Private healthcare facilities.

### *4.1.6 Catchment Area and Count of Building derived from the Voronoi Diagram according to Government and Private*

This entails the comparison of the total of sum of length of streets and count of buildings within the catchment area of each facility according to government and private and with regards to first and third hierarchy health facility.

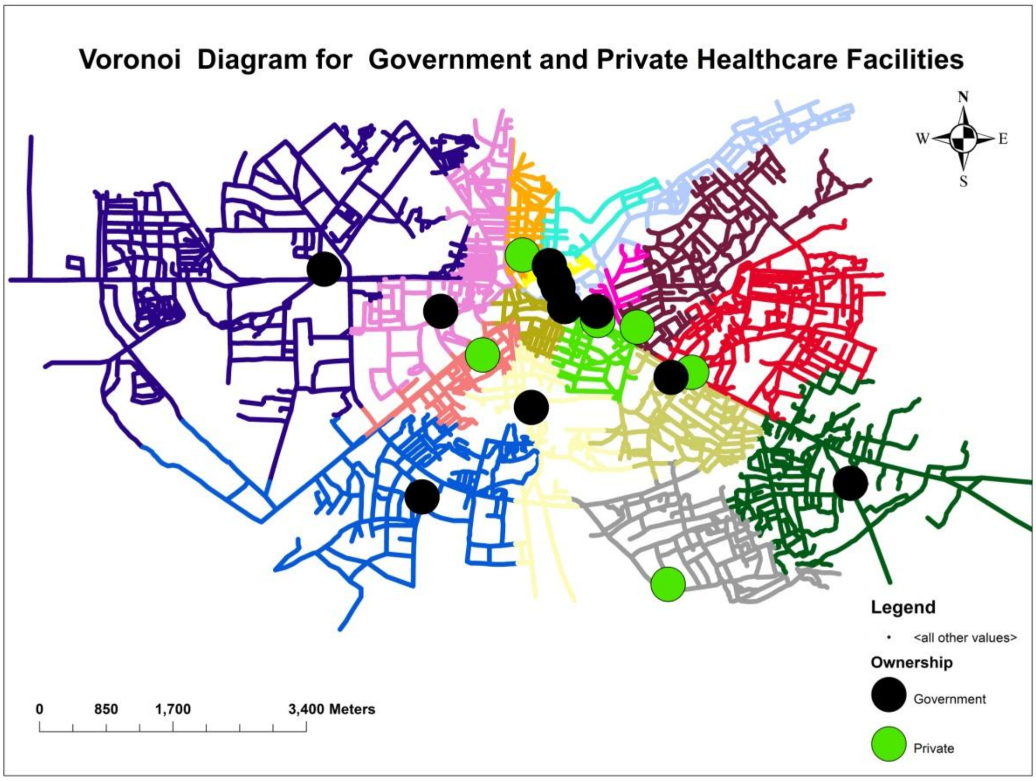



Figure 4.8 Voronoi diagram for government and private health facilities

Shown in figure 4.8, is the Voronoi diagram estimation of the catchment area for government and private healthcare facilities. This is further analyzed in to graphs comparing the catchment area of government and private healthcare as in the figure 4.9, 4.10 and 4.11

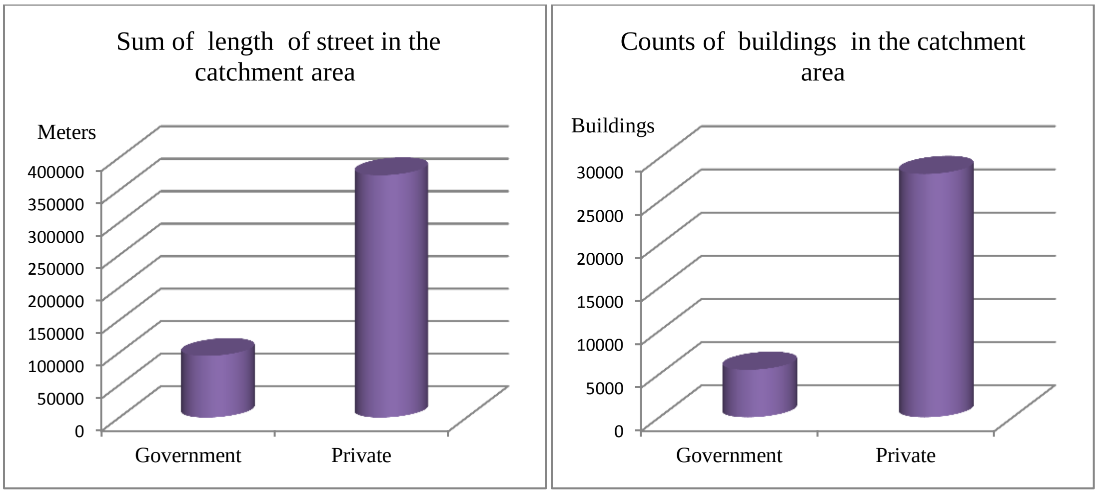



Figure 4.9 Sum of length and count of building of government/private facility under first hierarchy facilities derived from the Voronoi diagram

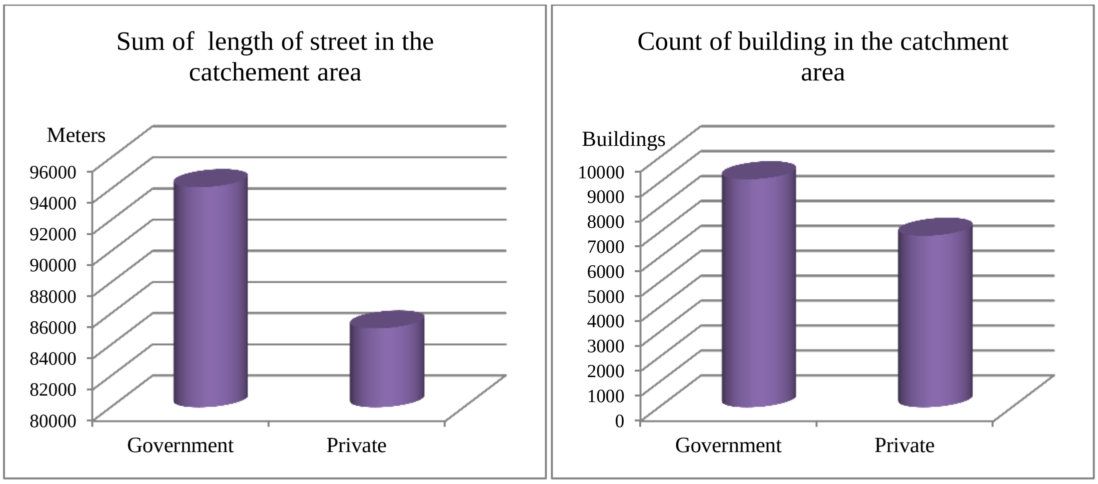



Figure 4.10 Sum of length and count of building of government and private facility under third hierarchy facilities derived from the Voronoi diagram

Figure 4.9 and Figure 4.10 which compares catchment area according to government and private shows that at the first hierarchy of healthcare, private facilities have the maximum sum of length and count of building than that of government and with the third hierarchy, government facilities has the maximum coverage of buildings than the private.

### *4.1.7 Sum of Length and Count of Building for Government and Private Health Facilities derived from the Voronoi Diagram*

The figure 4.11 entails the comparison of the total of sum of length of streets and the count of buildings within the catchment area of each facility according to government and private and not with regards to hierarchy.

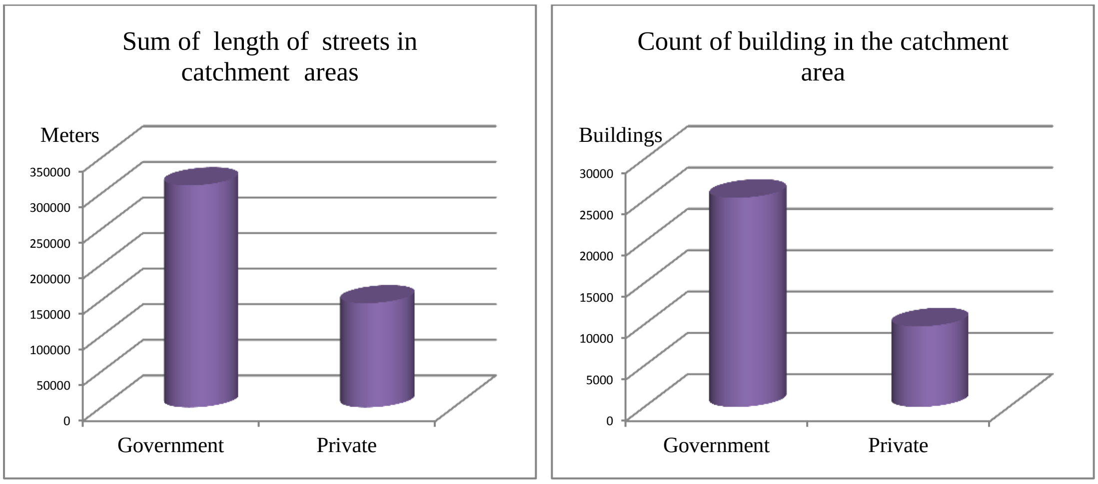



Figure 4.11 Sum of length and count of building of government and private facilities

Sum of length and count of buildings according to government and private as shown in figure 4.9 portrays that private healthcare facilities have a higher sum of length of streets and a higher count of buildings in the catchment area than that of government facilities for the first level of hierarchy. For the third level of hierarchy as shown in figure 4.10, government facilities have a higher sum of length of streets and a higher count of buildings in the catchment area than private healthcare facilities. Comparing government and private facilities according to count of buildings and sum of length of streets of the catchment area irrespective of hierarchy is shown in figure 4.11, depicts that government healthcare facilities have the highest sum of length of streets and count of buildings in the catchment area than that of private facilities.

Though some of the healthcare facilities had highest count buildings and highest sum of length of street to buildings does not guarantee accessibility. For not all the buildings will be accessible considering the high sum of length of street connecting the building to the healthcare facilities. For instance from figure 4.3, Vittin health centre had the highest sum of length of street but had the least count of building in its catchment area. Also, the distribution of both government and private healthcare facilities is not evenly. Most of the healthcare facilities are located around the city centre rendering such facilities accessible and leaving the peripheries with longer distance to have access to healthcare facility. Finally with this method of analysis, first hierarchy of Private healthcare facilities are accessible than that of government health facility of same hierarchy, however government healthcare facilities as a whole are more accessible than private healthcare facilities.

## 4.2 Spatial Network Analyst

Spatial network analyst is a tool that is used to solve variety of problems associated to spatial networks**.** The major capabilities of this tool include finding efficient and appropriate travel routes, locating the closest facility in relation to an incident, and estimating the service areas of incidents based on reasonable travel time.

### *4.2.1 Closest Analysis*

The closest facility analysis, measures either the cost or time involve in travelling from a facility to an incident and determines which incident is closer to the facility. In this study healthcare facility either based on hierarchy or ownership is used as the facility, and the buildings in the study area as the incident. The network analyst tool is activated in Arc Map. The network analyst tool bar contains a list of different solvers. New closet facility solver is chosen from the list of solvers. The facilities, incidents and the street network dataset set of the study area are loaded. The result is assigning buildings that are closer to a healthcare facility with an impendence of 700 meters of walking distance. The result further indicates the best and shortest routes between the healthcare facilities and buildings. The assumption is that, the maximum distance people are willing to travel to have access to healthcare is 700 meters. The closest analysis therefore estimates the count of buildings that are within the 700 meter search radius to the closest healthcare facilities. DBF file from the executed result in Arc Map is opened in Microsoft excel and further sorted to graphs using pivot table.

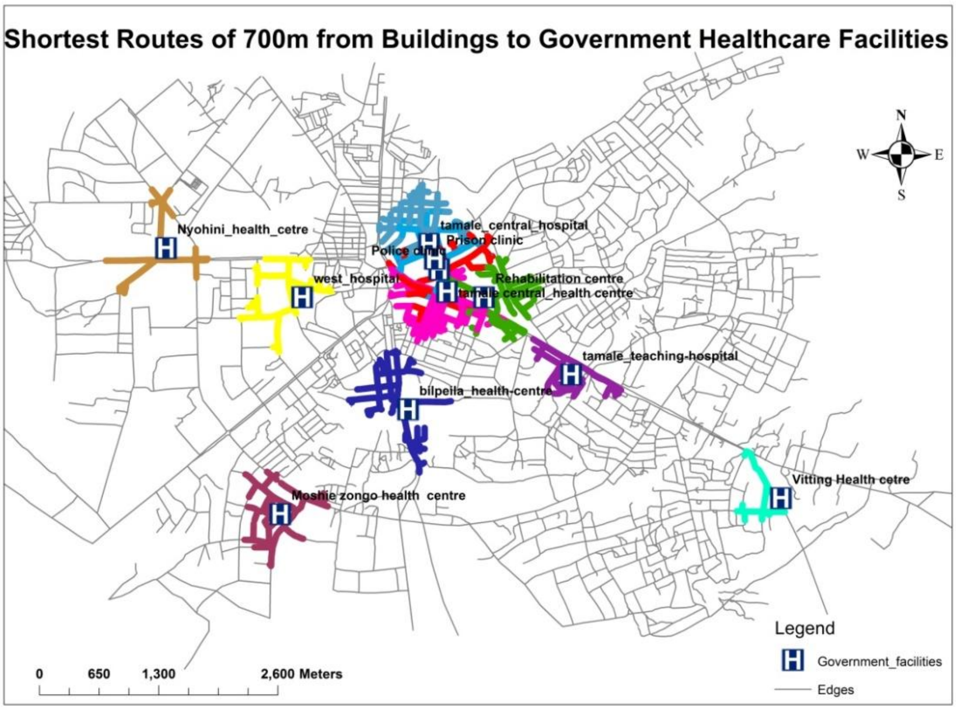



Figure 4.12 Shortest routes from buildings to government facilities

The figure 4.12 depicts the shortest routes from buildings to government healthcare facilities using the shortest distance of 700 meters. The map indicates that using a walking distance of 700 meters leaves a large proportion of the study area not accessible to government healthcare facilities. Though the buildings are not explicitly shown in figure 4.12, the information of the count of closest buildings to each government healthcare is found in the DBF file of the analysis which is used to derive the graphs of figure 4.13, 4.14 and 4.15

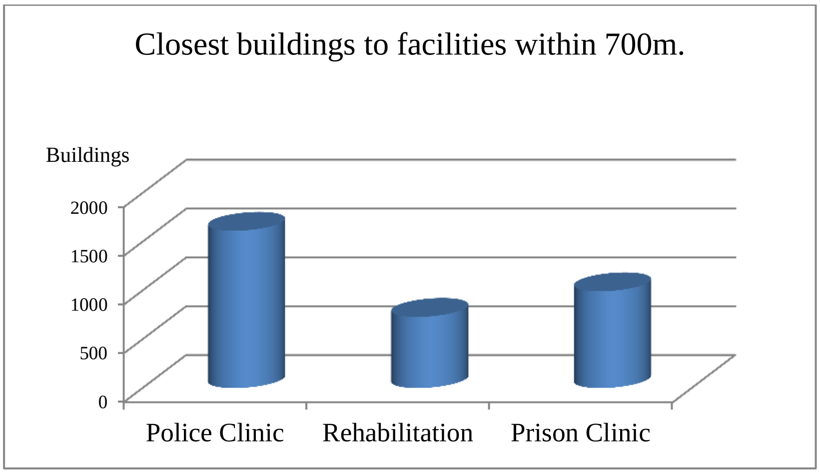



Figure 4.13 Closest buildings of government first hierarchy of healthcare facilities

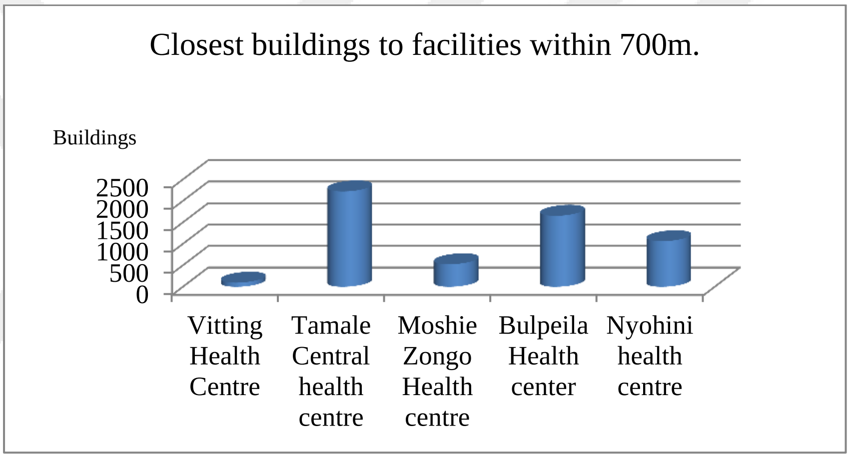



Figure 4.14 Closest buildings to government second hierarchy of healthcare facilities

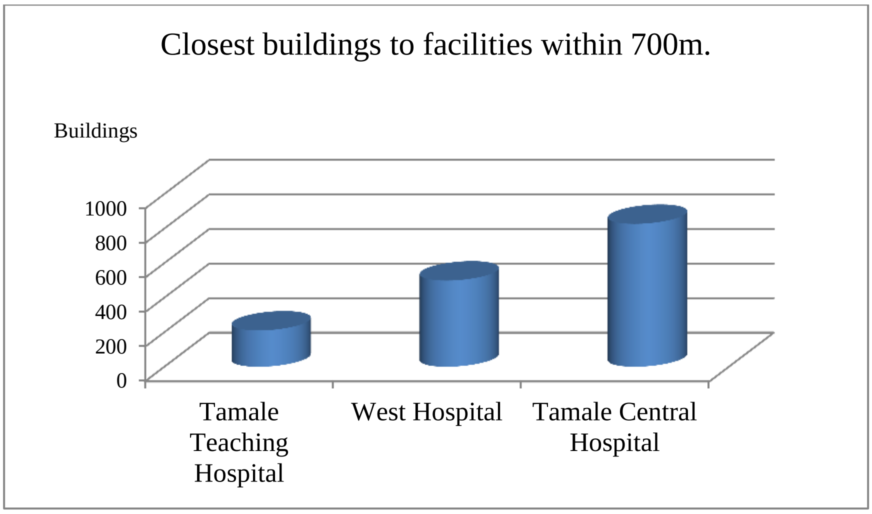



Figure 4.15 Closest buildings to government third hierarchy of healthcare facilities

The graph in Figure 4.13, 4.14 and 4.15 are closest buildings located along the shortest routes of 700 meter from the buildings to government healthcare facilities. Results of the closest buildings to government first hierarchy of facilities shows in figure 4.13 that, Police clinic has the highest number of buildings closer to it. Tamale central health centre has the maximum count of buildings closer to it among healthcare facilities of second hierarchy as in figure 4.14 and for the third hierarchy of healthcare facilities, Tamale central hospital has the highest number of buildings closer to it as depicted in figure 4.15.

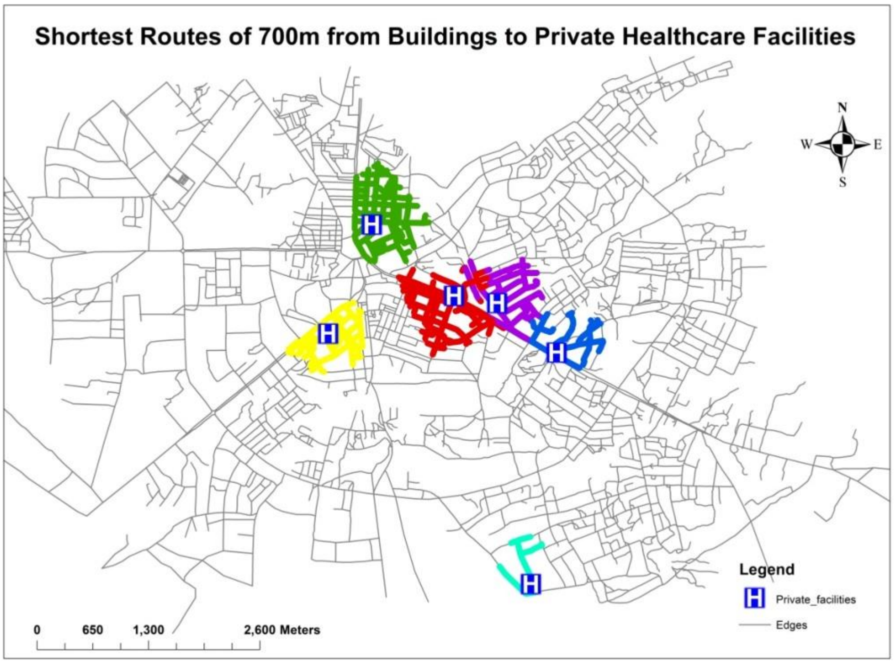



Figure 4.16 Shortest routes from buildings to private facilities

The figure 4.16 depicts the shortest routes from buildings to private healthcare facilities using the shortest distance of 700 meters. Count of buildings closest to each facility is not explicitly shown in figure 4.16. The information of the count of closest buildings to each government healthcare is found in the DBF file of the analysis which is used to derive the graphs in figure 4.17 and 4.18

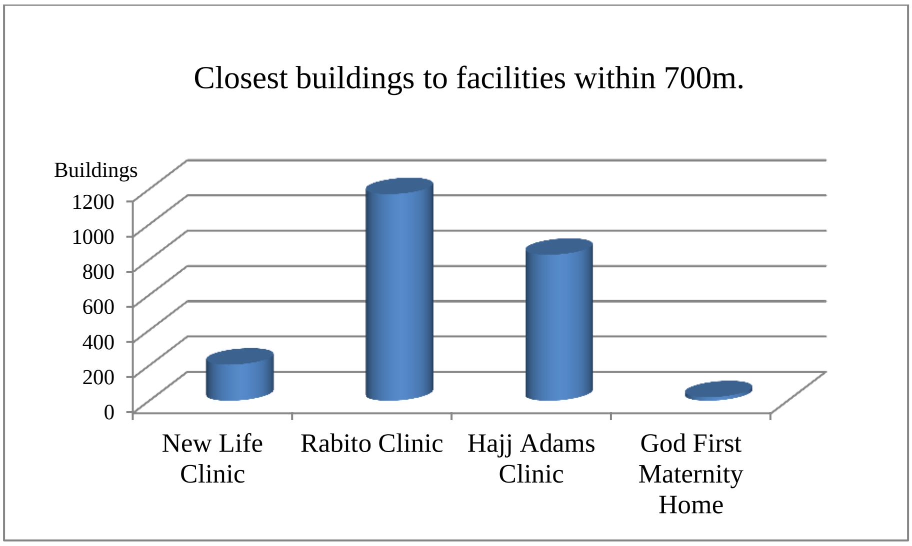



Figure 4.17 Closet buildings and sum of routes of private first hierarchy of health facilities

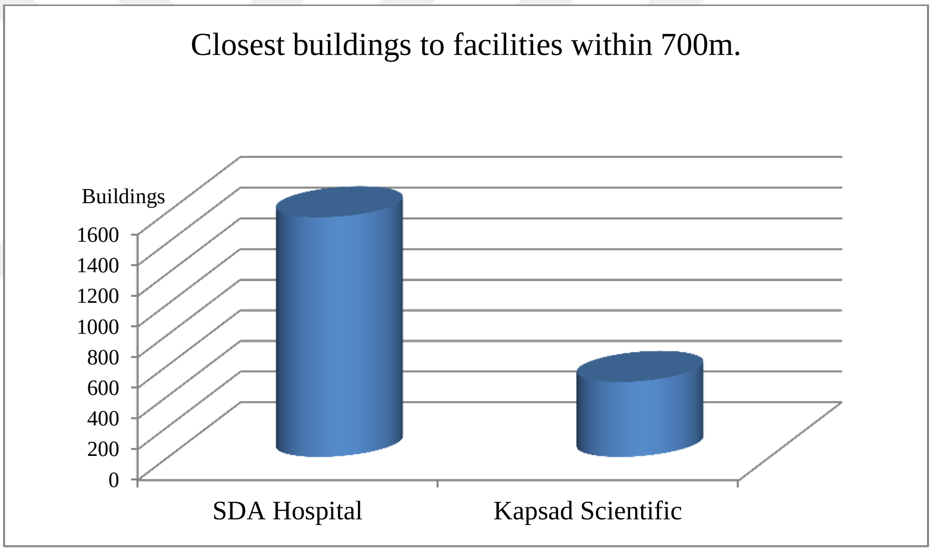



Figure 4.18 Closest buildings and sum of routes of private third hierarchy of health facilities

Private facility analysis of closest facility portrays from figure 4.17 that Rabito clinic has the highest count of closest buildings to it. At the third hierarchy, SDA hospital has the maximum count of buildings closer to it as shown in figure 4.18

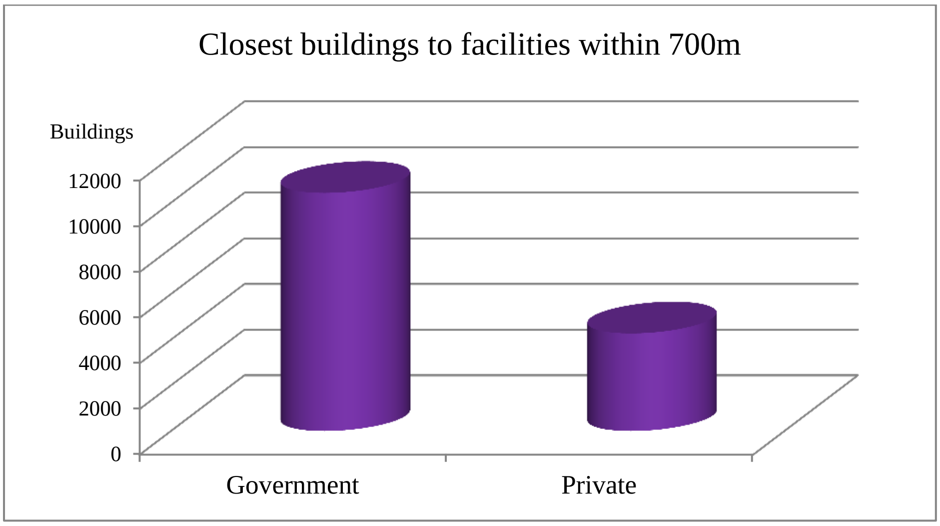



Figure 4.19 Closest buildings to government and private healthcare facilities

Comparing government healthcare facilities to private healthcare facilities according to the count of closest buildings, government facilities have the maximum number of buildings closer to it as in figure 4.21. This is still not encouraging since the total number of closest buildings of both private and government facilities using a walking distance of 700 meter does not meet 50 % coverage of the total buildings in the study area.

#### *4.2.2 Service Area of Healthcare Facilities*

Service area is a region that contains the streets and service facilities that can be access within a given search radius or impedance in a given settlement. In most service area analysis, driving time is use as the impedance. This study uses an impedance distance of 1200 meters considering both walking and automobile modes of transportation from home to healthcare facility. The study assumes that the maximum distance residents are willing to travel or coverage area of a healthcare facility to be within 1200 meters. The impedance value is used to generate polygons of the service areas of each healthcare facility. From the list of solvers in the network analyst, the service area solver is selected and the facilities of analysis and street network dataset of the study area is loaded. The service area solver generates a polygon of reachable buildings within 1200 meters for each healthcare facility.

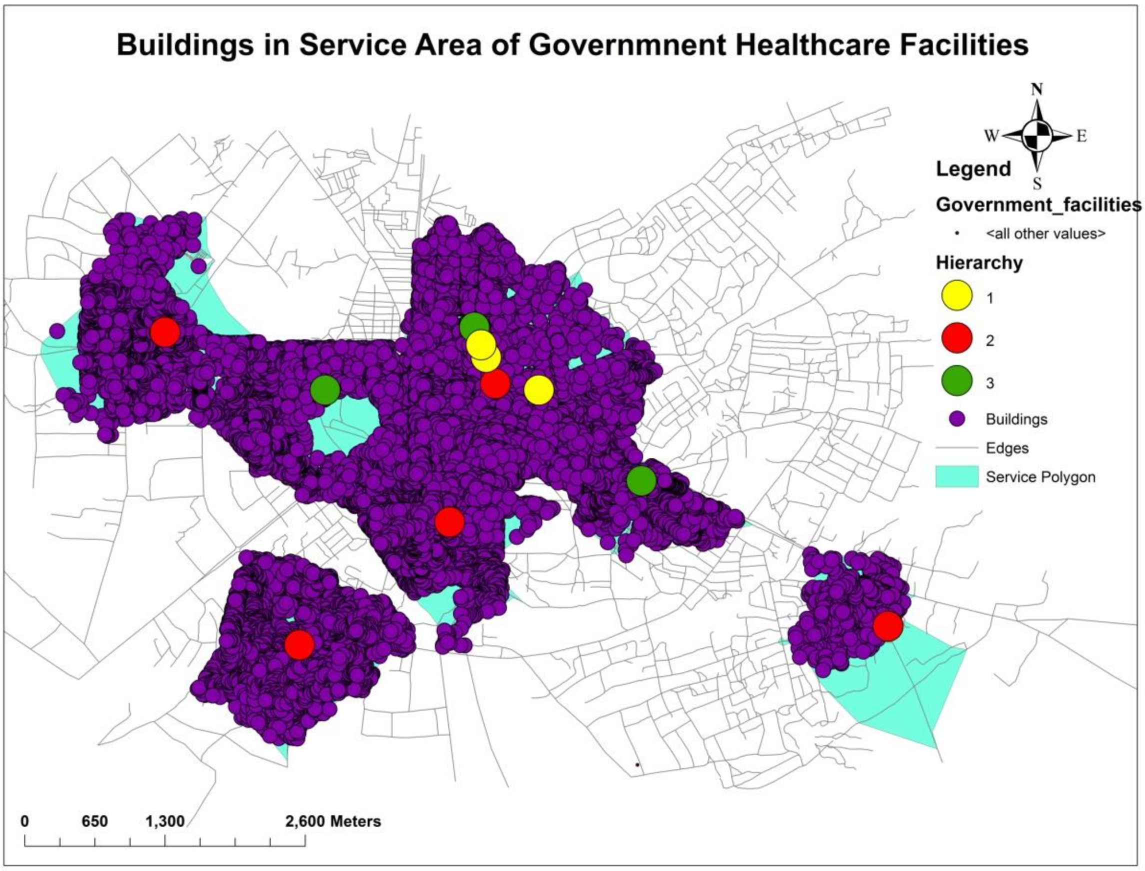



Figure 4.20 Buildings in the service areas of government healthcare facilities

With the given inpedance of 1200 meters, 17401 out of a total of 35048 buildings in the study area is within the service polygons of government healthcare facilites as shown ın figure 4.20

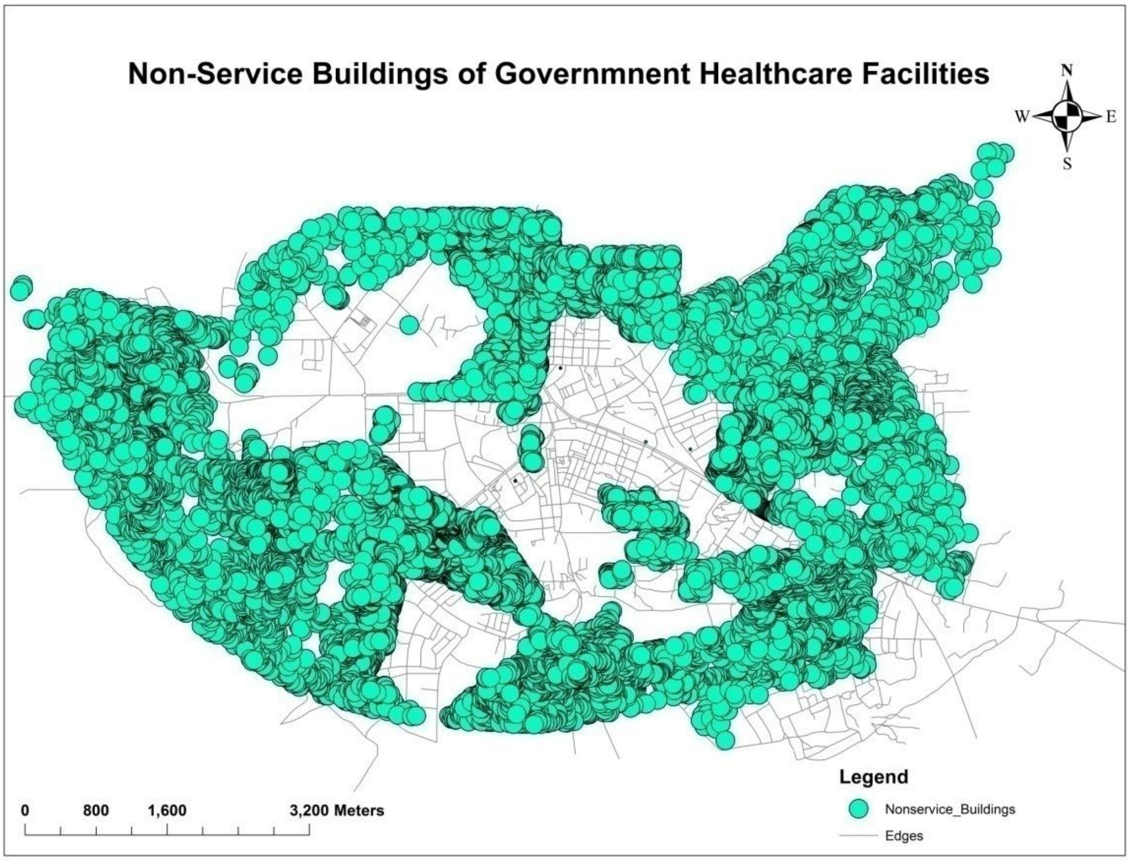



Figure 4.21 Non-service buildings of Government healthcare facilities

The government healthcare facilities recorded non-service buildings of 17648 which is greater than the service buildings. This shows that the government healthcare distribution of facilities do not meet the needs of majority of the population using the 700 meters distance required to have service to a healthcare facility.

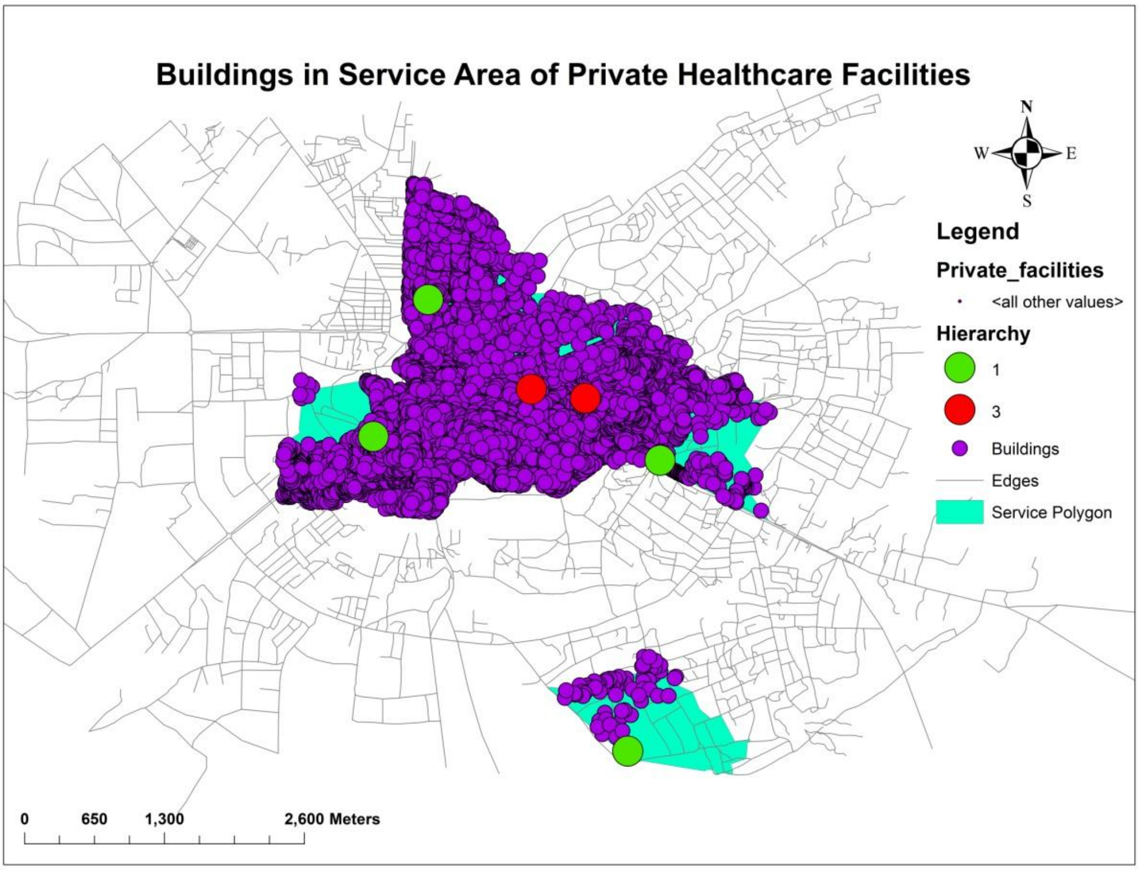



Figure 4.22 Buildings in the service areas of Private healthcare facilities

From figure 4.22 the private healthcare facilities had a lesser service buildings as compared to government healthcare facilities. The private facilities recorded service buildings of 10666 out of 35048 buildings.

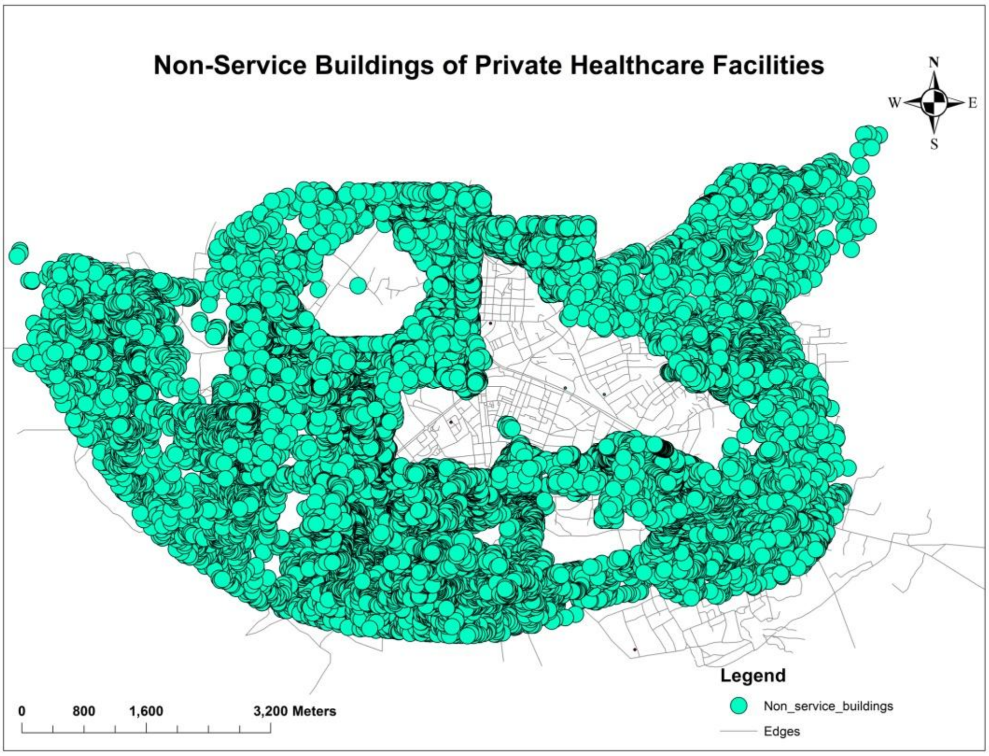



Figure 4.23 Non-service buildings of private healthcare facilities

The private healthcare facilities covers a relatively smaller part of the study area with it services as compared to the coverage of government healthcare facilities, for this reasons it has a large proportion of non-service buildings of 24384 buildings as shown in figure 4.23. The percentage of non-service buildings of private healthcare to total number of buildings in the study area is 70 percent.

Using a search radius of 1200 meter as the maximum distance within the service area of healthcare facilities, 17401 building out of a total of 35048 buildings are within the service area of government healthcare facilities. Private healthcare facilities have service buildings of 10665 out 35048 buildings. This renders many buildings out of the healthcare facility service areas. Healthcare facilities should be suited considering the population threshold around to prevent the under use of healthcare facilities. This is because the God first Maternity home had less buildings around it hence it would be under used due to its location. Disperse settlement which is a characteristic of the city peripheries affects the access to healthcare facilities since there exist long distance between buildings and healthcare facilities.

## 4.3 Network Centrality Indices

These are mathematical techniques for measuring the significance of elements in a network (Sevtsuk and Mekonnen 2012). The authors highlight the term “Centrality” meaning how central an element is in relation to its surrounding elements. It is also emphasized that previously centrality indices were calculated based on two elements of the network (nodes and edges) but the authors included a third element of building (Sevtsuk and Mekonnen, 2012). The authors argue that buildings are the integral part of the built environment, where diverse activities take place and for this reason buildings should be considered within the network to serve as the spatial unit for analysis. Most often buildings are the places where daily trips start and end. This tool requires the activation of network analyst and the installation of Urban Network Analyst toolbox. Urban Network Analysis toolbox (Sevtsuk and Mekonnen, 2012) is used to compute five types of centrality indices of spatial networks: straightness, reach, gravity, closeness and betweenness. The centrality tool is developed to fit well as an extension in the GIS application known as Urban Network Analysis (Sevtsuk and Mekonnen, 2012).

The mathematical formulas of the five indices are given below;

### *4.3.1 Reach Index*

Reach index counts the number of buildings that are reachable on a given network based on a given search radius. The formula (4.1) is developed by (Sevtsuk and Mekonnen, 2012).

Reach index is given as.

$$R^r[i]=|\{j \in G-\{i\}: d[i,j] \leq r\}| \quad (4.1)$$

The reach index $R^r$ [i], is the reach of a building ***i*** in a network ***G*** at a particular search radius.

Where $R^r$ is reach index, [i,j] is the shortest path between building i and j in the network G.

Weighted reach is calculated where the buildings attributes is expressed numerically such as floor area, building height, building size and number of persons in a building is considered as weight for calculation. Using weights for analysis enables the computation of how many of the attributes (e.g. residents, size) can be reached from a building within the given network search radius. The weighted Reach is given as

$$\text{Reach } [i^r] = \sum_{j \in G-\{i\}, d[i,j] \leq r} W[j] \quad (4.2)$$

### *4.3.2 Gravity Centrality Index*

The gravity measure mainly concerns the attractiveness of a building irrespective of the impedance factor, thus the number of destination around the surroundings of a building within a given search radius and sometimes weighted by building attributes. Gravity measure of accessibility was first introduced by Hansen (1959) when he distributed metropolitan population growth based on available vacant lands and accessibility. It is further develop by Sevtsuk and Mekonnen (2012)

Gravity is given as

$$\text{Gravity } [i^r] = \sum_{j \in G-\{i\}, d[i,j] \leq r} \frac{W[j]}{e^{\beta . d[i,j]}} \quad (4.3)$$

Where Gravity $[i^r]$ is the gravity index at building i in a given network at a particular search radius r. *W[j]* is the weight of destination j, d[i,j] is the distance from buildings i and j , and $\beta$ is the exponent mostly for adjusting the effect of distance decay. The gravity index thus captures both the attraction of the destinations *W[j]* and the spatial impedance of travel required to reach destinations $d[i,j]$ in a combined measure of accessibility. The above formula is a weighed gravity. In no weight gravity estimation, each destination building is considered as 1.

### *4.3.3 Betweeness Centrality Index*

It is the measure that shows the number of times a building lies on the shortest distances between all possible pairs of other reachable buildings in a network within a given network search radius (Freeman 1977). The *Betweenness* measure in some cases used to estimate the potential or likelihood of passerby at different buildings on the spatial network. The formula for betweeness in (4.4) was first brought up by Freedman and further modified by (Sevtsuk and Mekonnen 2012)

$$\text{Betweeness } [i^r] = \sum_{j,k \in G-\{i\}, d[j,k] \le r} \frac{njk[i]}{njk} . W[j] \qquad (4.4)$$

Where Betweeness$[i^r]$ is the betweenness index of node ***i*** on a network with a search radius of *r*, njk represents the number of shortest paths from a node j and node k on a network, njk[i] is the number of shortest paths from node j and node k on the network that passes by i and W[j] denotes the weight of the building i used in instance of weighted buildings. *Betweenness* for node i is computed by considering all pairs of nodes j and k that are within a distance r from each other.

### *4.3.4 Closeness Centrality Index*

Closeness is defined as the inverse of cumulative distance from a building in question to all other buildings in a network within a given search radius, thus it measures the nearness of a building in question to other buildings within a network (Sabidussi 1966). Closeness shows how close a building in a network is to all other surrounding buildings within a given search distance (Sevtsuk and Mekonnen, 2012). Formula 4.5 is first developed by Sabidussi (1966) and further developed by (Sevtsuk and Mekonnen 2012). Closeness is given as

$$\text{Closeness}[i^r] = \frac{1}{\sum_{j \in G-\{i\}, d\{i,j\} \le r} (d[i,j] . W[j])} \qquad (4.5)$$

Where closeness$[i^r]$ is the closeness of a building i with a search radius of $\boldsymbol{r}$. $d[i,j]$ is the shortest path between the points i and j, and W[j] is the weights of the destinations j.

### *4.3.5 Straightness Centrality Index*

The straightness index measures the extent to which the path of a node to all other nodes in a network deviates to a straight path (Porta et al, 2005) .The straightness index of a building i in a network G calculates how closely the shortest path between i and other paths in the network resembles an Euclidean distance. This model is initially used by (Porta et al., 2005) and further developed by (Sevtsuk and Mekonnen, 2012). Straightness is given as;

$$\text{Straightness } [i^r] = \sum_{j \in G-\{i\}, d[i,j] \le r} \frac{\delta[i,j]}{d[i,j]} \quad (4.6)$$

Where straightness $[i^r]$ is the straightness of a node i with a radius r, $\delta[i,j]$ is the as-a-crow-flies distance between nodes i and j and d[i,j] is the shortest distance between same pair of buildings using the network. Straightness is only possible for units of impedance measurement that in a linear distance (Porta et al., 2005; Sevtuk and Melonnen, 2012).

In order to calculate the indices for this study, a number of inputs are required including buildings modified as points, a network dataset, and the healthcare facilities also modified as points. The computation of the indices is done with a search radius of 500 meters. Following Handy and Niemeier (1997), the equivalents of Beta value in meters of 0.00217, for distance decay is used for gravity computations. The centrality indices for the study are limited to network analysis of gravity, reach and closeness.

### *4.3.6 Results of Executed Analysis of Network Centrality on the Data of the Tamale Metropolitan Area*

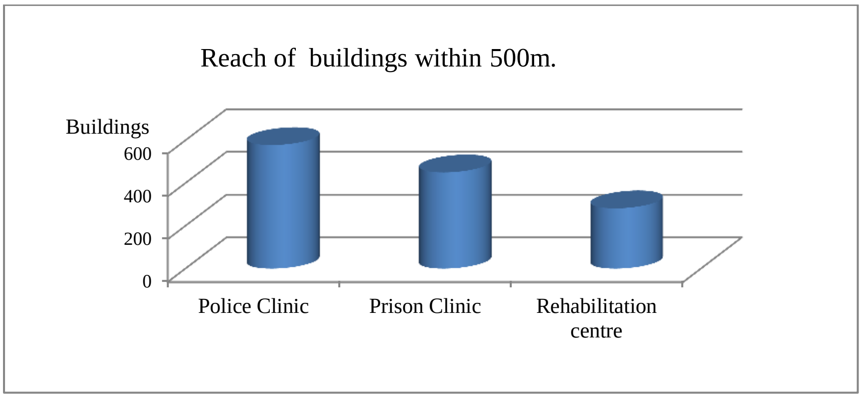



Figure 4.24 Reach centrality indices, government first hierarchy of health facilities

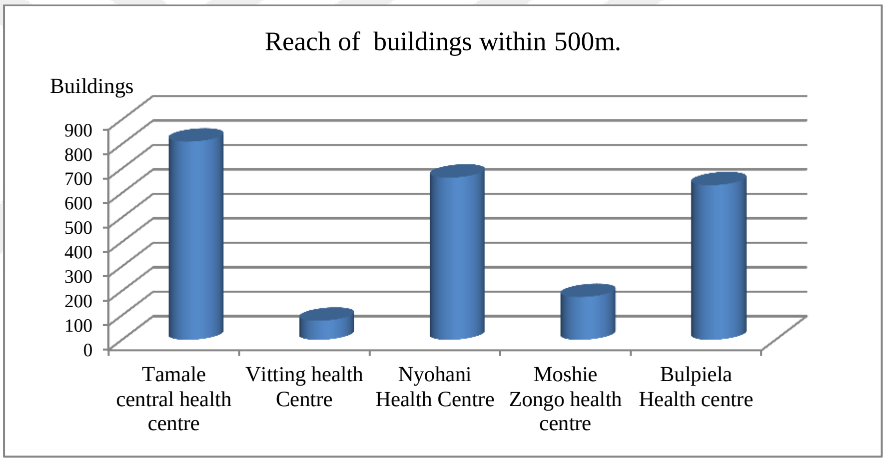



Figure 4.25 Reach centrality indices, government second hierarchy of health facilities

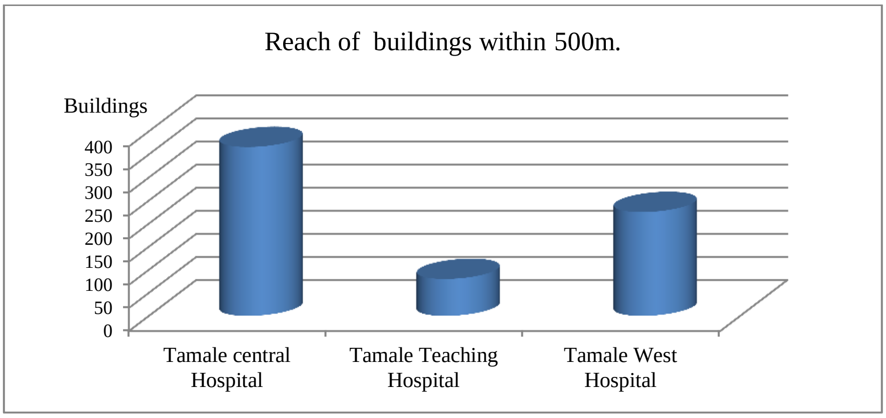



Figure 4.26 Reach centrality indices, government third hierarchy of health facilities

The reach value from figures 4.24, 4.25 and 4.26, indicates the number of buildings that are reachable to a healthcare facility within a search radius of 500 meters on the network using shortest distance. The results of reach index considering government facilities in figure 4.24 shows that with first hierarchy of government facilities, Police clinic is reachable to more buildings then the other facility of same hierarchy. The second hierarchy as shown in figure 4.25 indicates Tamale central healthcare facility as having the most reachable buildings within that hierarchy. Finally with the third hierarchy, Tamale central Hospital has the highest value of reachable buildings as in figure 4.26.

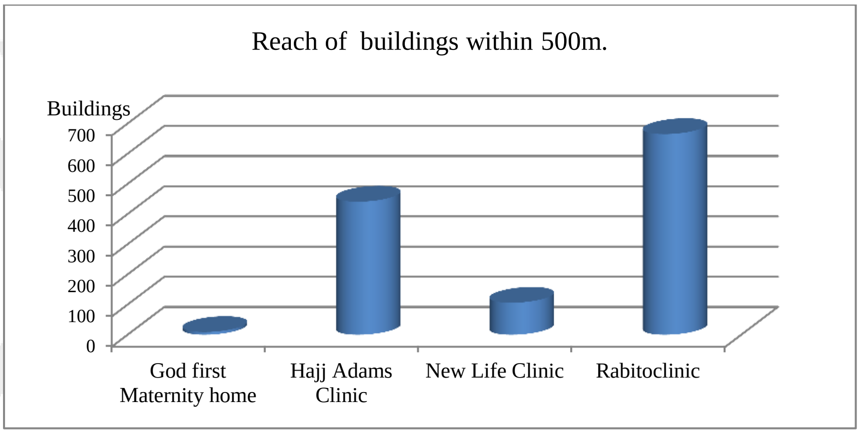



Figure 4.27 Reach centrality indices, private first hierarchy of health facilities

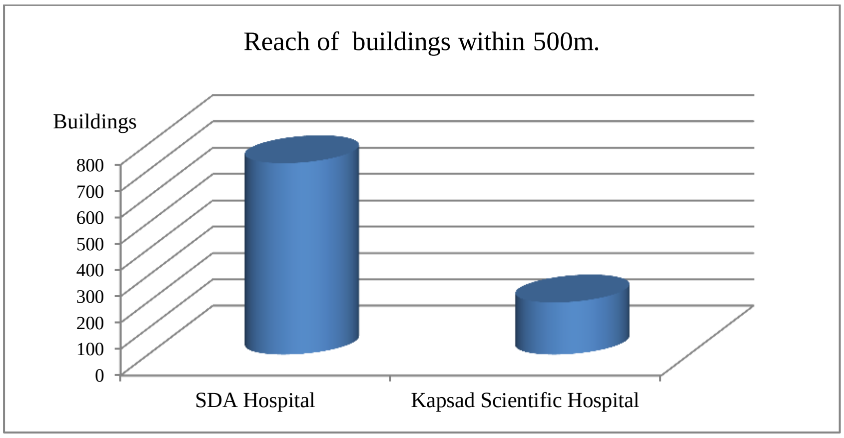



Figure 4.28 Reach centrality indices, private third hierarchy of health facilities

Reach value of the private healthcare facilities is based on two categories of hierarchies. That is the first and the third hierarchy of healthcare facilities. For the first hierarchy of facility as in figure 4.27, Rabito Clinic has the highest value of reachable buildings and with regards to the third hierarchy, from figure 4.28 SDA Hospital has the highest count of reachable buildings.

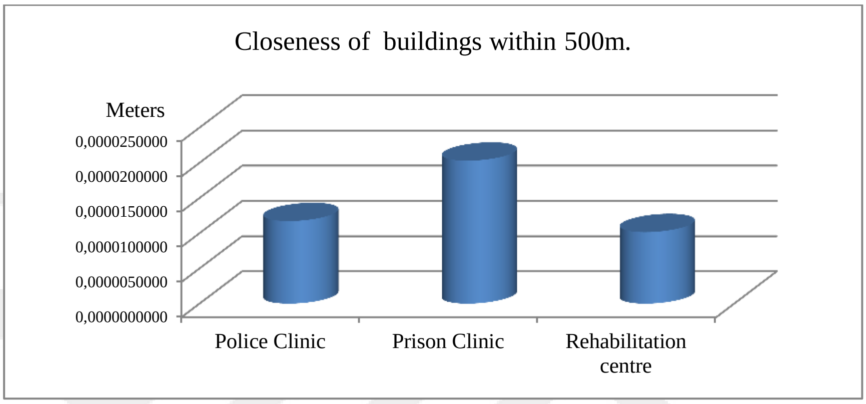



Figure 4.29 Closeness centrality indices, government first hierarchy of health facilities

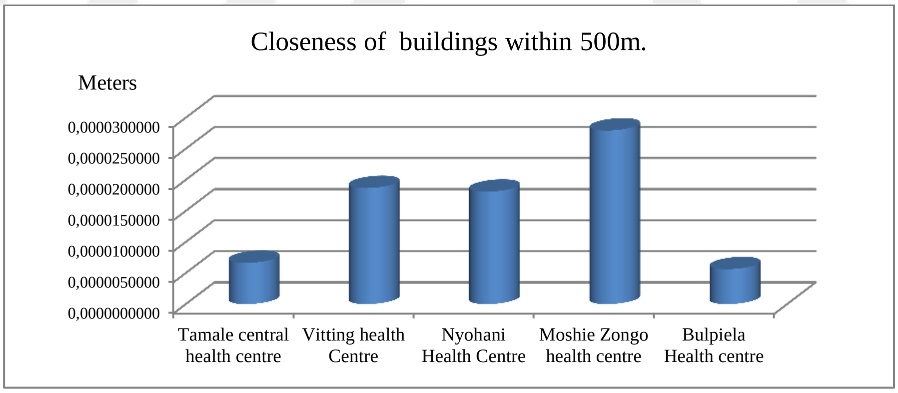



Figure 4.30 Closeness centrality indices, government second hierarchy of health facilities

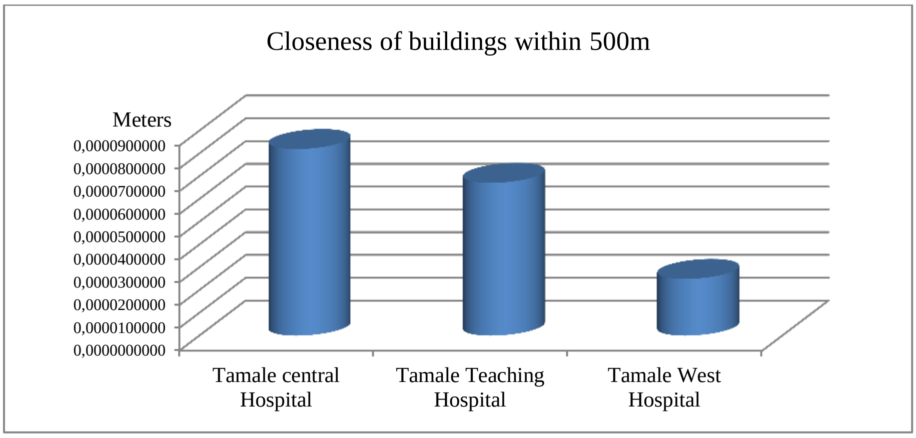



Figure 4.31 Closeness centrality indices, government third hierarchy to health facilities

With regard to the closeness centrality index, the lower the value of closeness, the more the building in question is closer to the other buildings within a given search radius. On the other hand the higher the value of closeness the farther the building in question is to the other surrounding buildings. Considering the closeness value from the figures 4.29, 4.30 and 4.31 shows how healthcare facilities are closer to its surrounding buildings within a search radius of 500 meters. From figure 4.29, the first hierarchy of government healthcare facilities has Rehabilitation health centre as the most closest to the surrounding buildings. The second hierarchy facility has Bulpiela healthcare centre as being the closest facility to its surroundings building as depicted in figure 4.30 and figure 4.31 shows that the third hierarchy of government healthcare facilities have Tamale west hospital as being closest to its surroundings buildings than the other facilities of same hierarchy.

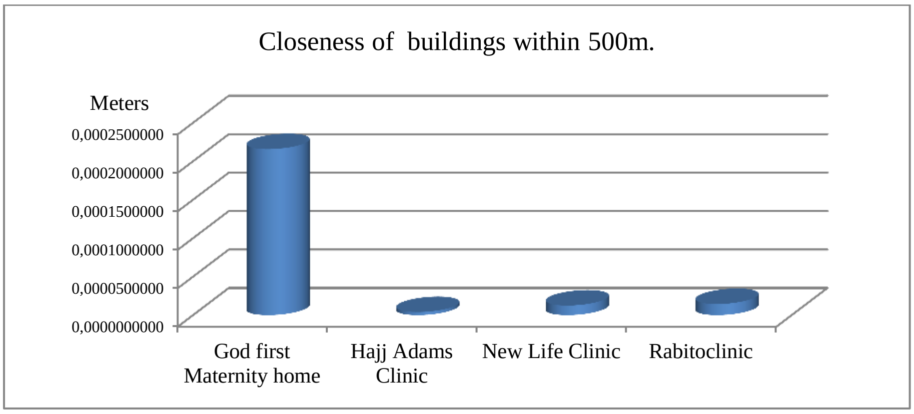



Figure 4.32 Closeness centrality indices, private first hierarchy of health facilities

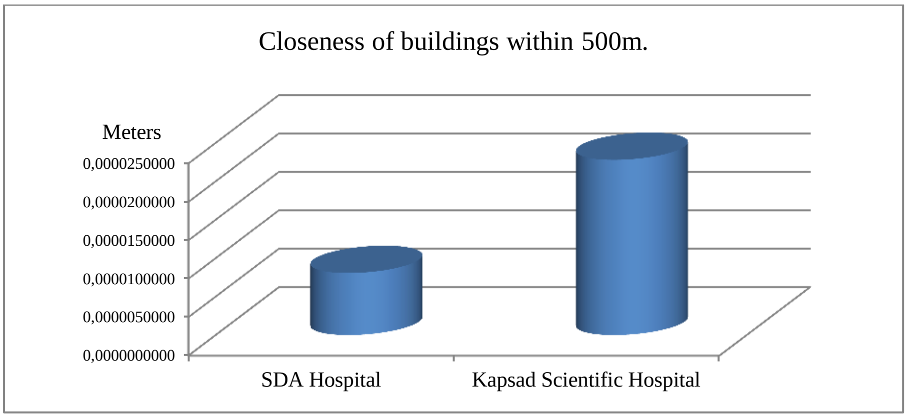



Figure 4.33 Closeness centrality indices, private third hierarchy of health facilities

Closeness analysis of private healthcare facility shows from figure 4.32 that Hajj Adam clinic as the closest to its surrounding buildings as compared to the other healthcare facility in same level, the third hierarchy on the other hand has SDA Hospital as the closest facility to its surrounding buildings for third hierarchy as showed in figure 4.33

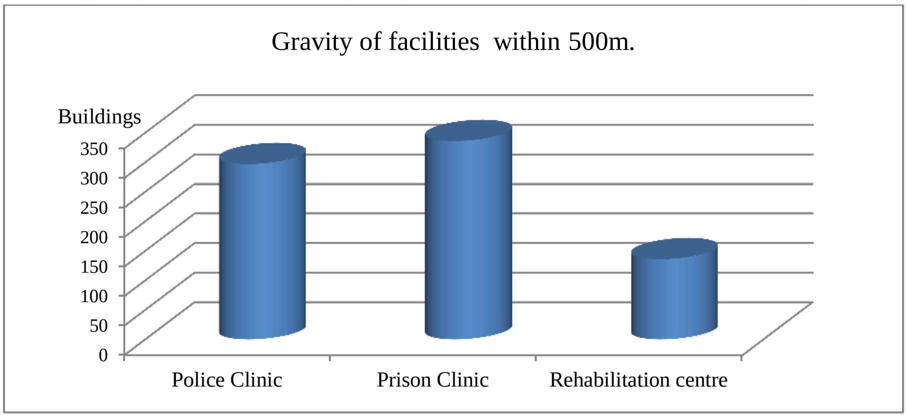



Figure 4.34 Gravity centrality indices, government first hierarchy of health facilities

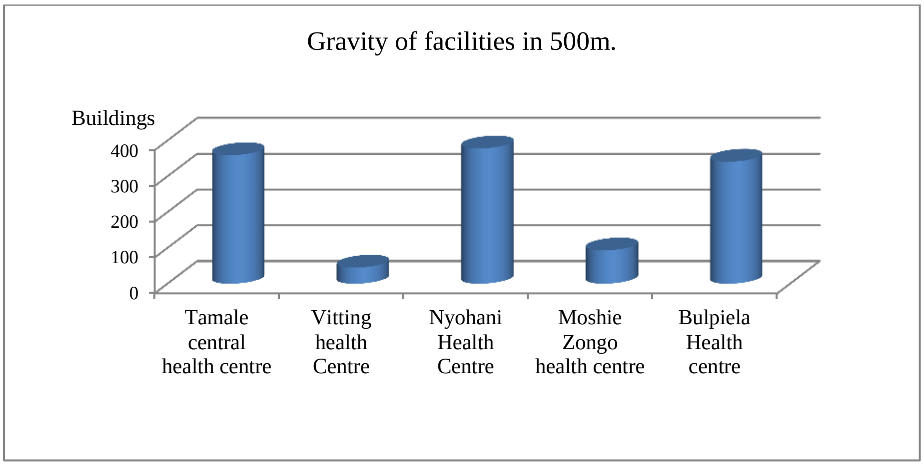



Figure 4.35 Gravity centrality indices, government second hierarchy of health facility

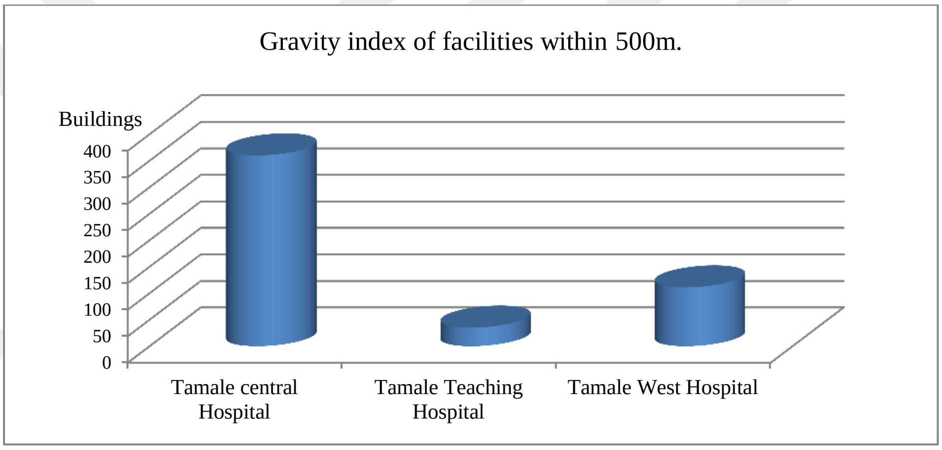



Figure 4.36 Gravity centrality indices, government third hierarchy to health facilities

Gravity assumes that accessibility of a building is about the buildings ability to attract a large population to it. A high value of gravity means there is a little or lower hindrance required to travel to a destinations and a low value of gravity means a high spatial hindrance to access a building. The result of the gravity analysis for government first hierarchy in figure 4.34 portrays that Prison clinic has a lowest spatial hindrance in accessing it. In figure 4.35, Nyohani Health Centre has the lowest spatial impedance in accessing facility under the second hierarchy of healthcare facilities and in figure 4.36 Tamale central hospital has the lowest amount of impedance in travelling to access third hierarchy of government healthcare facilities.

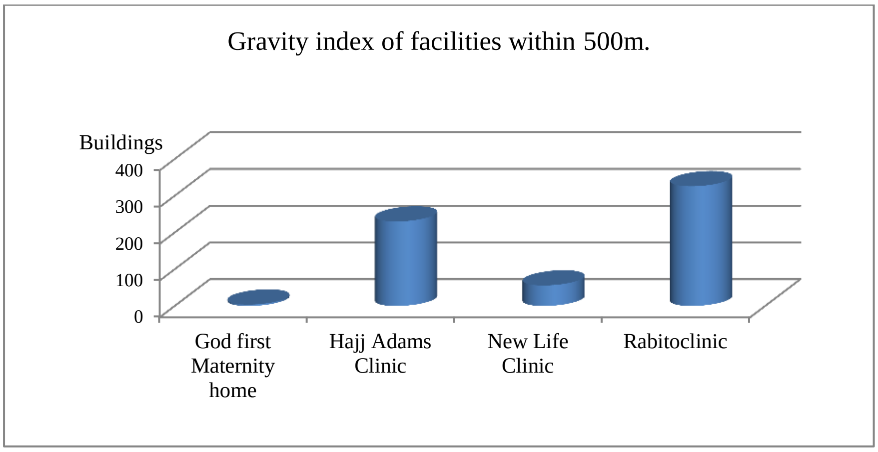



Figure 4.37 Gravity centrality indices, private first hierarchy to health facilities

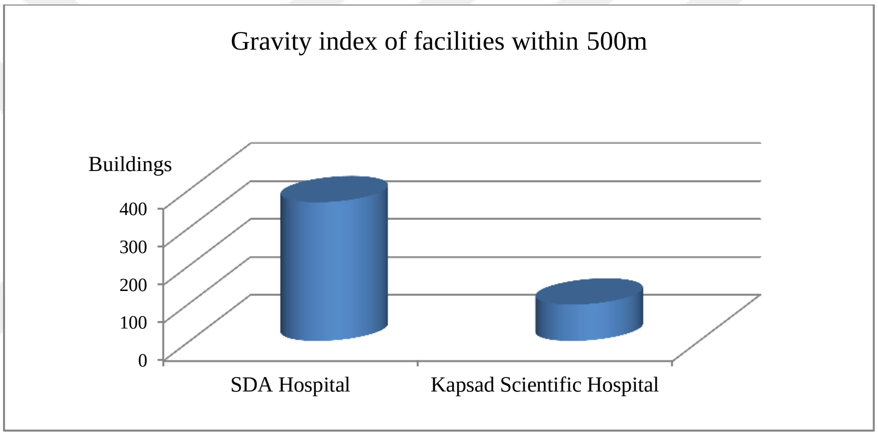



Figure 4.38 Gravity centrality indices, private third hierarchy to health facilities

Gravity values for Private healthcare facilities shows in figure 4.37 that Hajj Adams clinic have a lower spatial hindrance to travel in having access to it and in figure 4.38 SDA hospital for third hierarchy as having the least spatial hindrance in accessing it.

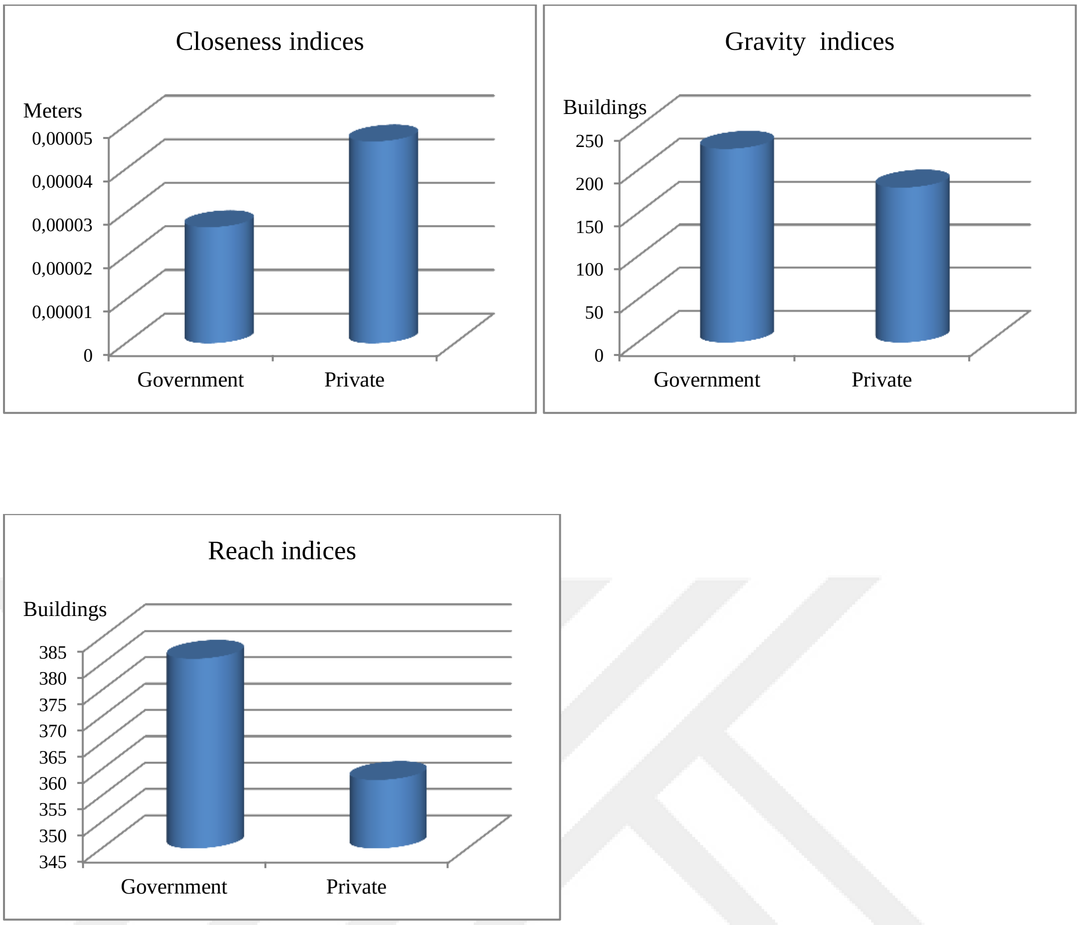



Figure 4.39 Comparison of closeness, gravity and reach indices according to government and private Facilities.

In a final comparison of the reach, closeness and gravity according to private and government facilities as shown in figure 4.39, it realized that government healthcare facilities are closer to its surrounding buildings than private facilities. Gravity index show that government facilities have less spatial impedance to travel than private healthcare facilities and more buildings are reachable to government healthcare facilities.

Reach and Gravity indices value from the study is influenced by the closeness of the healthcare facility to the city centre. Healthcare facilities located in parts of the city that had buildings to be relatively closer to each other had low values of closeness index depicting high closeness of building to healthcare facilities.

# CHAPTER FIVE
# DISCUSSIONS AND CONCLUSION

This study mainly focuses on assessing the accessibility levels of healthcare facilities in the Tamale metropolitan area. Accessibility to basic services has become a major challenge encountered by many cities of developing countries which are characterized by rapid population growth and spatial expansion. Literature shows that accessibility related studies often concentrate much on geographical accessibility factors such as distance and socio-economic factors like income, sex, education, neighborhood and many more, however much have not being explored to find out whether there exist peculiar factors of the spatial configuration or urban structure of a settlement that can serve as an opportunity or challenge in the accessibility of critical service needs of the population. Aday and Aderson (1974), points out that some researchers are of the view that access to health care services is often equated to population characteristics (family income, attitude about medical care and insurance coverage) or the delivery system whiles others argue that access depends on the utilization rates. Similarly, Wang and Luo (2003), use spatial and non-spatial factors to examine accessibility to primary health care. Spatial accessibility factors are defined as geographic barriers that exist between the provider and consumers of health care service and on the other hand non-spatial factors are mainly about non-geographic factors such as age, sex, income and social class.

The results from the study shows that all the three different methods and tools used for the analysis has Tamale West hospital, SDA hospital and Hajj clinic irrespective of hierarchy or ownership and different impedance level as having the maximum closest buildings in the catchment areas, highest count of building in the service areas, most reachable facilities and high gravity values that attract accessibility. This could be attributed to the fact that the three different tools had some similarities in the use of shortest distance of the network dataset in the distance estimation of closest facility, service area, catchment areas and centrality indices. However differences exist regarding the Voroino diagram estimation of service area where a specified search radius is not used. Again the tool does not make provision for building allocation in the given catchment area as in the case of network centrality tool and network analyst tools.

The result further provides insights that the healthcare facilities that are located closer to the city center to be more accessible than other healthcare facilities located in the periphery of the city. This tends to affirm the work of Sevtuk (2010), who reveal that a cluster of health and related shops is found in the central business district of his study cities; but in the other parts of the city, health shops are located in greater distances from each other. In addition the report from World Health Summary highlights that health should be a people centered service; thus health service should be restructured in away to respond to peoples' needs through delivery points located in parts of the communities where it is easily accessible. For instance, Cuba's "polyclinics" which are deeply located in the communities where it is easily accessible have helped Cubans to attain one of the longest life expectancies (World health summary, 2008). Also, once the city centre is more developed, could be the reasons why these facilities are located in there as confirmed in the work of Kumar (2004), who indicates that developed areas attracts healthcare centers than less develop areas. Thus a developed area has a greater concentrations of both private and government facilities, and further has a better geographic accessibility as compared to less developed areas. In contrast, closeness to healthcare facility does not always guarantee healthcare accessibility and utilization. For instances in a study of slum neighborhoods, it is reveal that the health risks confronting the urban poor were found to exceed rural risks, despite the proximity of modern health services to the urban poor (Montgomery, 2009).

In addition, healthcare facilities that are located along the major principal streets that passes through the city centre, have the highest account of buildings in its catchment area, and this tends to make the facilities more accessible by a shorter walking distance. This finding is also consistent with that of the findings of Litman (2016), who state that when a good number of destinations are located closer together along roadway, accessibility increases. It is emphasized that when destinations are quite closer enough together, they can be reached by walking. Centrality of a place or street plays an important role to accessibility and connectivity, Bavelas (1948); Porta et al. (2005) note that a central location in a network structure corresponds to its power in terms of how it influences, and control on others. Thus results to how some places or streets are more important than others in a network and tend to attract a large population to it.

The level of connectivity of the street network from buildings to facilities resulted in such healthcare facilities having the maximum sum of streets as well as buildings in its service area, this upholds the investigation of Litman (2016), where he indicates that factors of transport network connectivity that constitutes density of streets and roadway connections, quality of connections between modes of walking and cycling to public transport stations increases accessibility. Also as noted by Litman (2016), traditional grid network of a spatial unit that comprises of many connected roads that provides multiple and direct route choices, tends to reduce trip distances to destinations, increase travel choice, reduce congestion in the inner city, and increase accessibility.

Making a comparison between healthcare facilities at an aggregate level of government and private from the study shows that, government facilities have a high level of accessibility, but at the disaggregate level, where each facility is compared within government and private facilities and at the same time according to hierarchy showed private facilities having high level of accessibility at the first level of hierarchy between government and private. This can be attributed to the fact that, private healthcare facilities aim clearly to attain profit and will definitely locate facilities where they will have a large population having access to it. Most private facilities have the objective of maximizing profit but a public facility’s objective is often difficult to capture (Church and ReVelle, 1974; Rahman and Smith, 2000).

The findings finally provide a justification for the fact that the spatial structure of the built environment of a city affects the accessibility levels of households to healthcare facility. This is because the spatial structure of the built environment of the study city makes some facilities more accessible than others.

In the process of urban planning and policy formulation for a city experiencing population growth and spatial expansion where urban planner aims to ensure healthcare facilities meets the needs of the growing city and as well ensure the best use of land and resources that would direct the development of the city, preliminary studies of how the built environment or the spatial structure influences accessibility of service facilities is necessitated, through the estimations of service area given a reasonable search distance, closet health facilities, shortest routes etc. This is because every spatial structure has its unique characteristics that will either influence accessibility or inaccessibility which will inform policy makers on how best to plan for such a city taking such factors into consideration. For instance in Uganda a study by Lwasa, (2007) uses the spatial distribution of population and the location of health care services as well as key variables such as bed capacity and catchment distance as vital information for decisions regarding planning health care service.

Further to this, with the good knowledge of the spatial configuration factors that influence accessibility, location allocation methods such the maximal covering location problem (MCLP) can further be used to capture a large proportion of the population to have access to particular health care which will prevent the misuse of the limited recourses in establishing new facilities, this is highlighted in the study of Kumar, (2004) where it is stated that in real world, planners needs to adopt location criteria that responds to the demands of the people regarding health care facility to minimizes the cost of new services facilities if the existing ones are optimally used. The importance of GIS software and its extension in health facility accessibility analysis cannot be left out, this is also highlighted in the (Murad, 2008; Murad, 2004) where GIS base model is adopted for planning two main health service for the city of Jeddah and a module to create catchment areas of health centers in Makkah city all in Saudi Arabia, based on the demand( number of people living in a neighborhood) and supply (related to doctors working) in health facilities. The author further indicated that using GIS tools for analysis provided an understanding between locations, environment and disease. With this, health planners will be able to well define the coverage of health center based on their specification of the possible distance that would make a facility accessible.

Also in planning the urban city, consideration should be made to ensure that buildings within the settlement are well connected to street network that would facilitate accessibility to healthcare facility through multiples routes choices and varying modes of transportation from walking, biking to auto mobile. With adequate knowledge of which part of the city migrants or the population growth is likely to settle, plans will be geared towards relocating healthcare facility that is underused to such location, such that if not all the population but a large proportion of the population would have access to healthcare facilities. Health planners will be able to adequately define the coverage of healthcare facility based on the specification of the possible distance that would make a facility accessible.

Future research should focus on measuring variations in accessibility to healthcare facilities among neighborhood of a city. This will establish the accessibility levels of each neighborhood and what accounts for the difference in accessibility levels. The results obtained from this study could be compared to the master plan of the Tamale metropolitan assembly area for adequate examination and recommendations. In subsequent study, the three methods used for analysis can be merged as a single method.

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