

**EXPLORING THE USE OF OPEN DATA TO IMPROVE HEALTH
SERVICES IN GHANA'S KETU NORTH DISTRICT**

SEVOR MAWULI KODZO ERICSON

OPEN UNIVERSITY MALAYSIA /

ACCRA INSTITUTE OF TECHNOLOGY (AIT)

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**A Master's Thesis Submitted in Partial Fulfilment of the Requirements for
the Degree of Master of Information Technology (MIT)**

2014

DECLARATION

Name: Mawuli Kodzo Ericson Sevor

Student ID Number: MTSM12MIT0044Y

I hereby declare that this project is the result of my own work, except for quotations and summaries which have been duly acknowledged under the supervision of Dr. Justin Chisenga.

Signature:

Date: March, 2014

Signature:

Date: March, 2014

Supervisor: Dr. Justin Chisenga

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ABSTRACT

Healthcare information access in Ghana is restricted and many are in formats that are not understood by computers. This impacts negatively on service delivery and hinders reuse of information. This study as an exploratory study, sought to identify open datasets available in Ghana on healthcare, suggest health datasets that can be open, identify challenges in healthcare delivery that can be addressed using open data and explore the kinds of applications that can be developed using open data to address challenges identified. Data sampled from service providers in the Ketu North District and patrons of health services in Ohawu, show that healthcare providers have challenges in accessing data from related institutions in their sector, and have difficulties in training and recruiting staff that will generate and manage data. Clients of health services have challenges with service quality and do not have enough information about service provision. The study identified health facility rating and finder, alerts for immunisation, food and drugs, birth and deaths, registered and licensed professionals and institutions as some applications that can be built to address challenges identified. These applications will require commitment of service providers to generate and share data openly and participation of the general public in using and innovating with open data. The study was based on the Social Shaping of Technology (SST) approach combined with Open Innovation paradigm to serve as a foundation for the development and improving of health services using open data in Ghana; since no such study currently exists in Ghana.

Keywords: Open Data, Healthcare, Open Innovation

DEDICATION

To my daughter, Mawunya and my best friend, Kennedy Clancy-Cofie.

ACKNOWLEDGEMENTS

I thank Almighty God for guidance and protection in the successful completion of this study.

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LIST OF ABBREVIATIONS AND ACRONYMS

ADR: Spontaneous Adverse Drug Reaction

API: Application Programming Interface

DDHS: District Directorate of Health Services

DMHIS: District Mutual Health Insurance Scheme

GIS: Geographic Information System

GODI: Ghana Open Data Initiative

HIMS: Health Information Management Strategy

NHIA: National Health Insurance Authority

OPD: Out Patients' Department

SAH: St. Anthony's Hospital

SMS: Short Messaging Service

USA: United States of America

USB: Universal Serial Bus

CHAPTER ONE

GENERAL INTRODUCTION AND SUMMARY

1.1 Background

This study explores the availability of open health data, challenges it can address and applications that can be developed out of the data to improve healthcare delivery.

1.2 Research Field and Subject Area

It is a study in the Information Technology field with a focus on mHealth as the field of study. Information technology is a set of tools, processes, and methodologies (such as coding/programming, data communications, data conversion, storage and retrieval, systems analysis and design, systems control) and associated equipment employed to collect, process, and present information (WebFinance, Inc, 2013). According to Istepanian and Lacal, mHealth was initially defined in 2003 as wireless telemedicine involving the use of mobile telecommunications and multimedia technologies and their integration with mobile healthcare delivery systems (as cited in Qiang, Yamamichi, Hausman, & Altman, 2011). Currently, mhealth has come to encompass any use of mobile technology to address healthcare challenges such as access, quality, affordability, matching of resources, and behavioural norms (Qiang *et al.*, 2011).

1.3 Problem Statement

When information is obtained in formats which cannot be understood by computers (such as hard copies, images or PDFs) or when the software support used is not of an open format, then members of the public are limited in their possibility of reusing the information.” (Access Info Europe & Open Knowledge Foundation, 2011). Currently, the government of Ghana does not have a uniform data management policy. State institutions manage their data independently of each other in different storage formats and locations with varying degrees of accuracy. This results in generation and storage of redundant data, incompatible data formats and inaccessible data for everyday usage by public officials and other citizens. Request for data by any interested person from a state institution is normally met with hostility and reluctance with a question like “why do you need this information?” Generally, it is difficult to obtain information from government officials and departments.

Inaccessibility of data has contributed to the waste of scarce resources in pursuing the national developmental agenda. Opening up data and increasing accessibility is therefore believed to increase citizen participation and transparency which can reduce allegations of funds misappropriation, ghost names on government payroll, many agencies working on the same agenda without collaboration with each other, and the difficulty state prosecutors face in acquiring information from governmental sources to prosecute cases. Easy access to data and information will contribute to accelerating national development and bringing government closer to the people.

This is why open data initiatives such as tracking teacher absenteeism (Twaweza, 2010), tracking the community's share of mining revenue¹, exposure of a \$3.2 billion charity fraud in Canada, and creating an estimated \$1.5 billion industry out of the American weather data (LinkedGov, 2012) can help reduce corruption in the public sector, increase efficiency in public spending and create an enabling environment to support the creation and provision of new products and services.

The USA, the UK, Brazil, Indonesia, Norway, South Africa, the Philippines, Mexico, Ghana and many other countries recognise the huge potential of opening up information by launching the Open Government Partnership (OGP) (Stauffacher, Hattotuwa, & Weekes, 2012). The activities of the USA in opening up government data is co-ordinated by the Open Government Initiative², the government of the UK also has the Open Data Institute to innovate, use and research Open Data opportunities that will bring commercial value out of public data (Stauffacher, Hattotuwa, & Weekes, 2012). The World Bank also provides access to its data through the Open Aid Partnership³ by providing Application Programming Interfaces (APIs) to data at <http://data.worldbank.org/> while the United Nations (UN) Crisis Information Strategy (CiMS), recognises the value of sharing information and implementing systems that enable UN agencies and partners to share interoperable data (Stauffacher, Hattotuwa, & Weekes, 2012).

¹ <http://labs.code-africa.org/WhereMyMoneyDey/>

² www.data.gov

³ <http://wbi.worldbank.org/wbi/open-aid-partnership>

The Haiti government use of data during the 2010 earthquake in Haiti⁴ has been a crucial catalyst in changing the UN's thinking about the importance of transparent interoperable data (Stauffacher, Hattotuwa, & Weekes, 2012).

There is little research, however, done on sources of open data for health and how open data can improve healthcare delivery in Ghana. That is why this study sought to identify open datasets available in Ghana on healthcare, propose other health datasets that can be made open, identify challenges in healthcare delivery that can be addressed using open data and propose applications that can be built using health open data.

1.4 Objectives of the Study

1.4.1 General Objective

This study explores services that can be developed out of open data to improve healthcare delivery in Ghana's Ketu North District.

1.4.2 Specific Objectives

Specifically, it sought to:

1. Identify datasets available on healthcare for Ghana
2. Establish health related datasets that can be made open
3. Establish challenges in healthcare delivery that can be addressed using openly available data
4. Propose the development of mobile applications to address at least one challenge identified.

⁴ <http://www.haitidata.org>

1.5 Research Questions

This study explores the following questions:

- i. Which open data sets on health care are available in Ghana?
- ii. Which other data sets on health care should be made open in Ghana?
- iii. What healthcare delivery challenges can be addressed by openly available data?
- iv. What mobile applications can be developed to address challenges identified?

1.6 Significance of the Study

Information availability and dissemination is crucial during disasters and emergencies.

For example with mapping and Geographic Information System (GIS) information, health infrastructure related information, ground conditions, human and material resource information are key to protecting lives and reducing the impact of disaster and epidemics (Stauffacher, Hattotuwa, & Weekes, 2012).

Open data can increase access to health facility by providing information on services offered and professionals available. Health facility delivery is identified as necessary in reducing the risk of neonatal mortality by 29% in low and middle income countries (Tura, Fantahun, & Worku, 2013). It is therefore important for users to know which facilities have midwives available and are classified as natal friendly. Open datasets can also help government collect and share birth and death data with stakeholders to improve and inform development policy formulation and implementation.

This study is important because it suggests health datasets that should be open to increase citizen participation in healthcare services. It is a contribution to enhance the visibility of

open data in health services and possibly encourage health service providers and government to increasingly open up health data in Ghana.

This study provides insight into sources of open datasets on health in Ghana to serve as reference for further research into open health data. This research is a reference to application developers, data scientists, Civil Society Organisations (CSOs) and academia to easily identify and use openly available health data to bring healthcare and governance closer to the ordinary citizen through research and development.

Finally, it is significant because “an informed decision is preferable to an uninformed decision, in particular when facing life and death situations, the protection of vulnerable populations and other critical issues” (Stauffacher, Hattotuwa, & Weekes, 2012). The probability of citizens and service providers making informed decisions increases only when data is open.

1.7 Research Methodology

This study used exploratory research. Exploratory research is an investigation into a problem or situation which provides insights to the researcher. The research is meant to provide details where a small amount of information exists. It may use a variety of methods such as trial studies, interviews, group discussions, experiments, or other tactics for the purpose of gaining information (WebFinance, 2013). Exploratory research is a methodological approach that is primarily concerned with discovery and with generating or building theory (Davies, 2006). It involves literature search or conducting focus group interviews in order to identify key issues and key variables (Harvard University, n.a.).

Exploratory research is chosen because there is little information in terms of open data applications in healthcare in Ghana. Exploratory research provides us with the tools to

provide more information and insight in the field of study using tools like interviews, focus group discussions, and experiments. Exploratory research is a methodological approach that is primarily concerned with discovery and with generating or building theory (Sage Publications, 2006). This methodology enables us to discover open datasets and datasets that can be made open; it also enables us to identify challenges in healthcare and explore how these challenges can be addressed with open data.

1.8 Limitation and Delimitation of the study

1.8.1 Limitation

This study was constrained by time and funds. As exploratory research, the study did not intend to draw definite scientific conclusions. Data collected from discussions in such a study is subjective to the socio-economic circumstances of respondents. Informal discussions were held with health workers, and patrons of health institutions. Such discussions did not use pre-tested questionnaires because questions were based on the flow of conversation.

The kind or use of the applications proposed will depend on the availability of open datasets to solve the challenges identified.

Data collection was also influenced by respondents experiences not only from service providers in the area under study but other areas as well.

As an exploratory study that used small sample sizes, findings are not generalised to the population at large (Lynn University, 2013).

1.8.2 Delimitation

The subject of open data covers a wide area. This study focused on open data relating to provision of health services. Questions asked respondents were structured around challenges related to information access and not technical medical procedures.

1.9 Definition of Terms

This section defines terms that need to be understood in the context of this study. This is to reduce ambiguity concerning the use of these terms in other contexts

Licence: is permission granted someone to own or use something (Oxford University Press, 2013). In open data terms it grants permission to own or use data.

Metadata: the Merriam-Webster dictionary defines metadata as data that provides information about other data (Merriam-Webster, 2013). Another source expands on this definition and states that metadata is descriptive information about a particular data set, object, or resource, including how it is formatted, and when and by whom it was collected (University Information Technology Services, 2013).

Everyday use of technology leaves a trail or digital footprint which is a kind of metadata (The Guardian, 2013). This is why metadata is also described as data history that provides the Who, What, Where, Why and How of the data (Merriam-Powell Center for Environmental Research [MPCER], 2004).

Open government: means having a government that is transparent, participatory and collaborative (Office of Personnel Management [OPM], n.a.).

Open access literature: is material that is digitised, on the internet, free from financial cost, and free of most copyright and licensing restrictions (Suber, 2013). A simpler

definition says these materials should be provided for free access anywhere in the world by anyone on the internet (SHERPA, 2006).

E-Health: “is the transfer of health resources and health care by electronic means” (WHO, 2013). E-Health delivers information to health professionals and consumers through the Internet and telecommunications in order to improve public health services (WHO, 2013).

mHealth: encompasses any use of mobile technology to address healthcare challenges such as access, quality, affordability, matching of resources, and behavioural norms (Qiang *et al.*, 2011).

mHealth can therefore be termed a subset of E-Health using mobile devices.

Criteria for open data: access, redistribution, reuse, absence of technological restriction, attribution, integrity, no discrimination against persons or groups, no discrimination against fields of endeavour, distribution of license, license must not be specific to a package, and the license must not restrict the distribution of other works (Open Knowledge Foundation [OKF], 2013).

Open data: “a piece of data or content is open if anyone is free to use, reuse, and redistribute it — subject only, at most, to the requirement to attribute and/or share-alike” (Open Knowledge Foundation (OKF, n.d). Open data is also information that is available for anyone to use, for any purpose, at no cost” (Open Data Institute, 2012).

1.10 Outline of the Thesis

Chapter 1: General introduction

It introduces the proposed study and outlines the objectives and problem statement and the justification for the study.

Chapter 2: Literature review

It reviews relevant literature on data accessibility in Ghana, open data, visualisations and infographics, e-health strategy for Ghana, importance of ICT in improving healthcare, uses of mobile devices and applications for healthcare, and government 2.0.

Chapter 3: Research methodology

It outlines how the study was carried out, the tools, methodologies and resources that were used. It includes introduction of the chapter, the design of the study, research population, sampling techniques, instruments and procedures for data collection.

Chapter 4: Data analysis and discussion of results

It presents data collected and discusses the results of analysing the data

Chapter 5: Conclusions and recommendations

It gives a summary of the research and discusses challenges encountered and how they can be addressed by further research. This chapter also makes recommendations for industry and academia to improve open data services. It includes an introduction, summary of study, implications of the study, recommendations and suggestions for future research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews the literature on open data, data accessibility in Ghana, e-health strategy in Ghana, ICT in healthcare, and challenges in health delivery. These topics reviewed are to enrich the knowledge and skills of the researcher in order to improve quality of the study and to be aware of work done by other researchers in this area.

2.2 Data

2.2.1 What is data?

Data, the plural of datum, is a collection of facts statistics or items of information (Dictionary.com, n.d.). These items of information may be text that can be processed by a computer (Frاند, 2008). Data which is all around us is only known when a value is assigned to it (School of Data, n.d.). Data can be the age or name of a person or thing, it can be how much treatment of an ailment costs or it can be a list of licensed doctors in a district.

2.2.2 File formats

A file format defines the structure and type of data stored in a file (TechTerms, 2011). The file format of a document, whether proprietary or non-proprietary, has an effect on its accessibility to everyone. Proprietary formats are controlled and supported by just one software developer, or can only be read by a limited number of other programs while non-proprietary formats are supported by more than one developer and can be accessed with different software systems (Public Records Division, n.a.). A file format is called proprietary if the mode of presentation of its data is opaque and its specification is not publicly available (Open Formats, 2011).

Another definition states that a proprietary format is an exclusive manner in which software published by a particular firm accepts or outputs data (BusinessDictionary.com, n.a.). Exclusive hereby means that the publisher reserves the right to share the format details or not to share. This impedes various computer platforms from being used by other programs and makes them incompatible with other software formats (Dictionary, n.a.)

Proprietary file formats “that are published for anyone to read and study but which may or may not be encumbered by patents, copyrights or other restrictions on use” are called open formats (The Linux Information Project, 2011). Proprietary formats therefore may be open or closed depending on the restrictions imposed on usage.

A free file format, on the other hand, is a file format that is published for anyone to read and study in its entirety and is not encumbered by any copyrights, patents, trademarks or

other restrictions so that everybody can use it at no monetary cost for any desired purpose (The Linux Information Project, 2011). Free and open file formats include:

- Open Document Format for Office Applications (ODF), Device Independent (DVI), LaTeX, Electronic Publication (ePUB), Office Open XML, OpenDocument, OpenXPS, bzip2, gzip, tar and PostScript.
- eXtensible Markup Language (XML), Portable Document Format (PDF), JavaScript Object Notation (JSON), Hyper Text Markup Language (HTML), and Comma Separated Values (CSV) (Hendler & Pardo, 2012).
- Resource Description Framework (RDF), Really Simple Syndication (RSS), Atom, and Schema.org (Hendler & Pardo, 2012).

These formats are preferred for storing open data in order to meet all the criteria for data being open. This is because closed source proprietary formats are restrictive in that while the creator of a file may release the data as freely licensed, the format in which it is stored will force users to use particular software in order to use the data within. An example is given as follows:

Andrew Nicolson is a software developer who was involved in an (ultimately successful) campaign against the construction of a new road, the Westbury Eastern bypass, in the UK. Andrew was interested in accessing and using the road traffic data that was being used to justify the proposals. He managed to obtain some of the relevant data via freedom of information requests, but the local government provided the data in a proprietary format which can only be read using software produced by a company called Saturn, who specialise in traffic modelling and forecasting. There is no provision for a “read only” version of the

software, so Andrew's group had no choice but to purchase a software license, eventually paying £500 (€600) when making use of an educational discount. The main software packages on the April 2010 price list from Saturn start at £13,000 (over €15,000), a price which is beyond the reach of most ordinary citizens (Open Knowledge Foundation, 2012).

It is important that open data is platform independent, machine readable and made available to the public without restrictions that would impede the re-use of that information (Orszag, 2009). This means that an open format does not hide, from the public, specifications for the structure of the file format, it is not tied to the product(s) of any technology vendor and it is machine readable or machine understandable.

In a proposed rating scheme for open government data, Tim Berners-Lee suggests the use of one star for data available online, two stars for machine readable formats, three stars for open-formats, four stars for RDF format and five stars for RDF with links to other datasets (Hendler & Pardo, 2012). This rating places RDF at the top because it is machine understandable and includes metadata.

2.2.3 Data visualisations

In order to increase participation of the general public in the use of open data, it is important to put it in a form that will be easily understood and appreciated without need to be a data scientist; one of such forms are visualisations. Visualisation is the graphical presentation of information, with the goal of providing the viewer with a qualitative understanding of the information contents (Ward, n.a.). This definition stresses on the need to make meaning out of data. This is important because, data that is not meaningful

to an audience becomes useless data. Another source defines it as the presentation of data in a pictorial or graphical format (SAS Institute, n.a.). These two definitions agree that meaning can be made out of data if it is put in a picture-like form. Visualising data leads to the creation of images that display and explain information quickly and clearly, called infographics (Chalabi, 2013).

Many designers fail in using visualisations to communicate information (Friedman, 2008). It is therefore important to define what a good visualisation is. A good visualisation must be effective in making meaning to the audience, it must be accurate in presenting proportionate view of the source data, it must be efficient in using space available to show data and less metadata, it must appeal to the audience in an aesthetic way and it should be easy to adapt to various screens and uses (Ward, n.a.).

Though data visualisation is a wonderful tool and an extremely efficient way of communicating a message (Burn-Murdoch, 2013) it can mislead an audience who may not have the skill or access to look at and analyse the underlying data. It is therefore important that visualisations created of data are statistically valid.

2.2.4 Data privacy

Privacy is the quality or state of being apart from company or observation or it is the freedom from unauthorized intrusion (Merriam-Webster, 2013). Intrusion could mean a lot of different things; however, the Cyber Law Centre defines privacy as your right to control what happens with personal information about you (Cyber Law Centre, n.a.). This second definition is more applicable to data because information comes from data. The

right to control the release and use of personal information is interpreted and operationalised differently from country to country.

It is important for open data not to infringe on the privacy of individuals. However, a visit to a data protection list by McAfee, a software antivirus company, showed that many African countries do not have data privacy regulations (McAfee, 2013). Ghana is one of such countries. This may also be attributed to the fact that the Right to Information (RTI) Bill is not yet passed into law and as such government sees no need to restrict what kind of information to provide. It is therefore important that open data activists who liberate data to make it open should think about privacy issues without hiding behind the issue of no law demands that they do so in their country.

Most especially, health related open data must be de-personalised as much as possible in order to avoid embarrassing people. If open data should infringe on privacy rights of people, it will lead to hostility and rejection of open data projects by the public.

However, the Oath of Hippocrates, which is sworn to by doctors in many countries including Ghana, protects the privacy of the patient (Weill Cornell Medical College, 2005; Sokol, 2008; North, 2002). Most medical schools have their own versions with variations (Tyson, 2001) but have maintained the portion on privacy. A translation of the original version is as follows “*whatever I see or hear in the lives of my patients, whether in connection with my professional practice or not, which ought not to be spoken of outside, I will keep secret, as considering all such things to be private*” (North, para. 10, 2002).

With increasing reports of infringement on privacy, absence of privacy laws in some countries and the inability of privacy laws to keep up with technological advancements

(iKeepSafe, n.a.), it is important for doctors who swear the oath to protect health information of patients.

2.3 Open data

2.3.1 What is open data

The Open Knowledge Foundation (OKF) says that “a piece of data or content is open if anyone is free to use, reuse, and redistribute it — subject only, at most, to the requirement to attribute and/or share-alike”. The foundation further outlines the criteria that must be met to make a piece of data open, and these are: access, redistribution, reuse, absence of technological restriction, attribution, integrity, no discrimination against persons or groups, no discrimination against fields of endeavour, distribution of license, license must not be specific to a package, and the license must not restrict the distribution of other works (OKF, 2013).

The Open Data Institute also defines Open data as “information that is available for anyone to use, for any purpose, at no cost” (Open Data Institute, 2012), and agrees with OKF⁵ that open data should have a clearly defined licence.

These definitions can be paraphrased in the sense that data becomes open if it is in machine-readable standard format and is explicitly licensed in a way that permits commercial and non-commercial use and re-use without restrictions (The World Bank, 2013). “Machine readable format” is not the same as “digitally accessible” information (Hendler & Pardo, 2012). The World Wide Web Consortium (W3C) however makes an interesting distinction in stating that “digitally accessible” means “machine readable”

⁵ www.opendefinition.org

while what the World Bank (2013) and Hendler and Pardo (2012) call “machine readable” is better described as “machine understandable” (Lassila & Swick, 1999).

Machine understandable format means that computers should be able to process the file and make meaning out of it; not just as a digital file for storage. For example, a computer cannot make meaning out of a magazine cover photo but can make meaning out of a barcode on the magazine and know the price, issue number and even the title of the magazine (Hendler & Pardo, 2012). Similarly, reading a PDF or HTML file and making meaning out of a JPEG bar chart embedded in it does not mean the source data used in creating the chart is available to the user for reuse (Hendler & Pardo, 2012). While all machine understandable formats are digitally accessible, not all digitally accessible formats are machine understandable (Hendler & Pardo, 2012).

2.3.2 Potential use and applications of open data

It is important for data to be open for many reasons. According to Open Knowledge Foundation when government data is open it results in transparency and democratic control, self-empowerment, participatory governance, release of social and commercial value, improved or new private products and services, innovation, improved efficiency of government services, improved effectiveness of government services, impact measurement of policies, new knowledge from combined data sources and patterns in large data volumes (Open Knowledge Foundation, 2012).

The advantages listed above, however, did not mention easy access. Easy access reduces time spent by researchers, developers and data scientists to move from institution to

institution to collect data. Easy access will also reduce the cost involved in gathering data by users.

Open data can reduce corruption; for example, citizens can easily find out how much a District, Municipal, or Metropolitan Assembly collected from each market, each property and each license granted to businesses and individuals. It can help citizens track tender processes, and how much is spent on fuel in the operation of government vehicles.

Open data can improve accountability by providing real time statistics on how much was collected at every toll booth and how much commission the operators are paid.

Open data can also helps citizens in choosing appropriate sites to build. Citizens can easily determine if a particular plot of land is under litigation or located in a waterway.

Open data can help citizens find the nearest health centre, fuel station or police station in case of emergency. They can also easily locate phone numbers of such facilities that are near them instead of calling a national emergency line. Provision of these services will bring social and economic value as people use the data available to develop solutions. This view is reinforced by a collection of case studies and references to the economic impact of open data available on LinkedGov website⁶.

For example, \$3.2 billion charity fraud was exposed in Canada through open data, number of datasets downloaded and used in commercial applications in Austria went up by 7,000%, the American weather data supports an estimated \$1.5 billion industry and a transparency website saved the State of California over \$20 million (LinkedGov, 2012).

More research is showing that healthcare has a lot to benefit from open data. A McKinsey and Associates report estimated the annual economic value of big, open liquid health data at some \$350 billion annually (Howard, 2011).

⁶ www.linkedgov.org

2.3.3 Challenges with open data

In spite of the many benefits associated with open data, there are also a few challenges as well. Tait (2011) identified some of the challenges as return on investment, risk and liability. Many developers and data scientists are reluctant to work on open data projects because it is assumed that open data cannot be fully commercialised. Some institutions are also unwilling to release open data because they will not be able to charge commercial rates for making such datasets publicly available without restriction while others see it as attractive but not essential (Tait, 2011). Tait (2011, para. 9) expanded further to say that

Open data transfers the risk and liabilities of data accuracy and security from those who produce the data onto those who develop apps using it. The possibility that a data source might suddenly be withdrawn – leaving apps based on it redundant – or that data might be flawed, seemed to be making digital businesses wary of entering the open data sphere. The problem of liability was also cited as a reason why data-producers might be unwilling to release their data.

The challenges identified by Tait (2011) may be present in Ghana due to the absence of applications on the GODI website since its launch.

Other risks with open data include opening up data which might infringe on third-party rights or opening up data for free use may affect the position of other players supplying comparable data in the industry which can lead to legal battles (de Vries, 2012). This

may lead to unfair competition and organisations that rely on such protected data to pay taxes may complain of unfair competition.

2.3.4 Health related applications (health applications) and visualisations

This section is a listing of existing health related applications (apps) and visualisations that rely on open data.

- **The Cost of Getting Sick⁷**

General Electric (GE) provides this app to help users understand healthcare costs.

- **Take a Look at Health⁸**

Also from GE, it analyses and visualises the major health issues facing Americans today and some of the most common conditions, and how are they related to one another.

- **Women's Health⁹**

This app visualises controllable health risk factors, lifestyle habits and leading causes of female mortality in the U.S.

- **World Health¹⁰**

This visualisation looks at twelve (12) countries around the world, examining how far the money they are spending on health care is going towards improving health of their citizens.

⁷ http://visualization.geblogs.com/visualization/health_costs/

⁸ http://visualization.geblogs.com/visualization/health_visualizer/

⁹ <http://visualization.geblogs.com/visualization/women/>

¹⁰ http://visualization.geblogs.com/visualization/world_health/

- **Other Apps**

Howard (2010), compiled a list of health apps based on open data; these include HealthStatus2020, MedWatcher, CountyHealthRankings, HealthLandscape, iTriage, Pillbox, and Asthmapolis.

2.4 Open data in Ghana

The National Information Technology Agency (NITA), the ICT policy implementing arm of the Ministry of Communications of the Ghana Government (NITA, 2012), through the Ghana Open Data Initiative (GODI), is championing the provision and use of open datasets. This is in pursuance of NITA's mandate to facilitate engagement of government with citizens, and business using innovative technologies as directed by Act 771 of the Parliament of Ghana (Opare, 2012).

Opare (2012, p. 5) lists the following as the driving force behind GODI:

- GODI project will help government get feedback from citizens on governance
- Will improve policy development
- Increase efficiency in Ministries, Departments and Agencies (MDAs)
- Help government spend more prudently in areas where very little is being spent

Opare (2012, p. 6) further outlines the following as the vision of the project.

Develop an open data community bringing together government, civil society organizations, media practitioners, developers, academia and citizenry to interact

with one another through an open data portal with the view to provide valuable feedback to government to:

- Positively influence decision and policy making based on accurate data
- Improve service delivery,
- Create enabling environment for businesses to succeed,
- Create job opportunities and
- Drive innovation

This is in direction with current development in the United States of America (USA), the United Kingdom (UK), Kenya and other countries where open data is being used to provide interactive applications and tell stories that citizens can easily appreciate and act upon (Data.gov, 2013; Data.gov.uk, 2013; Opendata.go.ke, 2013; Data.gov.in, 2013).

In the United Kingdom, for example, open data has helped citizens identify Members of Parliament (MPs) who submitted inflated claims (Burn-Murdoch, 2012) and developers to develop applications such as Accident Black Spots, Weather Chart, Energy Consumption Guide, Numberhood, Beat the Burglar, Locatable and Road Traffic Injury Map (Data.gov.uk, 2013).

In the USA, open data has been used to develop applications such as Alternative Fuel Locator, Child Safety Seat Inspections Station Locator, Energy Index for Commercial Buildings, Electricity Data Browser, BioEnergy Atlas, AIRNow, NAEP (National Assessment of Education Progress) Results and ABQ Ride (Data.gov, 2013).

In Kenya, the Code4Kenya¹¹ project, through publicly available data, has provided a platform and enabling environment for individuals and organisations to build applications

¹¹ <http://www.code4kenya.org/>

such as Data Story, Star Health, County Safety Crime Visualisation and Find My School which provide valuable services to citizens.

It is therefore necessary that developers and data scientists have access to datasets to develop visualisations, services and applications that will bring value to citizens in Ghana as is being done in other countries.

2.4.1 The Right to Information

The Public Records and Archives Administration Department (PRAAD) which is supposed to manage archival files in Ghana is in a deplorable building at the mercy of the weather (Bokpe, 2012). It is also reported that about ninety five percent (95%) of national records are in paper form and without backup (Ghana News Agency [GNA], 2011). This means that searching for a piece of data or information can be resource consuming which will make it difficult for officers in that department to comply with requests by ordinary individuals. It also means that if any document is lost and no other ministry, department or agency has a copy of that document, then it is lost forever. This was what happened when the Ministry of Foreign Affairs building was burnt and valuable documents, with some dating before the independence of Ghana, lost in the fire (Ghana News Agency, 2009).

Poor record keeping is still prevalent today; proceedings at the Judgement Debt Commission attest to that (Landtblom, 2013). Governmental agencies appearing before the Commission are unable to present requested documents concerning Judgement Debts; meaning, it will be close to impossible for even private individuals to get any information from these state institutions (Landtblom, 2013). It is either a deliberate attempt by state

officials to hide information or poor management of resources. This is because PRAAD has the trained personnel to manage records for the state (Landtblom, 2013).

The Right to Information (RTI) Bill, 2009 of the Republic of Ghana intends to implement the constitutional right to information held by a government agency, subject to the exemptions that are necessary and consistent with the protection of the public interest in a democratic society, to foster a culture of transparency and accountability in public affairs and to provide for related matters (Ministry for Justice, Ghana, 2009). This bill, first drafted in 2002 and laid before parliament in 2010 is still not passed into law to enable implementation.

The RTI bill makes provision for identifying and contacting the person in a government agency or department responsible for information availability but does not specify in which form that information should be available. In its current state, if RTI bill becomes a law, governmental agencies are not obliged to proactively make data open. The bill only makes provision for reactive provision of information. This will result in delays because the citizen in need of the data or information has to apply and wait for a response. It does not promote the timely use of governmental information whether for research, news or building products and services with real time functionality. A report on Europe revealed that:

“The standards for the right of access to information do not yet encompass a right of access to full databases, to raw datasets, and to information in electronic, machine-processable, and non-proprietary formats. These shortcomings are preventing full access to government data, with a number of countries excluding access to databases from the

national access to information law and with a practice of releasing documents in formats from which data cannot be extracted for reuse. When information is obtained in formats which cannot be understood by computers (such as hard copies, images or PDFs) or when the software support used is not of an open format, then members of the public are limited in their possibility of reusing the information.” (Access Info Europe & Open Knowledge Foundation, 2011). The findings in that report can validly be applied to the Ghanaian situation considering the content of RTI bill.

2.5 ICT in healthcare

2.5.1 Improving Health Care Delivery using ICT

Qiang and Rossotto (as cited by the World Bank and Africa Development Bank, 2012) stated that the use of mobile telephony results in 0.81% GDP growth and internet usage results in 1.38% GDP growth in low income economies. The report (World Bank and African Development Bank, 2012) defined eHealth as

the use of information and communication technology (ICT) – including computers, mobile phones, satellites, software, information systems and digital platforms, etc – to enable, support and deliver health services to patients and populations.

The report titled “The Transformational Use of Information and Communication Technologies in Africa” says that many countries are falling behind on their commitments to the Millennium Development Goals but ICT provides opportunities to positively improve health care (World Bank and African Development Bank, 2012). Some challenges identified in the report are insufficient skilled healthcare workers, lack

of health information systems and inadequate public information about preventable diseases. These challenges can be addressed using ICTs.

The report identified work in progress from various countries. Some of the success stories are the use of an online platform for online training and sharing of best practices between health professionals in ten Francophone countries, Botswana's eLearning programme for community health workers and the use of Sproxil by mPedigree of Ghana to track and reduce counterfeit drugs in developing countries.

This is important considering the fact that though there are success stories, from various countries, in the use of ICTs to improve service delivery, most public health IT systems in developing countries exist in silos (Albright Stonebridge Group [ASG], n.a). This makes access to data difficult for government officials, development partners and other citizens.

Through the use of open data publicly available, citizens can take preventive measures, access treatment guidelines online, locate nearest service providers, rate service per service provider and report disease outbreak in their communities. Furthermore open data can help provide educational interventions to support healthcare delivery.

ICT can therefore “improve access, quality and efficiency of health care provision, through better communication, data and information management” (International Institute for Communication and Development [IICD], 2012). This is why ICT for Accelerated Development (ICT4D) policy document of Ghana “identified health as one of the priority sectors in which the broad adoption of ICT can enable the government to achieve its development goals” (Ministry of Health, Ghana, 2005). However the Health Sector ICT

Policy and Strategy document of Ghana, though well documented, has little e-health support (International Institute for Communication and Development [IICD], 2012).

2.5.2 Mobile Health (mHealth)

Istepanian and Lacal say that mhealth was defined in 2003 as wireless telemedicine involving the use of mobile telecommunications and multimedia technologies and their integration with mobile healthcare delivery systems (as cited by Qiang *et al.*, 2011). Currently, mhealth has come to encompass any use of mobile technology to address healthcare challenges such as access, quality, affordability, matching of resources, and behavioural norms (Qiang *et al.*, 2011).

This is promising since a Global System for Mobile Communications Association (GSMA) commissioned report estimates that mobile interventions could help cut healthcare costs by 400 billion USD in developed countries by 2017 and save over a million lives in Sub-Saharan Africa (PwC, 2013).

It is possible because global mobile penetration reached 89 percent in the fourth quarter of 2012 and mobile subscriptions now total around 6.3 billion with actual number of subscribers around 4.4 billion because many people have several subscriptions (Ericsson, 2013). More importantly, estimated mobile penetration in Africa was 70% (Ericsson, 2013). The use of mhealth in Ghana alone is estimated to save 13,800 lives over the next five years (PwC, 2013).

Mhealth using open data will ensure that healthcare is delivered at affordable rates to rural people who may be far away from health service providers. This could be in the form of education on diet, treatments for common ailments, or a means of reporting

health problems. It could also enable stakeholders monitor health interventions and deliver solutions to users. To promote affordability, such systems must be as simple as possible to enable low end phones to access the services provided.

2.6 Challenges of healthcare delivery in Africa

The World Health Organisation (WHO) (2013), in its latest report on Africa titled African Regional Health Report, identified skilled health workers, information and knowledge, funds, infrastructure, essential medicines and medical equipment as basic ingredients of a healthcare system. Absence or inadequacy of these ingredients in Africa has led to deaths among women, newborns and children in Africa who suffer from preventable and treatable conditions (World Health Organisation, 2013); WHO has termed this tragedy the “silent epidemic”. Nineteen (19) of the twenty (20) countries with the highest maternal mortality ratios worldwide, are in Africa; and the region has the highest neonatal death rate in the world WHO (2013).

2.6.1 High cost of treatment

WHO’s report revealed that out-of-pocket payments for health services are high in proportion to household incomes and are a major factor driving poverty in Africa (WHO, 2013). What this means is that many households go below the poverty line after a major incident that requires medical attention. The implication is that, many families will delay seeking medical treatment until it is very late or too late, and those who seek treatment may not be able to seek further treatment again because they cannot afford it. This further implies that increasing resources allocated to healthcare delivery without bringing down

cost of treatment will not reduce mortality and morbidity. Quoting from the report, “just as health can drive economic growth, ill-health can push people into poverty and make it very difficult for them to escape the poverty trap” (WHO, 2013). An analysis of malaria treatment in Ghana showed that 85% of the cost of treatment went to households while government took care of only 15%. This is illustrated below:

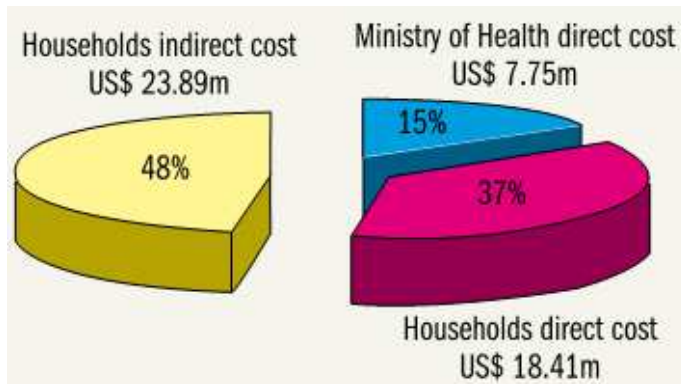


Figure 2. 1 Total cost of malaria illness, Ghana, 2002

Source: WHO Regional Office for Africa as cited in WHO (2013)

This is why the introduction of National Health Insurance Scheme (NHIS) in Ghana has been welcomed by all stakeholders in health delivery. However, ten years after its introduction, NHIS is reported to cover only thirty five percent (35%) of the population with many private service providers pulling out of the scheme (Wereko-Brobby, 2013). This means that the scheme is bedevilled with challenges that are affecting its achievement of national coverage. While the NHIS complain of financial challenges affecting its ability to invest in the health sector, it has managed to put up a headquarters building which many see as not reflecting an organisation with financial challenges (Wereko-Brobby, 2013). It means that transparency in the use of funds at the NHIS is crucial in getting public support in its operations.

2.6.2 Inadequate human resource

It is important for health service providers to have adequate trained personnel. Doctor-patient ratio of the world reveals that African countries have fewer doctors per population compared to European and American countries. This is interestingly illustrated by Jacobs (2006) in the following infographics:



Figure 2. 2 Doctor-patient map of the world

Source: Jacobs (2007)

Doctors are not the only health professionals needed in the health service. Nurses, midwives, pharmacists, radiologists, lab technicians are all among the many skilled persons needed to provide efficient health services.

Many developing countries after spending scarce public resources in training health professionals lose them to developed economies because of better conditions of service outside Africa (Wen, 2007). WHO (2013) reported that Ghana, Zambia and Zimbabwe estimated losses of 15–40% of employees in the public sector every year which was attributed to death, migration and poor conditions of service. This has led to increased demand for expatriates in countries like Ghana (MyJoyOnline, 2013). The figure below shows the flow of doctors in selected African countries between the years 1993 and 2002. It is clear that Ghana and Kenya lost a lot of doctors to other countries between the periods under study.

Country	No. of health workers reported migrated	Main destination
Burundi	127	Belgium, Benin, France, Rwanda
Cameroon	82	Canada, Central African Republic, France, Namibia, Senegal, UK, USA
Central African Republic	176	Cameroon, Côte d'Ivoire, France, Senegal
Côte d'Ivoire	641	Canada, France
Democratic Republic of the Congo	337	Canada, Côte d'Ivoire, France, Senegal, USA, Zambia
Gabon	128	Canada, France
Gambia	233	UK, USA
Ghana	1169	Gabon, Saudi Arabia, South Africa, UK, USA
Kenya	1734	Saudi Arabia, UK, USA, Zambia
Madagascar	341	France, Zambia
Malawi	484	UK, USA
Mali	93	Cameroon, Canada, Côte d'Ivoire, France, USA, Zambia
Nigeria	213	France, Gambia, Kenya, Namibia, UK, USA, Zambia
Sao Tome and Principe	103	Gabon, Namibia, Portugal
United Republic of Tanzania	446	Botswana, Comoros, Equatorial Guinea, Kenya, Mauritania, Namibia, UK, United Arab Emirates, Zimbabwe, USA
Zambia	974	Botswana, UK, USA
Total	7281	

Source: *Survey on migration of health workers in the African Region*. Brazzaville: WHO Regional Office for Africa; 2003.

Figure 2. 3 Outflow of health workers from 16 African countries, 1993–2002

Source: (WHO, 2013)

2.6.3 Scarce and mismanaged resources

Health institutions in Africa have scarce resources and yet drugs and equipment bought for health facilities are stolen by workers and sold on the black market (WHO, 2013).

In Korle-Bu Teaching Hospital for example, workers are reported to break down equipment or deceive clients that equipments are broken down in order to redirect clients to their private outfits around the hospital where they charge exorbitant fees (Benson, Activities of "Goro Boys" short circuit Korle-Bu revenue, 2013). Accountants are also reported to be diverting revenue into their pockets by reducing the bill clients pay to the hospital (Myjoyonline.com, 2013). It is interesting to note that hospital authorities claimed ignorance of mismanagement of resources by underlings until the media made news out of it (Benson, 2013). It means that open data is not only important for clients of the health service providers but also for health service administrators and managers.

2.6.4 Poor drug regulatory system

Results of a survey by IMANI Ghana showed that the Food and Drugs Authority (FDA) of Ghana is perceived by the pharmaceutical industry as needing substantial improvement in quality of service, responsiveness, and general excellence of delivery (IMANI Ghana, 2013). Complaints of clients of the FDA relevant to open data have to do with absence of right amount of information. Respondents said they find it difficult knowing what is being done about their drug certification applications with more than two-thirds of the respondents saying that it takes more than a year to register one product submitted to the FDA (IMANI Ghana, 2013).

This may be one of the reasons why a lot of importers take the risk of bringing in medicines without bothering about certification or FDA approval. In an environment of openly available data, it should be possible for the clients of the FDA and other interested parties to have access to the progression of certification processes in order to ensure that no official or department hinders the process. Cloaking certification processes of drugs targeted at the public in secrecy only serve as a breeding ground for corrupt and inefficient officials.

If data is readily available, the accusations and counter accusations between Tobinco Pharmaceuticals Ltd and the FDA (Essel, 2013) will not be necessary because interested parties will be able to make more informed discussions and conclusions.

2.6.5 Access to health services

It is reported that on average, in Ghana, 40% of the population live more than an hour's travel time from the nearest health centre while 50% live within a 30 minutes travel distance. However 90% of people in northern Ghana do not have access to health services. Complicating the situation further is the fact that, specialist services are largely limited to the regional capitals (IICD, 2000). However, these challenges can be addressed by e-health strategies that will enable citizens' access to services remotely.

2.6.6 Other challenges

Other challenges identified by Kirigia and Barry (2008) include weak public health leadership and management; inadequate health-related legislations and their enforcement; limited community participation in planning, management and monitoring of health services; weak inter-sectoral action; horizontal and vertical inequities in health systems; inefficiency in resource allocation and use; and weak national health information and

research systems. The Health Coordinating Council Bill of 2010 agrees to the issue of governance challenges by stating that irregular meetings of heads of health agencies in Ghana has undermined their ability to provide adequate leadership for the health sector (Parliament of Ghana, 2010).

It is clear that challenges facing health care delivery are many, complex and policy related. While governments are struggling to implement policies that will improve service delivery, they need to involve communities in planning, monitoring and management (Kirigia & Barry, 2008).

In the process of planning interventions to challenges affecting efficient healthcare delivery, it is important to consider sustainability of these interventions. Sustainability must consider the use of readily available resources, easy adoption and value addition to interventions by users.

2.7 Theoretical framework of the study

“Theories are formulated to explain, predict, and understand phenomena and, in many cases, to challenge and extend existing knowledge, within the limits of the critical bounding assumptions. The theoretical framework is the structure that can hold or support a theory of a research study. The theoretical framework introduces and describes the theory which explains why the research problem under study exists” (University of Southern California [USC], 2013). A theoretical framework consists of concepts, together with their definitions, and existing theory or theories that are used for a particular study (USC, 2013). A theoretical framework is important in exploratory studies, where you really don't know much about what is going on, and are trying to learn more (Borgatti, 1999). A theoretical framework therefore helps the researcher to explicitly state or

describe how the philosophy driving the study is linked to practical components on the ground (McCann, 2006).

There are many theories for developing theoretical frameworks but none specifically fits into the study on opening up data. Such theories include the Technology Determinist and Social Shaping of Technology.

Technology Determinist is the theory that technology is a vitally important aspect of the human condition, a prime antecedent that causes change in society, and the fundamental condition underlying the pattern of social organization because new technologies transform society at every level, including institutions, social interaction and individuals (Chandler, 2000; MacKenzie & Wajcman, 1999) however it is inadequate in relating the influence societal interactions have on innovations. This means that it views technology as the main agent of change without considering the people who use the technology. This view means that technology development is not influenced by interactions with users in the society. The Social Shaping of Technology (SST) theory believes that the content of technology and processes of innovation have an influence on its development (Gerst, Bunduchi, & Robin, 2005). Even though SST identifies the importance of innovation, it does not emphasise on the need for opening up data.

This study has therefore adopted the theory of Open Innovation. This theory says that firms can and should use external ideas as well as internal ideas in developing products and services (Eclipse Foundation, 2007). Open innovation provides motivation for outsiders to supply an ongoing stream of external innovations (West & Gallagher, 2006). Open innovation is therefore a partnership with those outside your company in order to

share the risks and rewards of the outcome and process of innovation (100Open, n.a.). This theory is most suitable for this study because it advocates opening up intellectual property of an organisation to the public in order for the public to innovate with it to provide goods and services. This is in line with open data initiatives to open up data of an organisation to the general public in order to improve transparency, interaction and collaboration with users.

Currently, many health sector institutions have realised the need to involve non-professionals in the research and development of health services. Gone are the days of assuming that only health care professionals are able to devise, develop, and disseminate novel concepts and solutions in healthcare (Bullinger, Rass, Adamczyk, Moeslein, & Sohn, 2012).

The theoretical framework of this study is therefore as follows:

- Health institutions in Ghana generate lots of data that can be made open
- There is currently little attempt by health institutions to make data openly available. This may not be for negative reasons but may be due to logistical and technical difficulties in making it happen.
- Open health related data sets can be used to reduce cost of healthcare services, reduce mortality and morbidity and increase the rate of recovery of patients.
- Health related applications (apps) can become an economically viable ecosystem
- Making data openly available in an interactive manner promotes user interest and participation in improving the information available and starts a chain reaction that creates other services and products from such data.
- Information technology automates, informs and transforms health care delivery.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

The purpose of this study is to investigate the possibility of using open health data to improve health service delivery. It sought to identify challenges of health delivery services, how they can be resolved and what kind of open data is needed to resolve them. This chapter therefore describes the type of research design used, instruments for data collection and framework for data analysis.

3.2 Research Design

Trochim (2006) states that a design is used to structure the study in order to show how samples, measurements, treatments or programs and methods used in the study work together to answer research questions. There are many designs for carrying out research. It is important to select an appropriate design that will enable achievement of the objectives of the study. A research design fuses parts of the study together (Trochim, 2006). Research designs include randomised experiments, quasi-experiments, and the non-experimental (Trochim, 2006).

Randomised designs are concerned with cause-effect relationships using random assignment of groups, quasi-experiments are concerned with cause-effect relationships

without random assignments and use multiple groups or waves of measurements while non-experimental design is not concerned with cause-effect relationships. This study is a non-experimental exploratory study.

3.2.1 Exploratory studies

A non-experimental exploratory design is appropriate for this study because it is not about cause-effect relationships but rather trying to understand what is in existence and what can be synthesised from it. This study therefore involves literature search and conducting interviews in order to identify key issues and key variables (Harvard University, n.a.).

Exploratory research is an investigation into a problem or situation which provides insights to the researcher. The research is meant to provide details where a small amount of information exists. It may use a variety of methods such as trial studies, interviews, group discussions, experiments, or other tactics for the purpose of gaining information (WebFinance, 2013). Exploratory research is a methodological approach that is primarily concerned with discovery and with generating or building theory (Davies, 2006).

For example, this exploratory study interviewed respondents and did document search to collect data. It then matched challenges identified with the kind of data required to deal with each challenge.

As a qualitative research, the study is an exploration because, variables were not easily identified but theories must be developed to guide further study. This study is therefore suitable for *how* open data can improve health delivery, *what* are the datasets available or needed and *what* challenges exist with service delivery that can be addressed with open data (Ruskin, n.a.).

3.3 Research population

The study was interested in health service providers and people who patronise health services in the Ketu North District. The district had an estimated population of 99,133 during the 2010 Population and Housing Census (Ghana Statistical Service, n.a.). However, it concentrated on residents of Ohawu village in the Volta Region. Ohawu had a projected population of 2019 people in 2013 based on data available from the Ketu North District Assembly. This was based on the fact that the researcher resides in Ohawu and has strong interest in seeing an improvement in health services in Ohawu.

The rural community of Ohawu was selected because as a rural community, the people of Ohawu face challenges in healthcare delivery which are common to rural communities in Ghana. Such challenges identified by the Community-based Health Planning and Service (CHPS) Initiative include geographic access as a barrier, disparity in urban and rural health status, high mortality rates compared to other regions worldwide, high fertility rates, and brain drain (Ghana Health Service, 2002). It is therefore believed that identifying non-clinical challenges related to open data using a rural community can produce results that can be replicated in other rural communities nationwide.

3.1.1 Health Service Providers

The people of Ohawu patronise seven (7) public health centres under the control of the District Directorate of Health Services (DDHS). These health facilities generate and present monthly reports to the DDHS. These facilities also receive supplies and personnel from the district directorate. Other service providers in the district include two (2)

independent hospitals, one (1) private clinic and one (1) District Mutual Health Insurance Scheme (DMHIS).

3.1.2 Health Service Patrons

The major occupation of the people in Ohawu is farming of cassava, maize and cowpea. The community has a public health centre, connection to the national electricity grid, basic school and a tertiary Agricultural College. Geographical coordinates for Ohawu are 6°7'60" N and 0°54'0" E.

3.4 Sampling technique and sample size

Sampling techniques can be grouped into two broad groups of probability and non-probability sampling techniques. Probability sampling techniques select units from the population at random using probabilistic methods (Lund Research, n.a.) where every unit has a chance of being selected (Statistics Canada, 2013). Probability sampling techniques include simple random sampling, systematic random sampling, and stratified random sampling.

However, non-probability sampling does not involve random selection of respondents. In non-probability sampling, units are selected arbitrarily based on the assumption that there is an even distribution of characteristics within the population (Statistics Canada, 2013) based on the subjective judgement of the researcher (Lund Research, n.a.). Non-probability sampling is useful in exploratory research in order to find out if a problem or issue even exists in a quick and inexpensive way (Lund Research, n.a.). Examples of non-probability sampling techniques are quota sampling, convenience sampling, purposive sampling, self-selection sampling and snowball sampling.

Purposive sampling enables the researcher to decide who takes part in a study based upon a variety of criteria which may include specialist knowledge of the research issue, or capacity and willingness to participate in the research (Oliver, 2006). Purposive sampling, for example, can be divided into maximum variation sampling, homogenous sampling, typical case sampling, extreme or deviant case sampling, critical case sampling, total population sampling and expert sampling.

This study employed a survey using expert purposive non-probability sampling technique. Expert sampling is a type of purposive sampling technique is suitable for collecting data from respondents that have particular expertise or experience (Lund Research, n.a.).

This section is broken down into how health service providers and patrons were selected.

3.4.1 Patrons of Health Services

As an explorative study, this study was interested in respondents who had personal experience at health facilities either through treatment or accompanying somebody else for treatment or consultation within the past two (2) years.

This study did not visit health centres to meet respondents because it would be difficult talking to ill people who might be experiencing one discomfort or the other at that particular moment.

Secondly, respondents who might be experiencing challenges with service provision at that particular moment might be emotional and not cooperate properly or be objective in sharing their experiences. The study therefore decided to use respondents who have ever visited health facilities within the past two years. Respondents were therefore identified by home visits and their willingness to take part in the data collection process.

Average number of clients seen in a day at the health facilities in the District was used in determining the sample size. Records available from the district directorate of the Ghana Health Service showed that the average number of clients seen in a day in 2012 was 351 and that of 2013 was 365. The average of these figures, 358 clients per day was therefore adopted for as the sample size for health service patrons. This figure was used instead of the average number of visits at the public health centre in Ohawu which was only 7 visits per day because it was too small. It is to be noted that the data from the Ghana Health Service did not consider whether there were multiple visits to the health centres or not. Respondents were chosen purposively based on their experience at health service providers.

Out of the three hundred and fifty eight (358) respondents sampled as patrons of health services, two hundred and ten (210) were females with the rest being males. Fifteen (15) of the females were pregnant and thirty five (39) were lactating mothers who visited health facilities regularly.

3.4.2 Providers of Health Services

The 7 public health centres in the district are managed centrally by the DDHS. As such, their data management and reporting structure is under the control of the DDHS. The district directorate of health therefore was used as the sample from this category. Data collection did not target individuals of the DDHS but the DDHS as a body. Respondents were the District Administrator and District Health Information Officer. These two respondents manage data for the DDHS on a daily basis and such were competent in providing data.

The four other health care providers (DMHIS, 2 hospitals and 1 clinic) were not included in the sample because of administrative bottlenecks on their part. While the DMHIS gave excuses of oath of secrecy, the private institutions were not under any obligation to make their data public and gave one excuse after the other in spite of persistent requests by the researcher.

3.5 Instrumentation

The main instruments for data collection were interviews and document search. Interviews enable the researcher to conduct one-on-one questioning of participants (Driscoll, 2001).

Letters were sent to health service providers stating clearly, among other things, the purpose and rationale behind the study, affiliation of interviewer, confidentiality of the respondents, and who to contact should there be the need for clarification of any question.

Interviews provide in-depth information about a particular research issue or question using few subjects (Rider University, n.a.). Questions asked in the interviews were structured around open data. This is to avoid dealing with medical issues which are beyond the skills and interest of the researcher.

3.5.1 Questions to DDHS

Respondents were interviewed on what they know about open data, health related legislation, the mobile devices they use, the kind of data they believe should be made open, the kind of data they already make publicly available, challenges they face in service delivery that can be addressed by making data openly available, challenges that

prevent them from making data openly available and how they think challenges identified can be addressed. A sample questionnaire is attached as Appendix 1.

3.5.2 Questions to patrons of health services

Questions were related to challenges they face in accessing healthcare, the kinds of mobile devices they use, what they know about open data, what they know about health related legislation, and what suggestions they have for improving health services using openly available data. A sample questionnaire is attached as Appendix 2.

3.6 Data collection procedures

Data through interview of respondents were collected to enable the researcher identify health delivery challenges, the perception of respondents about opening up data and expectations of the health care system.

Secondary data was collected from various health related sources. The forms used in collecting data at various health institutions in the district were also requested and analysed in order to identify data that can be opened.

3.7 Framework of data analysis

Analysis of qualitative exploratory study involves identifying themes and subthemes, describing phenomenon, and making comparisons (Ryan, n.d.).

Data is analysed based on the following procedure:

- Using responses from respondents to establish gaps in service delivery that can be addressed using open data

- Proposing applications that can be built to close such gaps
- Identifying and suggesting datasets that need to be collected, and or made public for such applications to be built.
- Identifying sources that might have datasets or that can generate datasets required for applications
- Identifying challenges that hinder generating and opening up data

CHAPTER FOUR

DATA ANALYSIS AND RESULTS

4.1 Introduction

As an exploratory study, this thesis did not test hypothesis validity; it identified challenges and made suggestions about how they might be solved (Brizee, 2010). As a qualitative research, it must be noted that respondents were selected based on their qualities as people who have experienced service delivery at health facilities before. As such, responses were not experimentally examined or measured in terms of quantity, amount, intensity, or frequency (Denzin & Lincoln, 2000).

This chapter presents the results of data collection and analysis. As stated in Chapter 1, this study seeks to identify services that can be developed out of open data to improve the delivery of healthcare in Ghana. The data was collected through personal interview and questionnaires. Descriptive statistics was used to analyse primary data from two sources; from health service providers and users of health services. Data from secondary sources was also analysed to determine how useful they are to the stated objectives. The software package used for this study was MS Excel 2007. The findings are presented in tables and figures below together with related analysis. Even though data was collected from the DDHS, it represents or manages 7 public health centres in the district.

4.2 Background data

4.2.1 Internet connectivity at DDHS

None of the health centres had connection to the internet. Internet connectivity for the DDHS was through a USB stick modem.

4.2.2 Mobile technologies used by service patrons

It was noted that 30% of those without phones could not read or write English while 58% of those who had phones could read and write English. Out of the 319 people who had phones, 120 of them (representing 37.62%) had more than one phone. Users who had smart phones said they use them to access internet enabled applications like Whatsapp and Facebook. This is not surprising considering the popularity of these applications for social networking. Only five (5) people reported having tablet devices.

Table 4. 1 Mobile phones used by respondents

Feature phone		Smart phone		No phone	Total
Quantity	Frequency of use	Quantity	Frequency of use		
242	Very frequent	77	Very frequent	39	358

Based on the data collected, it is evident that applications that can be developed should not make tablet devices their main target. It is clear that a lot of users still rely on feature phones for non-internet activities. Though most of the feature phones can access the internet, they are mostly poorly designed for browsing because they display webpage content as boxes. As such, mobile applications that will not require the use of camera and

voice recorder but can be accessed through SMS should be built in such a way that all mobile devices can access them.

However, considering the increase in smartphone usage in Ghana¹², smart phone versions of apps should also be built to meet demand of users.

4.3 Types of data/datasets available from DDHS

The District Directorate of Health Services (DDHS) stores data in electronic file based systems, relational databases and paper. Long term storage is done using the District Health Information Management Systems (DHIMS). The respondents noted that they are not aware of any government policy, legislation, industry and or institutional rules and regulations that guide their organization in the release of data to the public. They also believe that all data listed below should be made publicly available provided it does not contain personally identifiable information. They therefore make the data types listed below available upon District Director's approval.

Table 4. 2 Data generated by DDHS

Type of Data	Restrictions
Number of patients visiting facility periodically	Every data is partially restricted. Approval from the District Director is
Types of diseases treated at the facility	
Summary of diseases reported or identified per month or year	
Kinds of drugs in stock	
Conditions covered by National Health Insurance	

¹² <http://www.modernghana.com/news/439865/1/increasing-use-of-smartphones-made-ghana-no1-in-mo.html>

Table 4.2, continued

Conditions not covered by National Health Insurance	required for release to the public
Fees charged per condition or treatment	
Categories of health professionals available	
Roll (list) of health professionals and their qualifications	
Number of births and deaths at the facility in given period	
Schedule of health workers per week or month	
Results of research done by the institution	
Vacancies and job announcements	
Financial related data generated per month or year	

4.4 Challenges in healthcare related to data and information

4.4.1 Service delivery challenges

Major challenges identified are grouped as follows:

- Inadequate capacity: improper data collection, untrained record collection and management personnel, and inadequate technical staff for data collection and management.
- Inadequate technology: Poor record storage, inadequate or lack (in some cases) of technology
- Poor access to information: Poor flow of information from health centres, false data provided by clients and partners, difficult to access data/information needed

from other organizations, difficult to access data/information on medicines available from suppliers, pharmacies and drug stores, difficult to access results of research about health produced by universities and health research institutes in the country

- Inadequate and unclear policy and strategy: finance, unclear alignment of HIMS strategy with district and national health strategy.

It is evident from the data above that, while government continues to invest money in training, recruiting and resourcing health workers in data generation, analysis, storage and sharing, it should empower organisations in the health sector to align their HIMS strategy to healthcare delivery strategy in general. This will ensure that investments in HIMS will be not be ad hoc, and will have clearly measurable results. It will also make it easier for institutions to generate and share data with other players in the sector. In order to make it a sustainable process, district and regional health directorates should be encouraged to allocate part of their resources in training personnel in using mobile devices for generating and reporting data because mobile devices are more accessible and less expensive compared to desktops, laptops and servers. Use of mobile devices will also reduce the need for printing forms and generated data which will reduce time spent in entering redundant data, correcting mistakes and the cost of stationery supply.

Due to challenges faced by service providers in generating and managing data, their ability to receive and act on reports of complications from health service users in a timely manner will be reduced. This can lead to high maternal mortality, for example¹³.

Respondents suggested the following:

¹³ <http://www.ghanaweb.com/GhanaHomePage/health/artikel.php?ID=285727>

- Sponsorship of staff for further studies to enable the DDHS train and maintain more competent staff in data generation and management. This is to reduce the rate at which staffs seek transfer to more attractive districts with more lucrative opportunities.
- In-service training in data collection and management is given staff; especially basic ICT training.

While their suggestions will not address all the challenges identified, it will ensure that competent staff exists for data generation and management. In their opinion, without competent staff first, dealing with other challenges will still be futile. The researcher however believes that competent staff should not be out of practice for a long duration because this can lead to skills becoming rusty. It is therefore important that policies in the health sector are streamlined to ensure that HIMS personnel development and inputs for their work is available with policy backing to make their output measurable.

4.4.2 Data needed to be public from other related service providers

The following data were listed as needed by the DDHS

1. Certified drug list and description from the Food and Drugs Authority
2. Drugs in stock by pharmacies/drug stores in the district
3. Approved/Licensed drug sellers in the district from the Pharmacy Council

Respondents stated that they will support open data provided it is not released in the form that will cause panic and misinterpretation by the general public. This is because their industry is specialised one with data that can cause fear and panic if not properly communicated.

4.4.3 Challenges faced by health service patrons

Respondents were asked to describe challenges faced at the health centres and these have been grouped under the following types of challenges.

Table 4. 3 Types of challenges faced at health centres

Challenge	No. of Respondents	% of Respondents
No information on stock of drugs, medicines and other supplies	358	100
Unprofessional behaviour of health workers	358	100
Language/communication difficulty with health workers	234	65.36
No information on kinds of services offered	358	100
Inadequate information on schedule of specialists	358	100
Inadequate information on fees charged per condition or treatment	358	100
Information on categories of health professionals unavailable	358	100
Roll (list) of health professionals and their qualifications unavailable	358	100
Facility map and directions unavailable	156	43.58
Referrals to private service providers	83	23.18
Congestion at the health centre	198	55.31

It is important to note that in cases where all respondents identified the same challenges, it was not because they experienced it on every visit to the hospital but because they occur frequently.

The results of Table 4.3 above agrees with a study by the Centre for Democratic Development (CDD) which reported that 44% of Ghanaians said they have to wait a long time in order to access health care, 32% complained of having to deal with lack of medicine supplies, 31% said that service was too expensive, with 29% saying that there is lack of respect and attention from service providers, while a good number talked about absent doctors and also dirty facilities (Benson, 2013)¹⁴.

Congestion at health facilities can be attributed to the implementation of the National Health Insurance Scheme (NHIS) (Yawson, Nimo, & Biritwum, 2013)¹⁵ which resulted in increased access to healthcare. However, this leads to increased client waiting time which can lead to deterioration of client's condition. Congestion can also be attributed to inadequate of health professionals considering increasing access to healthcare due to NHIS. However, congestion may be higher in urban areas compared to a rural area like Ohawu.

A related study conducted at Koforidua Regional Hospital¹⁶ also reported that 46.6% of respondents rated nurse-patient relationship as unsatisfactory, with 60.2% of respondents rating pharmacist explanation of drug information as not encouraging and 90% of respondents reporting spending more time of between 3 to 6 hours at the health facility (Ofosu-Kwarteng, 2012). Delays encountered were further attributed to processing the

¹⁴ <http://www.myjoyonline.com/news/2013/December-11th/improve-commitment-towards-transparency-prof-gyimah-boadi-tells-government.php>

¹⁵ <http://ghcps.org/wp-content/uploads/2013/02/1NHIS-article.pdf>

¹⁶ <http://dspace.knust.edu.gh:8080/jspui/bitstream/123456789/4821/1/Ofosu%20Kwarteng.pdf>

National Health Insurance Cards of outpatients, many patients and inadequate doctors and nurses, long and cumbersome procedures, low output of doctors and nurses, dispensary slow in serving patients, favouritism and discrimination. The study by Ofori-Kwarteng (2012) therefore confirms results collected in this study about challenges faced by clients of health services.

4.5 Datasets that can be made open or that can be generated

There are many datasets on healthcare; however, this study is interested in data that can be made open. This section therefore identifies sources of data that will be of help to the public in general.

4.5.1 Service quality parameters

It will require generation of the following data on a periodic basis by an interested third party like the Ghana Health Service or the National Health Insurance Authority. Such datasets can include the following:

- How often did nurses communicate well with patients?
- How often did doctors communicate well with patients?
- How often did patients receive help quickly from hospital staff?
- How often was patients' pain well controlled?
- How often did staff explain about medicines before giving them to patients?
- How often the patients' rooms and bathrooms were kept clean?

- How often the area around patients' rooms was kept quiet at night?
- Were patients given information about what to do during their recovery at home?
- How do patients rate the hospital overall?
- Would patients recommend the hospital to friends and family?

The questions listed above were based on datasets available at the USA Medicare¹⁷ website; meaning that they are questions used by Medicare in the USA to rate health centres. However, conditions that favour collection of such datasets in the USA do not exist in Ghana therefore considering the existing challenges with data generation; it will require serious commitment and retooling of health service regulators to make it a success.

Other service parameters for datasets can include effect of medical procedures like surgery and medicine prescription.

4.5.2 Food and Drugs

The National Pharmacovigilance Centre receives suspected Spontaneous Adverse Drug Reaction (ADR) reports from healthcare professionals (Food and Drugs Authority [FDA], 2013). These reports are used to generate the top twenty (20) drugs with the most reported ADRs. The Food and Drugs Authority (FDA) of Ghana also publishes a periodic list of approved drugs and foods in Ghana. These datasets if made available to the general public will help in protecting the consumer. Regular alerts¹⁸ describing what consumers must look for to determine fake and unregistered substances should be done.

¹⁷ <https://data.medicare.gov/data/hospital-compare>

¹⁸ <http://www.ghananewsagency.org/health/fda-arrests-fake-medicine-peddlers--66991>

The National Health Insurance Authority (NHIA) currently provides a list of medicines approved for the NHIS¹⁹. This list shows the generic name of the drug, unit of pricing, price and level of prescription but does not specify when the list was last updated. Though it is openly available, it needs to be made into open data to enable interested third parties track changes to the list, and to easily use it in their applications.

4.5.3 Registered professionals

The Pharmacy Council of Ghana, Nurses and Midwives Council of Ghana, Medical and Dental Council of Ghana are some of the organisations that register professionals in the health sector. The lists of registered members could be made available. The Medical and Dental Council (MDC) of Ghana makes available yearly standing registers of Medical, Dental²⁰ and Physician Assistant²¹ practitioners. However these data are in the Portable Document Format (PDF) and therefore cannot be classified as open datasets.

For other health professionals, it is easy to find a list of lawyers and legal service providers in Ghana from the State Department website²² of the United States of America and its embassy in Ghana website²³ than to find that of other registered health workers in Ghana. If we consider health as important to national productivity, then we must improve upon sharing such datasets.

These datasets can reduce the number of unlicensed shops and individuals peddling drugs at the lorry stations, schools and offices in the country. While it is easy to find a list of people with pictures claiming to be health professionals in Ghana available from

¹⁹ <http://www.nhis.gov.gh/MedList.aspx>

²⁰ <http://www.mdcghana.org/pdfs/STANDING%20REGISTER%202013.pdf>

²¹ <http://www.mdcghana.org/pdfs/PHYSICIAN%20ASSISTANTS%27%20STANDING%20REGISTER%202013.pdf>

²² http://photos.state.gov/libraries/ghana/231771/PDFs/List_of_attorneys_in_ghana_july_2012.pdf

²³ <http://ghana.usembassy.gov/root/pdfs/attorneys.pdf>

LinkedIn²⁴, it is difficult to identify or verify the authenticity of such claims from the websites of the various associations and professional registering bodies. Making these datasets publicly available will help in marketing the registered professionals and licensed shops and give them an edge over peddlers and quacks.

4.5.4 Registered health centres

It is important that care is given by qualified practitioners and at registered facilities that meet the standards of health care regulators. However, many clinics are not registered but are patronised by the general public. A typical case was that of a quack doctor who was performing abortions in an unlicensed facility while abusing the victims in the process (Anas, 2012). Provision of a list of registered health centres will enable users know what kind of services are offered at each facility instead of going to the facility before being referred to another facility.

The NHIA has a list of registered health insurance providers on their website²⁵. These providers range from drug stores to hospitals. However, it is difficult to determine the service or drugs stocked by such facilities.

4.5.5 Health care indicators

The various district, municipal and metropolitan health directorates collect data on various parameters from service providers in their jurisdictions. Such datasets include:

- Top 10 OPD diagnosis

²⁴ <http://gh.linkedin.com/title/pharmacist> , <http://gh.linkedin.com/title/nurse>, <http://gh.linkedin.com/title/dentist>, <http://gh.linkedin.com/title/medical+doctor>

²⁵ <http://www.nhis.gov.gh/ProviderInfo.aspx>

- Top 10 admission causes
- Top 10 causes of deaths
- Number of OPD attendance in a day at each facility
- Rate of OPD attendance by insured and non-insured
- Rate of total admission by insured and non-insured

These datasets could guide citizens to know what is affecting them most in their locality in order to plan their lives accordingly. As local representatives of the ministry of health, the directorates can make service delivery more competitive by taking data on quality of care delivery through monthly or quarterly surveys. These surveys can be done in collaboration with the Mutual Health Insurance Schemes in order to let citizens make informed choices on where to go for treatment or consultation.

Another source of data is the Ghana Open Data Initiative (GODI). Datasets available from GODI²⁶ include:

- Sector Wide Indicators For Health Care in each region
- List of health facilities in Ghana
- Number of ambulance emergency response

It will however be better if more detail can be provided on the datasets provided from the district levels.

²⁶ <http://www.data.gov.gh/>

4.6 Proposal of health related apps

This section proposes health related apps based on challenges identified by service providers and users. Some of the apps already have some suitable datasets available while others will require the opening up of more datasets or the generation of more data to make their development feasible. Some of these apps can be full blown smartphone apps or feature phone apps based on complexity and target audience.

4.6.1 Health facility finder

This app will assist users locate a facility based on data on distance from user, cost of treatment, quality of care, drugs in stock, type of treatment provided, congestion at the OPD, equipment and practitioner availability. It will require the following datasets:

Table 4. 4 Data for health facility finder

Dataset	Openly available	Where?
Facility name, type and location	Yes	http://data.gov.gh/
Drugs in stock	No	
Services provided	No	
Service quality	No	
Average daily OPD attendance	No	
Logistics in stock	No	
Staff strength and specialisations	No	
Rating	No	
Personnel	No	

This app will rank facilities by service quality rankings, an algorithm to use facility geological codes to calculate distance of facility from the device accessing the app or distance from a specific town. It will also rank facilities based on previous monthly OPD visits or if possible use live data to report congestion level in real time. This will enable emergency care providers determine which facility to send a casualty to and not just rush to the nearest facility based on distance but based on availability of resources. Probably, the nearest health facility that might not be congested will have first aid personnel to assist before onward transfer to specialised centres.

This app can be in two forms; a feature phone oriented service and a smartphone app.

- **Feature phone oriented services**

For example, by default, a missed call to a short code, say 227, should return a message of the nearest health centre based on distance while an SMS with “Q” as content should return the nearest health centre based on service quality and an SMS with “G” as content should return directions to the nearest centre with a Gynaecologist or Midwife. Telecommunication service providers can sponsor this service and provide it for free for a pilot period and at a reduced fee to subscribers. This app can calculate distance from device because telecommunication service providers can estimate distance of a device from a cell tower.

- **Smartphone app**

The smartphone app can have a pre-loaded list of facilities, contact numbers, directions, initial ratings and other details. The app can be configured to check online for regular

updates to the list in order to stay updated. The advantage with such an app is that, an always on internet connectivity is not required for most of its services to work. Such an app can show maps of facilities to help clients locate the facility. A user can use the app to post comments or rate a facility they have just attended. Such an app can provide a search box to type in a facility, town, district, or region name and look through the result to compare facilities based on the many parameters available.

4.6.2 Indicator visualisations

Visualisations can be about weight and height of facility user over time; progress on response to treatment; or health care indicators in the district over time. These are necessary to enable citizens who might not be statistically inclined or less literate to read full reports to easily understand what they need to know.

- **Progress over time on feature phones**

It is good for showing ante-natal progress of children. Nurses can enter records of babies into their phones and it will be sent as an SMS to the parents' registered phone and a graph displayed using previously recorded data. Or it could be accessed by the parent using Interactive Voice Response (IVR) to tell the parent in a local dialect that "your child has increased in weight by 2kg" or "your child has decreased in weight by 3kg".

There was an incident narrated of a parent who saw 23 and thought it was 2.3 and got worried that the child's weight has dropped.

- **Progress of user over time on smart phones**

Patients can be trained to use the app to record, store and share their progress over time and visualise it as graphs, or animations or listen to an audio in order to make meaning out of it.

Table 4. 5 Data for indicator visualisations

Dataset	Available	Where is it available?
Growth parameters	Yes	Patient records at the health centre
Drugs administered	Yes	
Immunisations received	Yes	
Treatment received	Yes	
Cost of treatment	Yes	

4.6.3 Immunisation alerts

Tracking movement of immunisation workers in a community will enable authorities monitor their performance and progress in achieving set targets. It will also enable citizenry estimate when the health worker will be in their community and where the nearest meeting point is. This will ensure that interested citizens do not miss vaccination teams because of work, leisure or any other reason.

Such an app will require health workers to carry mobile devices as they move about the community administering vaccines. Instead of using paper to record their progress, workers can be trained to enter records directly on the mobile phone which will synchronise data periodically in the background with the monitoring centre. Community

members can also send a missed call to a short code and the nearest worker's phone number or location can be sent to their phone to enable them meet with little or no problem.

An app can also be designed to send regular blast messages to community members of a scheduled immunisation campaign, its progress and points of contact.

Table 4. 6 Data required for immunisation alerts

Dataset	Openly available	Where is it available?
Geo location of health worker	No	Telecommunication companies
Quantity of vaccine left	No	Records of health worker
Schedule of health worker	No	Records of health worker
Contact number of health worker	No	Programme coordinators

4.6.4 Food and drug alerts

Whenever license is given to a drug store to operate in a locality, interested authorities should be notified in order to monitor. Proactively, when application is received for licensing, local authorities should be notified to make inputs.

A list of approved drugs and unapproved drugs identified on the market should be easily accessible to the general public and other health service providers.

Similar to the immunisation apps, blast messages can be sent to registered users anytime there is an update to the list of approved or unapproved drugs and food items.

To increase transparency, an app can also used to enable interested parties monitor the evaluation process and reports of new drugs being introduced into the market.

Table 4. 7 Data required for food and drug alerts

Dataset	Openly available	Where is it available?
Approved drugs	No	Food and Drugs Authority
Approved drugs	Yes	NHIA
Unapproved drugs	No	Food and Drugs Authority
ADR reports	No	Food and Drugs Authority

4.6.5 Birth and death registrations

This app can be an SMS based app. On the birth or death of a person, users will send SMS to a short code. For example “D GOV1255” meaning person with birth certificate number GOV1255 is dead. If it is the birth of a child, “B 0208359041” can be sent to the short code meaning a child has been born, please call 0208359041 in order to register this child. It is then up to officials of the Birth and Death Registry of Ghana to use the message to investigate and update their records.

Table 4. 8 Source of data for birth and death registration

Dataset	Openly available	Where is it available?
Report of new born	No	Birth and Death Registry
Report of death	No	Birth and Death Registry/Mortuary
Births and deaths in a period in an area	No	Birth and Death Registry

4.6.6 Stock levels of essential health logistics

It is important that local authorities know when essential health inputs are at a critical low or approaching critical low stock levels in the area. It ensures that shortage of inputs is reduced. It also enables citizenry track and help care providers account more transparently to the general public. It promotes preparedness in order to handle likely disasters in an efficient and timely manner.

Such an app will rely on an electronic store system to send SMS to the necessary authorities when essential logistics reach critical levels. It will also provide rate of use of logistics over time to users. Emergency workers in need of a particular logistic can also query the system to determine which nearest hospital have it in stock in order for fast efficient response in times of crises.

For example, reports of shortage of snake venom anti-serum by the media and subsequent denial by the Ministry of Health²⁷ would not have arisen if such a system were to be in place.

Table 4. 9 Data sources for health logistics

Dataset	Openly available	Where is it available?
Essential drugs	No	Ghana Health Service/Health Centres
Vaccines	No	Ghana Health Service/Health Centres
Surgery logistics	No	Ghana Health Service/Health Centres

²⁷ <http://citifmonline.com/mobile/index.php?id=1.1613620>, <http://www.modernghana.com/news/504678/1/re-shortage-of-snake-venom-anti-serum.html>, <http://www.ghanaweb.com/GhanaHomePage/NewsArchive/artikel.php?ID=293003>

4.6.7 Registered and licensed health workers

It will enable facility users easily ascertain the authenticity of qualification claims by health workers and to also find specialists based on their conditions or needs.

Table 4. 10 Data sources for identifying qualified registered health professionals

Dataset	Openly available	Where is it available?
List of registered nurses	No	Nurses and Midwives Council of Ghana
List of registered pharmacists	No	Pharmacy Council of Ghana
List of registered doctors	No	Ghana Medical and Dental Council
Ratings	No	

Users of such an app can browse through registered list of personnel by facility name, specialisation and registration numbers. An SMS system can be built to enable users text, for example, “MD 345” where MD means “medical doctor” and 345 is the unique code of the health centre boldly displayed on its signboard to ascertain the list of doctors at that facility.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter deals with summary of study, implications, limitations of the study, directions for future research and other recommendations based on data discussed in previous chapters.

5.1 Summary of main findings

This study sought to identify datasets available on healthcare for Ghana, establish health related datasets that can be made open, establish challenges in healthcare delivery that can be addressed using openly available data and propose mobile applications that can address challenges identified.

5.1.1 Datasets available on healthcare in Ghana

Datasets are available on health care in Ghana from the District Health Directorates, professional association bodies, National Health Insurance Authority, Food and Drugs Authority, and the Ghana Open Data Initiative (GODI) website²⁸. The data available range from list of qualified personnel, health facility names and locations, registered drugs, health indicators, patient records, financial and other administrative records. These datasets, apart from those at the GODI website, are not open data. There are restrictions

²⁸ www.data.gov.gh

on them and some are not in electronically accessible format. All datasets that are not available on GODI website must be made open and shared on the GODI platform.

Considering the effort involved in making open datasets, institutions can make their data open access so that interested third parties can turn these open access documents into open data. This will be in line with the theoretical framework adopted by this study of Open Innovation. Sharing on the GODI platform reduces the risks and expenditures involved in individual service providers hosting their own open datasets online.

5.1.2 Healthcare delivery challenges that can be addressed using open data

A list of challenges is presented in tables 4.5 and 4.8 of chapter four above. The study established key challenges that can be addressed using open data and these include poor service quality at the facilities, poor personnel-clients relationships, inter-organisational sharing of data and information, inadequate transparency in logistics and store management, difficulty to distinguish qualified personnel from unqualified personnel, sharing of research findings between institutions.

5.1.3 Suggested health apps based on open data

Possible apps identified include those for identifying approved drugs, registered health workers and centres, knowing stock levels of logistics at each facility, birth and death recording, food and drug alerts, immunisation alerts, health indicator visualisations and health facility finder. Many of these apps do not have their required data openly available and some will require collection of new data.

Successful implementation of these apps requires commitment, retooling and training of personnel by service providers, industry regulators and professional associations.

5.1.4 Proposed health facility application (app)

Application features

This app will enable users to search for a facility, find contact details of departments or units in the facility and location on a map. It will also enable users to rate and view rating of various services provided at the facility as well as rate health workers and view details of qualifications, skills set and experience of health workers. Ratings by users can be compared with ratings by industry regulatory bodies. The app will also enable users to view medications, drugs and other clinical resources in stock at each facility and compare client congestion data at the facilities. Alerts and announcements from the facility for users can also be viewed by users. This app is expected to give users more data in making informed decisions on which facility to visit especially since majority of facilities are offering National Health Insurance services.

Data required

Data for the various features suggested above are all not available. Geolocation, type of facility, ownership, NHIS status and other details of facilities are available from the GODI²⁹ platform and NHIA³⁰ website.

²⁹ www.data.gov.gh

³⁰ <http://www.nhis.gov.gh/ProviderInfo.aspx>

Conceptual framework proposed for application development

Conceptual frameworks are used to present a preferred approach to an idea or thought (Ulrich Schiel, Vieira, & Salgado, 2010). Considering the fact that all the data is not available and many users, though with challenges, may not want what they do not yet know is possible or available (Hawn, 2011), a prototype model is proposed for developing the app. A prototype model fits into Todd Park's Rules for Innovators (Hawn, 2011) and it is proposed based on the Contingency Framework for software development (Tatikonda & Lorence, 2002).

By creating a model, user information can be solicited to help in clarifying the requirements (Rowen, 1990). The prototype model enables apps to be developed with a minimum set of features, release early to users, modify existing features and add new features based on new data availability and user feedback.

A rapid prototype has therefore been developed using jQuery Mobile, data from GODI platform and Google Maps. This app is available at <http://mawulisevor.github.io>.

5.2 Implications

The DDHS identified weak human resource and institutional capacity for information management, gaps, duplication and waste among parallel health information systems, lack of timely reporting and feedback, unstructured investments and deployment of ICT, poor quality data, and inadequate use of information for decision making as impeding their role in collecting, managing and sharing health data.

Addressing these issues will require commitment by District, Municipal and Metropolitan Assemblies (MMDAs), decentralised departments and agencies in the MMDAs, regional, national directorates and ministries in ensuring that health information generation and management is made a priority. As is evident from a publication from the Christian Health Association of Ghana (CHAG) website³¹, “the production, analysis, dissemination and use of reliable and timely information for decision making, planning, lobbying and advocacy and performance management purposes has always been a major challenge” for health service providers. However, if managers and administrators can be trained to use and improve performance of their facilities using information and data, they will be ready to invest more into health information systems.

It must be noted that, the theory of Open Innovation discussed in Chapter 2 above will help service providers reduce the risks and challenges involved in generating, opening up data and building data applications. Opening up data will enable enthusiastic developers and entrepreneurs fill the existing gap and create applications and services that will augment or support what service providers are using. Open data is therefore not an attempt at necessarily exposing what is wrong in the system; it is rather a tool to invite partners to share in improving healthcare quality, efficiency and success.

This requires the formulation of health facility information systems strategic plan that will align Health Information Management Systems (HIMS) creation and operation with organisational objectives. If this is done, value generated from HIMS can be linked to organisational goals and objectives because top level managers might be interested in short term results while strategic plans normally have a focus of 1 to 3 years.

³¹ <http://www.chag.org.gh/index.php/2011-11-12-17-32-20/health-information>

Opening up data also require policies and strategies to protect personalised patient data to protect the privacy of clients. It also requires the creation and adoption of legislation and open licenses to guide the sharing and use of data. In this direction, health authorities and other interested parties can look at the suite of licenses from the Creative Commons ³²and guidelines for what is open data from publications on open data discussed in Chapter 2 of this thesis.

The following approach is therefore suggested as the way forward for opening up data by health service providers:

- Formulate and implement an I.T. strategic plan, if not already in existence and implementation. This plan must be in line with organisational goals and objectives.
- Analyse the strategic plan and identify data that can be made open.
- Identify copyright and legal issues that need to be addressed.
- Reach out to I.T. and health professionals and other interested persons to contribute to opening up data through specific projects and competitions.
- Dialogue with sister institutions and partners with strengths in a specific field to collaborate and share resources for open data project. One such partner can be the GODI platform.
- Open up the process of data acquisition and generation.

³² <http://creativecommons.org/weblog/entry/41061>
http://wiki.creativecommons.org/Intergovernmental_Organizations#FAQ:_CC_
http://www.wipo.int/pressroom/en/articles/2013/article_0026.html

- Make data sharing easy by depersonalising data, removing copyright and legal restrictions and making data available in digital machine readable formats.
- National Health Insurance Authority, Ghana Health Service, Christian Health Association of Ghana, health personnel professional bodies and the Food and Drugs Board should collaborate in accelerating adoption of open innovation strategies by service providers.

In the form of a diagram, the process is presented below:

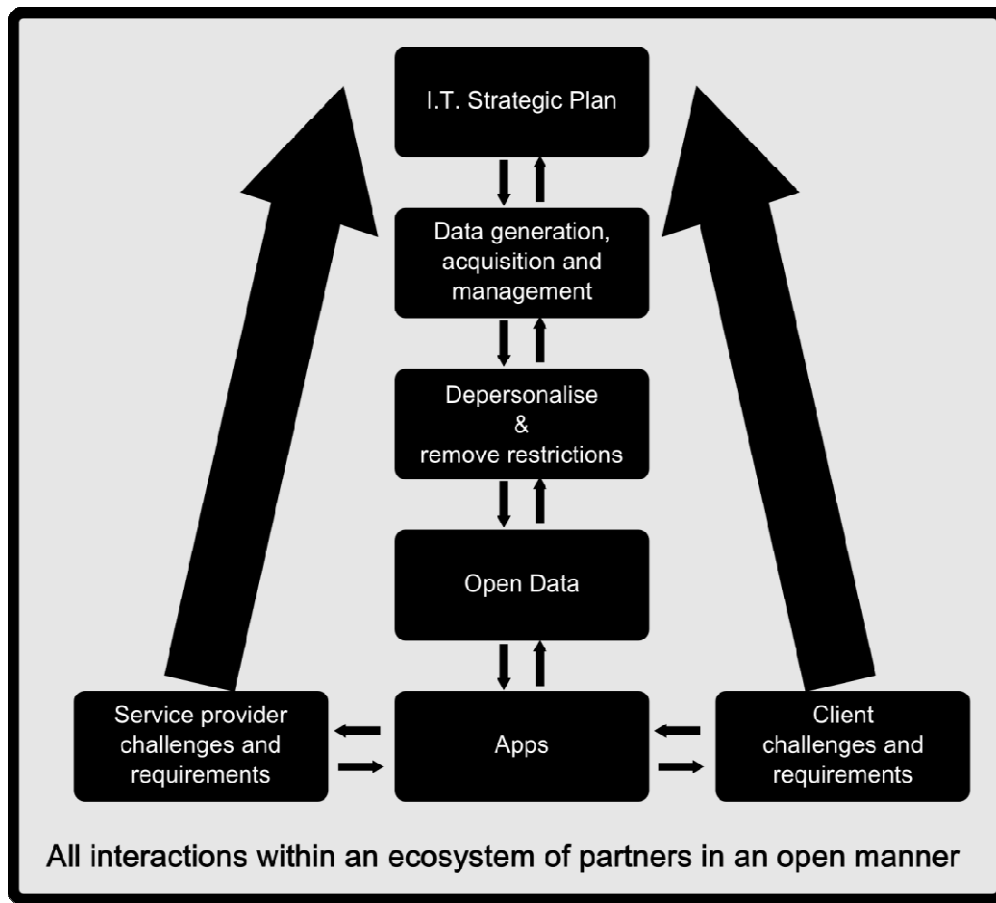


Figure 5. 1 How to adopt Open Innovation for Health Service Providers

5.3 Limitations of the Study

As an exploratory study, this study did not concern itself with empirical data analysis. Data provided therefore is not for inference to a general population. It has however successfully been able to achieve its stated objectives which will require further research and study.

5.4 Directions for Future Research

The study identified the following questions that can be used in formulating hypothesis for future studies in improving health delivery using open data.

- Is the absence of congestion information the reason why people queue at health facilities?
- Will the rating of service quality improve service delivery at health facilities and make service delivery competitive among service providers?
- Will the ready availability of details of registered and licensed service providers, professionals and shops reduce the patronage and presence of quacks or illegal providers?
- Will the opening up of store, supply and logistic records increase transparency and ensure efficient delivery of emergency services?
- Will the opening up of logistic records increase or improve access to drugs at facilities?
- How can data be generated and shared in a sustainable way in resource constrained environments?
- What open licenses will be suitable for health care systems in Ghana?

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QUESTIONNAIRE

*Exploring the Use of Open Data to Improve the
Delivery of Health Services in Ghana's Ketu
North District*

November, 2013

**Accra Institute of Technology (AIT)
campus of the Open University, Malaysia
(OUM)**

CONTACTS

Graduate student: Mawuli K.E. Sevor	(0208359041)
Supervisor: Justin Chisenga (PhD)	(0549584044)

Dear Sir/Madam,

My name is Mawuli K.E. Sevor and I am a student at the Accra Institute of Technology (AIT) campus of the Open University, Malaysia (OUM). I am studying for a Master's Degree in Information Technology. For my research, I am "*Exploring the Use of Open Data to Improve the Delivery of Health Services in Ghana's Ketu North District*". I am inviting your organization to take part in this research by completing this questionnaire.

In this research, **open data** is defined as a piece of data or content which is free for anyone to use, reuse, and redistribute it - subject only to acknowledging the data source/owner or share-alike. Open data is also information that is available for anyone to use, for any purpose at no cost; while **Open access** (OA) describes access to literature that is digital, online, free of charge, and free of most copyright and licensing restrictions.

The focus of the study is to identify datasets (collections of data) available on healthcare for Ghana, establish datasets in the health sector that can be made open, establish challenges related to data/information in healthcare delivery that can be addressed using open data and to propose a design for a mobile application to address at least one challenge identified. The data from the survey will contribute to achieving the objectives of the research.

Data collected in this study will be treated as confidential and only be used for the purpose of writing the dissertation and proposing a design for a mobile application.

Please, note that the survey is about the organization and not about the individual completing the questionnaire.

Thanking you in advance for participating in the survey,

Mawuli K.E. Sevor

Tel. 0208359041

Email: mawulisevor@gmail.com

A. GENERAL INFORMATION

Name of institution: _____

Address: _____

Telephone (for clarification purposes relating to this study): _____

Job title/position of person completing the questionnaire: _____

Your organization is a (**please circle the applicable option**):

a). clinic

b). hospital

c). government department/unit

d). Other (please specify): _____

B. MOBILE TECHNOLOGIES/DEVICES USED

1. In the table below, please indicate the brand and model of the **mobile phones** that you use, and tick (✓) the frequency of use of the phone(s). (*Please list all that apply*)

Table 1: Mobile phones used

BRAND	MODEL	FREQUENCY OF USE (Please tick ✓)		
		Very Frequent	Slightly frequent	Not frequent
Examples				
Samsung	GT-E1500	✓		
Tecno	N95			✓
Nokia				
Samsung				
Tecno				
Huawei				
LG				
iPhone				
rLG				
Bird				
HTC				
Blackberry				
Others (please specify)				

2. In the table below, please indicate the brand and model of the **tablet devices** that you use, and tick (\checkmark) the frequency of use of the phone(s). (*Please list all that apply*)

Table 2: Tablet devices used

BRAND	MODEL	FREQUENCY OF USE (Please tick ✓)		
		Very Frequent	Slightly frequent	Not frequent
Examples				
Samsung	Galaxy Tab 3		✓	
Zepto	T10	✓		
Samsung				
Tecno				
Huawei				
iPad				
rLG				
Lenovo				
HTC				
Surface				
Zepto				
Others (please specify)				

C. TYPES OF DATA/DATASETS GENERATED

3. Which of the follow data/datasets are generated by your organization and what restrictions are there in making the data publicly accessible? *(Please tick all that apply)*

Type of Data	Please tick (√) if generated by your organization	Restrictions on making it public (Please tick √)		
		No restriction	Partially restricted	Fully restricted
Number of patients visiting facility periodically				
Types of diseases treated at the facility				
Summary of diseases reported or identified per month or year				
Kinds of drugs in stock				
Conditions covered by National Health Insurance				
Conditions not covered by National Health Insurance				
Fees charged per condition or treatment				
Categories of health professionals available				
Roll (list) of health professionals and their qualifications				
Number of births and deaths at the facility in given period				
Schedule of health workers per week or month				
Results of research done by the institution				
Vacancies and job announcements				
Financial related data generated per month or year				
	Others (please specify)			

4. In what forms do you store data in your organization? *(Please circle the applicable Option)*
- Electronic file based systems *(Eg: MS Word, Excel ...)*
 - Relational databases *(Eg: MySQL, Access, MS SQL, Oracle DB)*

- c) Paper
- d) A combination of answers (e.g.: a/b or a/b/c from above) _____

D. CHALLENGES IN SERVICE DELIVERY

5. What challenges (relating to data and information) does your organization face in the delivery of its services to the general public and to internal departments/clients?.

CHALLENGES	Please tick <input checked="" type="checkbox"/> all that apply
Improper data collection	
Untrained record keeping personnel	
Poor record keeping/storage	
Poor flow of information	
False data provided by clients / partners	
Lack or inadequate availability of technology for data collection, processing and management	
Financial constraints in data generation and storage	
Difficult to access data/information needed from other similar organizations	
Difficult to access data/information needed from the Ministry of Health and government departments	
Difficult to access data/information on medicines available from suppliers and in pharmacies	
Difficult to access results of research in health produced by universities and health research institutes in the country	
Others (<i>Please specify</i>)	

E. OPENING UP DATA

In relation to types of data/datasets identified in section C as generated by your institution, please answer the following in this section.

6. Is there any government policy, legislation, industry and or institutional rules and regulations that guide your organization in the release of data to the public? (*Please circle your response*)

Yes

No

7. If your response to Question 1 above in this section is “Yes”, please answer the following:

What is/are these legislations? For example: *Ghana Health Service Regulation 456*

(Please number or label your responses)

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and extend across the width of the page. There are no margins, text, or other markings on the paper.

8. Considering data/datasets generated by your institution, what kind of data/datasets do you believe should be made publicly available? (*Please number or label your responses*)

[illegible]

9. What kind of data does your institution currently make publicly available? (*Please number or label your responses*)

[illegible]

10. What challenges or obstacles prevent your institution from making data publicly available?

(Please number or label your responses)

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

11. How do you think the challenges identified in Question 5 above can be addressed to make data publicly available? (*Please number or label your responses*)

[illegible]

12. Considering data/datasets related to health services generated by **OTHER ORGANIZATIONS** including the Government (i.e. Ministry of Health, Food and Drugs Authority (FDA), Pharmacies, etc), what kind of data/datasets do you believe should be made publicly available? *(Please number or label your responses)*

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Yes

No

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QUESTIONNAIRE

(Clients)

*Exploring the Use of Open Data to Improve the
Delivery of Health Services in Ghana's Ketu North
District*

November, 2013

**Accra Institute of Technology (AIT) campus
of the Open University, Malaysia (OUM)**

CONTACTS

Graduate student: Mawuli K.E. Sevor	(0208359041)
Supervisor: Justin Chisenga (PhD)	(0549584044)

Dear Sir/Madam,

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Thanking you in advance for participating in the survey,

Mawuli K.E. Sevor

Tel. 0208359041

Email: mawulisevor@gmail.com

B. GENERAL INFORMATION

Name of respondent: _____

Address: _____

Telephone (for clarification purposes relating to this study): _____

B. MOBILE TECHNOLOGIES/DEVICES USED

15. In the table below, please indicate the brand and model of the **mobile phones** that you use, and tick (✓) the frequency of use of the phone(s). *(Please list all that apply)*

Table 1: Mobile phones used

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Tecno	N95			✓
Nokia				
Samsung				
Tecno				
Huawei				
LG				
iPhone				
rLG				
Bird				
HTC				
Blackberry				
Others (please specify)				

16. In the table below, please indicate the brand and model of the **tablet devices** that you use, and tick (✓) the frequency of use of the phone(s). *(Please list all that apply)*

Table 2: Tablet devices used

BRAND	MODEL	FREQUENCY OF USE (Please tick ✓)		
		Very Frequent	Slightly frequent	Not frequent
Examples				
Samsung	Galaxy Tab 3		✓	
Zepto	T10	✓		
Samsung				
Tecno				
Huawei				
iPad				
rLG				
Lenovo				
HTC				
Surface				
Zepto				
Others (please specify)				

C. TYPES OF CHALLENGES FACED

17. What challenges do you encounter when interacting with health professionals like nurses, doctors and laboratory technicians, dispensing technicians and pharmacists?

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18. What difficulty do you face in buying medicines prescribed?

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19. How do you find reception when you arrive at the health facility?

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20. Do you face difficulties in determining the services provided at the facility? Yes []
No []

21. Do you have communication problem with staff at the facilities? Yes [] No []

22. Do you face difficulties in meeting the doctor after you have been given an appointment?
Yes [] No []

23. Have you ever felt cheated in the payment of a fee for a service or product? Yes []
No []

24. Do you have difficulties reading health reports given you? Yes [] No []

25. Please indicate below other kinds of challenges you face when accessing health services

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Thank you for your help!

APPENDIX 3: Sample summary of some interaction with health facility users

Respondent 1

- * Educated people challenge you; "I know my rights"
- * Educated people “take over your job” after observing you perform an activity; in the process, they complicate issues. A case in point is the administration of Quinine drip
- * Uneducated clients do not follow instructions. They seem confused after they leave
- * Experienced nurses are not regarded by doctors, especially new doctors. They assume that their education is higher than the nurses and so they will not take their advice on cases
- * Requisition by the health centres are not honoured by the General stores of the Ghana Health Service. They sometimes reduce the quantity requested.
- * Clients do not understand why there should be a shortage of drugs covered by Health Insurance. It means they have to take the cost of travelling and risk of searching for the drug
- * Doctors & nurses required for the job are not enough
- * Shortage of gloves, disinfectants and other protective inputs. It forces health workers to force and "economise" the limited resources. It can lead to infection of client and health worker.

Respondent 2

- * Impatient nurses.
- * Inadequate facilities. Can there be a way of grading facilities based on ratings by clients? Can there be a way of knowing congestion (the traffic) at each facility?
- * There is no clear way of determining whether the specialist for a case is present or not until it reaches your turn in a queue

Respondent 3

- * Responses and attitude of nurses not warm
- * Sitting space inadequate
- * Language barrier between clients and health workers. Nurses should be assigned based on dialect
- * Clients feel cheated in the paying of fees, or getting drugs from only a specific private drug store as directed by drug dispensing personnel.
- * Doctor is not yet in, please wait only to be told he will not come today.

Respondent 4

- * Long queues when waiting to be admitted into the consulting room
- * Drugs are not given based on proper diagnosis. Try and error
- * Insufficient doctors and other health professionals
- * Inadequate infrastructure, equipment ...
- * Nurses are impatient

Respondent 5

- * Method of receiving patients. It wastes time. They repeat questions. Preferential treatment given to pregnant and lactating mothers and patients with excuses and critical conditions
- * Care or attention given is reduced when they realise you are in school uniform
- * Without listening fully to what you have to say about the sickness or condition, they ask you to stop and then they start writing prescription for you.
- * Long queues, inadequate seats.

- * Doctors waste time making private calls while patient waits.
- * Doctors go on break and do not come on the time mentioned to patients
- * Drug is finished or not there meanwhile you have wasted time in the queue to go to the medicine or drug dispensary.
- * Impatient, emotional and rude nurses