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Identifying Dimensions of Information Quality

Development of a Model to Support Information Flow in Malawi Health Information Systems

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Abstract

This thesis explores and maps the current flow of information within the Malawi Health Information Systems (HIS), which is paper based but now moving towards a digitalized system. This transition provides a unique opportunity to map and study how dimensions of Information Quality (IQ) can indicate the effectiveness of information flow. In comparing the paper based information flow and the transition towards digitalization, this research can not only indicate whether or not such transition could yield a positive outcome, but also demonstrate how effective data management system could have far reaching consequences ranging from economic to social.

This research takes the form of a Design Science. Due to the novelty of research conducted on the information flow of Malawi HIS, providing an innovative and purposeful design solution would be the best approach to this research topic. As the first step in design theory is to understand the design environment, this research addresses its application domain: Malawi Health System, Malawi Health Information System, and Integrated Disease Surveillance and Response. As part of the improvement of the Malawi HIS includes digitalization, our design process also takes into consideration Supporting Life's mobile health application.

Following the rigor cycle in developing a new artifact, a model of information flow within Malawi HIS, this research is grounded on existing theories in science and evaluates the design ideas through the lens of the justificatory knowledge of Information Quality. Dimensions pertaining to accessibility, completeness, concise representation and timeliness are most likely to improve while as dimensions of appropriate amount and ease of manipulation are likely to be improved. Additionally, dimensions of believability, consistent representation, relevancy, reputation and value added could be affected in the future implementation stage of the artifact proposed.

Keywords

Information Flow, Information Quality, Information Quality Dimensions, Health System, Health Information Systems, Integrated Disease Surveillance and Response, Supporting Life Mobile Application and Design Science Research.

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Table of Abbreviations

Abbreviation	Definition
IDSR	Integrated Disease Surveillance and Response
DPHS	Director of Preventive Health Services (Head of Preventive Health Services, one of the directorates in the Ministry of Health)
CMED	Center for Monitoring and Evaluation Division
DHIS 2	District Health Information System 2
HIS	Health Information Systems
HS	Health Systems
DHO	District Health Office
CHAM	Christian Health Association of Malawi
HSA	Health Surveillance Assistant
EMR	Electronic Medical Records
OPD	Outpatient Department
ART	Antiretroviral Therapy
IMCI	Integrated Management of Childhood Illness
CCM	Community Case Management

1 Introduction

This thesis explores the information flow within the Health Information Systems (HIS) across the various levels of Malawi health care stakeholders. Key to this exploration is the utilization of Information Quality (IQ) as a framework for approaching the analysis of such flow of information. This work intends to provide an artifact that may be of use in improving communication within the Malawi Health System (HS) through implementing a system of disease surveillance and response—ultimately to improve the quality of health care.

IQ has raised significant concern in organizations' awareness about the importance of improving the quality of data for the use of organization's Management Information Systems (Lee et al., 2002). In fact, the cost of poor IQ is a loss to the society and to its stakeholders (English, 2009). What is more, the costs are not simply economic, but also affect the safety, well-being, and equal treatment of societies (Ibid). Therefore, in order to design an effective data flow, ensuring IQ within an organization such as a country's HIS is critical. As HIS in and of itself is dealing with the society and the well-being of the society, warranting IQ could in fact contribute towards an improved quality of health care.

1.1 Settings

Malawi is a small, narrow country in sub-Saharan Africa, and is one of the most densely populated countries in the region—estimated at 13.1 million in 2008. There has been high population growth in the recent years due to high fertility rate and low contraceptive use. In fact, nearly half of the population is under the age of 15; more specifically, 22% are children under the age of 5, while 7% of the population is infants under age 1 ("Malawi: Introduction to Country Context – AHO", 2017). The Government of Malawi and the Ministry of Health have identified that while there is a large population growth, lack of financial resources results in inability provide proper health care services (Malawi Ministry of Health, 2011). In fact, Malawi is one of the poorest countries in the world, with a GDP per capita of 290 USD in 2009 ("Malawi: Introduction to Country Context – AHO", 2017). It was estimated that 39% of the population was living below the poverty line in 2009, with 43% of the population inhabiting in rural areas living below the poverty line (Ibid).

Due to lack of resources, responses to disease outbreaks are slow and difficult to manage. Government and development partners around the world have worked to improve the quality of care to even the most remote areas of Malawi. One of the major concerns is the fact that

quality of treatment is low, which results in in high morbidity and mortality rates for newborn babies and mothers. According to the World Health Organization (WHO), the infrastructure of facilities are poor and the health works are not fully trained and lack the ability to care for newborns, particularly if they are ill. Lack of medical supplies further contributes to the issue of high number of deaths among infants and mothers. Despite the efforts made to reduce the number of such infant mortality and morbidity, Malawi has the highest premature birth rate in the world. This can be explained by increase in adolescent mothers, who are at risk for giving birth to premature babies and babies with low birth weight. (Wedenig & Nyarko, 2015).

It is widely believed that computer-based information systems in health care is seen as a necessary step towards improving the quality of health care systems (AbouZahr & Boerma, 2005). Paper-based communication is no longer a valid solution for data sharing in the face of advancements in technology. One initiative working towards improving the Health Information Systems (HIS) in Malawi is aiming to provide a comprehensive low-cost intervention to disease control through a mobile health application. Mobile health, mHealth, applications are used "[to] help with the flow of information over a mobile network and […] improve communication, specifically between individuals and clinicians" (AHIMA Guide 2013, p.1). According to Levy (2014), the ubiquity of mobile technology offers unlimited opportunities within the healthcare industry. Such opportunities include making healthcare more accessible, faster, better and cheaper.

The benefits of using mobile technology in combination with healthcare include the portability of the devices (anywhere), immediacy (any time) and convenience (easy access), allowing for access to vital information that is much more pervasive when contrasted with what is available via desktop hardware (Norris, Stockdale and Sharma, 2009). In line with this belief and its perceived benefits, the Supporting Life project developed an mHealth app to assist the HS in Malawi, specifically the Health Surveillance Agents (HSAs) at the point of diagnosis, allowing for quicker assessment, more accurate diagnosis, and better treatment of ill children (Supporting Life, 2015).

As the beneficial aspects of the mHealth application are apparent, certain priorities merit consideration when evaluating its ability to effectively enhance its impact on Malawi's Health Information Systems (HIS). In particular, there needs to be a careful analysis of how information gathered by the application can be accessed by particular stakeholders in the HIS within a timely, appropriate, and accurate manner. Digitalized HIS could allow for better communication of information, which would result in higher standard of health services through disease surveillance and response. In fact, one objective of Supporting Life is to develop design guidelines for the information gathered from the mobile phone, to regional, national surveillance level (Supporting Life – Work Package 5). For instance, the design guidelines must be fit for information management for disease control surveillance as well as exploration of information-based disease outbreaks and control.

With the digitalization of processes, such as with Supporting Life's mobile health application, Malawi's HIS could progress towards higher information communication. In turn, this level

of communication within Malawi HIS would allow for improvement in the overall quality of health care in Malawi HS.

However, there is currently no existing understanding of the health information communication in Malawi (WHO, 2016). The fact that there is not currently a validated or approved model that depicts the flow of information communication within the Malawi HIS can be identified as the core problem in the advancement of Malawi's health care services. Currently, HIS is collected via paper (shown in Image 1.1). Additionally, in Image 1.2, the health care staff is demonstrating the process of a paper-based tool to diagnose children.

Image 1.1 Newly Printed Paper Based Diagnosis & Data Collection in Malawi Health Systems

Image 1.2 Health Surveillance Agent Demonstrating the Process of Diagnosing a Patient with a Paper Guide

In order to understand the context of this research to come up with design ideas, the research should begin with understanding the current existing health information communication in Malawi HIS. Then that understanding of the information could be utilized to apply the information gathered in order to create a flow of information to the various stakeholders in the Malawi HIS. Furthermore, this sharing of information would not only create transparency within the Malawi HIS, but also to allow for better surveillance.

Research Question: How can information quality be implemented to improve and support the information communication within Malawi HIS?

Motivation of our Research: To contribute towards improving the general standards of health care in Malawi HIS.

1.2 Research Purpose

The purpose of this research is to suggest improvements within the current information flow of Malawi HIS. The research will consider the dimensions of information quality within the Malawi HIS, and implement such dimensions into the workflow of the Malawi HIS. The design of the model of information communication flow of HS in Malawi will aim to ensure that each stakeholder is receiving high quality information. In achieving this purpose, this research would address its motivation to improve the overall health care provided in Malawi. Finally, this thesis will identify opportunities for improvement, and further research in this field.

Purpose of this research: To provide a validated model of health information communication in Malawi HIS.

1.3 Research Delimitations

The research topic of the Health Information Systems in Malawi is a broad one. Therefore, it was import to limit the scope of the research. This study will address the information communication within the HIS—more specifically, how the information is gathered, shared, and used.

Many factors can be used to impact the information communication within Malawi HS. However, this study will focus only on dimensions of information quality provided by a validated model of information communication.

1.4 Chapter Summary

Currently, Malawi utilizes a paper-based communication as part of its Health Information Systems, which is no longer believed to be a valid solution for data sharing in the face of technological advancements. Therefore, this research takes into consideration a mobile health application called Supporting Life, as an example of a digitalization process as an improvement of information communication in the Malawi HIS. In order to improve upon the current communication in the Malawi HIS, as part of the lack of general standard of health care in Malawi, this research is motivated to focus specifically on creating a model of information communication. Approaching this topic, specifically the model of information communication, directly by deriving at a design-based solution rather than a theoretical solution would be the most direct way to address this specific topic.

There does not exist validated model of information communication within Malawi HIS, in addition to the fact that this research could have consequences on the potential well being of citizens of Malawi. Therefore, we will examine the information flow across the stakeholders of Malawi HS through the lens of information quality. Taking into such dimensions of IQ would allow for the research to focus on qualities that would impact the management of Malawi HIS.

Purpose of this research: To provide a validated model of health information communication in Malawi HS.

Motivation of our Research: To contribute towards improving the general standards of health care in Malawi HIS.

Research Question: How can information quality be implemented to improve and support the information communication within Malawi HIS?

2 Research Approach

In this chapter, Design Science is introduced as the main guide of our research approach. We provide an outline and motivation for choosing this particular research approach. Finally, we present Gregor & Jones' (2007) IS Design Theory (ISDT) and its eight components.

2.1 Design Science

2.1.1 Design Science as a Research Approach

> *"We need a science of design – intellectually tough, analytic, partly formalizable, partly empirical and teachable."* – The Science of the Artificial (Simon, 1996, pp.37)

The science of the artificial is concerned not with how things are currently, but with how things might be—in other words, in terms of design (Simon, 1996). In fact, the goal of a Design Science Research (DSR) is to create artifacts in order to address questions regarding human problems and to contribute a new knowledge to the body of science (Hevner & Chatterjee, 2010). Artifacts should be both useful and fundamental in understanding that problem (Hevner & Chatterjee, 2010). Design is a core activity for those researchers who conduct research within Information Systems (IS), and IS is the tool for organizations and individuals to become more productive and efficient (Chatterjee, 2015).

The first principle of DSR is knowledge and understanding of a design problem and that the solution is acquired through building of an artifact (Hevner & Chatterjee, 2010). In line with this first principle, before we create the artifact (information flow of Malawi HIS), we must first understand and gain knowledge of the design problem (Malawi HS, HIS). Therefore, Chapter 3 will explore each of these topics in detail.

Additionally, we will follow Hevner & Chatterjee's (2010) principles of DSR by building the artifacts as the solution driven from the understanding of the design problem of the current workflow. In fact, for the purposes of this study, we aim to create one artifact: a valid model of the data information flow of the various stakeholders. This model could provide as a solution to the design problem by allowing for better communication and disease surveillance and response.

The potential impact and contribution of a Design Science Research is a determining factor in selecting a research approach. As DSR has its roots in engineering science, the paradigm of design science is fundamentally within problem solving—more specifically, in solving *wicked problems* (Simon, 1996; Hevner & Chatterjee, 2010). *Wicked problems* can be defined as having unstable requirements, complex interactions between components, unstable conditions, and dependent upon human cognition and social abilities (Hevner & Chatterjee, 2010). The components of our research are dependent on the social abilities of Malawi, as well as the human ability to provide information quality. Therefore, our research setting can indeed be described as a wicked problem.

The mission of Design Science is: "knowledge that can be used in designing solutions to problems in question*"* (Aken, 2004, p. 225). In other words, the mission of a DSR is to develop knowledge for the realization of artifacts, which answers the problem at hand (Aken, 2004). Design Science is the effective way in order to solve and address those "wicked organizational problems," instead of using Natural Sciences, which is more appropriate when focusing on already existing problems and phenomenon (Hevner & Chatterjee, 2010, pp.13). Therefore, choosing to approach our research question, a wicked problem, through Design Science is more appropriate than taking other research approaches.

Furthermore, this paper will take form of a qualitative strategy (Carlsson et al., 2011) using interpretation of data in addition to iterative reflective inquiry (Hevner et al., 2004, Gregor & Jones, 2007). DSR and qualitative strategies are suitable for research in novel areas, due to its iterative and exploratory nature of both strategies. In such cases, knowledge may be gradually and collaboratively developed through the design process (Kuechler and Vaishnavi, 2007; Carlson et al., 2011; Gregor & Jones, 2007). This strategy will allow the design artifact to be iteratively assessed and revised to fit the suitable terms and specific needs of the Malawi health workers and other stakeholders. Details of the iterative design process are explained in Chapter 6.

2.1.2 Design Science in Information Systems

DSR has been an important paradigm within the field of IS (Gregor & Hevner, 2013). In the recent years, DSR has been receiving more and more traction as an eligible approach within IS research. DSR is a method that was formalized by important papers and research contributors such as Nunamaker et al (1991), Hevner et al (2004), Hevner & Chatterjee (2010), marking this research approach as both useful and widely accepted (Chatterjee, 2015).

Specifically, the 2004 *MIS Quarterly* (*MISQ*) paper by Hevner et al. (2004) has had a significant impact on the field of research within IS in terms of supporting the usage of DSR. Hevner et al. (2004) provided the frameworks that have since enabled researchers to utilize a design science research process with a clear purpose of devising an artifact as a solution in accordance to the application domain. The domains could range from healthcare, e-commerce, biology and transportation—the impact of designed artifacts can aid any of the

domain-specific systems and processes that have a problem to be solved (Hevner & Chatterjee, 2010). The domain of this research is within healthcare.

DSR incorporates the design and development of different socio-technical artifacts, which includes decision support systems, modeling tools, governance strategies, and methods for IS analysis (Gregor & Hevner, 2013). Nevertheless, there is some controversy about what can be considered as an IT artifact. One argument is that abstract knowledge contributions made from DSR can be considered as a type of an artifact (Gregor & Hevner, 2013). What is more, this artifact can be transformed into a material existence / model or a process / method (Ibid).

Authors often refer theory to the domain of the natural world, while DSR focuses instead on the artificial world (Chatterjee, 2015; Simon, 1996). In terms of our research in question, we will not simply be addressing the information communication within the current setting—in the "natural world"—but rather how it may be improved in the future—in the "artificial world".

2.1.3 Motivations for using Design Science Research

For the purposes of this research paper, we will be following Gregor & Hevner's classification of an artifact. As stated previously, an artifact can be defined as one that contributes to the abstract body of knowledge, which could later be transformed into a material existence (Gregor & Hevner, 2013). We will be focusing on adding conceptual contributions through our model of information. In other words, provide an artifact (a model) that in turn contributes to the body knowledge.

The purpose DSR in IS to create an IT artifact to address a problem in the organization (Hevner et al, 2004). This model of information flow (IT artifact) within the Malawi HS (the organization) should be innovative and purposeful. In order to make sure that the design fulfills its purpose, we will follow the goals and guidelines set by the WHO and the Ministry of Health called Technical Guidelines for Integrated Disease Surveillance and Response (IDSR). This will be explained in detail in 3.1.1.

2.2 Three Cycles of Design Science Research

The goal of DSR is to enable utility; truth and utility are inseparable (Hevner et al., 2004). In other words, in order for utility to exist, the researcher must discover the true problem and the true need within its application domain.

After its initial presentation by Hevner et al. (2004), the framework (Refer to Figure 2.1) was revised to consist of additional cycles (Hevner, 2007). This IS framework of Relevance Cycle,

Design Cycle and Rigor Cycle has been presented in several articles written by Hevner (2007), Hevner & Chatterjee (2010) and Hevner and March (2003).

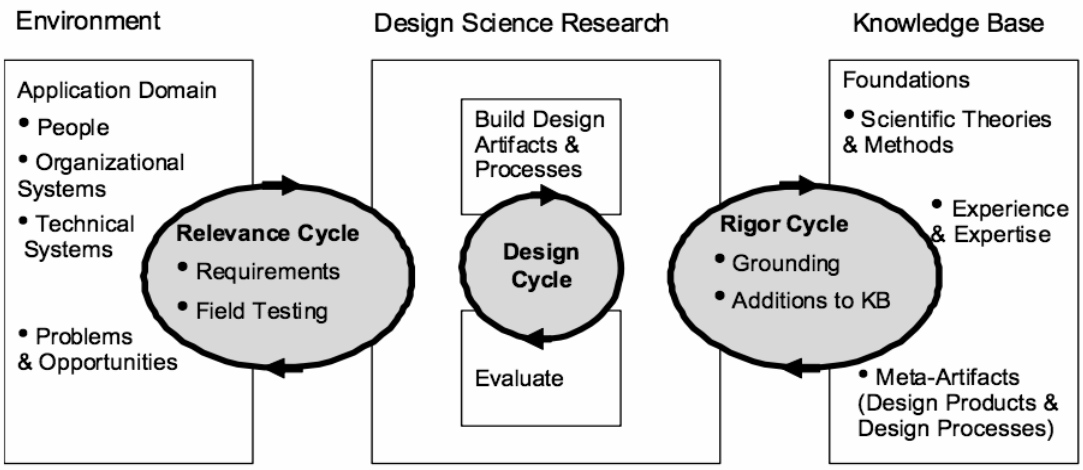


Figure 2.1 The Three Cycles of Design Science Research (Hevner, 2007, pp. 2)

2.2.1 Relevance Cycle

The Relevance Cycle presented by Hevner & Chatterjee (2010) in Figure 2.1, is the starting point of the DSR. Here, the requirements for research and criteria for evaluation of research are addressed. Therefore, by using the Relevance Cycle, the research question will be highly relevant and enable a contribution to the body of knowledge. This cycle is part of the environment, which is further explained by Hevner & March (2003) and Hevner (2007) as the context where the definition of the problem space is defined, which includes people, organizations, and already existing technology as well as future technology use. In other words, the *Application Domain* is the component that sets the goals, tasks, problems, and opportunities within the environment, by defining the needs of the organization (Hevner and March, 2003).

The application domain of this research consists of: Malawi Health System (main organization), Malawi Health Information System (technical system used by the organization), and Supporting Life Mobile Application (new technology implementation within Malawi HIS). Chapter 3 will explain each of the application domains in detail.

2.2.2 Rigor Cycle

The Rigor Cycle is the cycle where past knowledge—Knowledge Base (KB)—is used as measuring stick to determine whether or not there is truly new contribution to the body of knowledge (Hevner, 2007; Hevner & Chatterjee, 2011). KB provides the raw materials that

are needed in order to accomplish IS research (Hevner, 2007). Researcher must skillfully choose and utilize already existing theories in order to develop and evaluate a design outcome as an artifact—and achieve rigor (Ibid).

According to Hevner (2007), the development of a new artifact is based on the already existing theories, and thereby considered as an addition to the knowledge base, which also includes extensions and the usage of original theories and methods. Here, Hevner is in agreement with Gregor & Hevner's (2013) view of DSR, who claim that a contribution of DSR is not only to the model or process, but also to the experience and knowledge in the process of developing a new model or process.

Our research will be based upon scientific theories (Information Quality) in order to add to KB in the form of a design product (model of Information Flow within Malawi HIS). This will be explained further in Chapter 4. Research Methods.

Deductive Reasoning

DSR complements both positivism and relativism (Hevner & Chatterjee, 2010) and stems from critical realism. DSR is built on both induction and deduction, but since we will base our knowledge from existing knowledge as well as the guidelines set by the IDSR, we will use deduction for the purposes of our DSR.

2.2.3 Design Cycle

The Design Cycle consists of rapid iteration of building and evaluating. To build is to create and refine artifact design both as a product and a process. Evaluation consists of rigorous scientific study of the artifact in a controlled environment. The Design Cycle should be iterated until the artifact is ready for field test in the application environment or there is new knowledge appropriate for addition to KB.

The detailed process of building our artifact and the evaluation process can be found in Chapter 6.

2.3 Reporting Our Research

The results of DSR, its contributions to knowledge, should be usable when designing new solutions to problems within a chosen field of research (Aken, 2004). Keeping this in mind, we must consider our contribution to knowledge through this research. The Knowledge Contribution Frameworks (Figure 2.1) provides an explanation of how to best provide a contribution within a DSR (Gregor & Hevner, 2013). The authors claim that the determining

factors of knowledge contribution vary according to the context of the designed artifact. In other words, the researcher must consider the audience that the artifact speaks to. The contribution can also vary in its degree of contribution—though even a small incremental contribution can still have an innovative and disruptive effect to the public.

As in any research, it is important to make a useful contribution, as it is true for DSR in its contribution to knowledge (Gregor & Hevner, 2013; Aken, 2004). Therefore, it is important to clarify the relationship between the nature of the artifact and the problem space in study (Gregor & Hevner, 2013; Aken, 2004; Hevner et al, 2004).

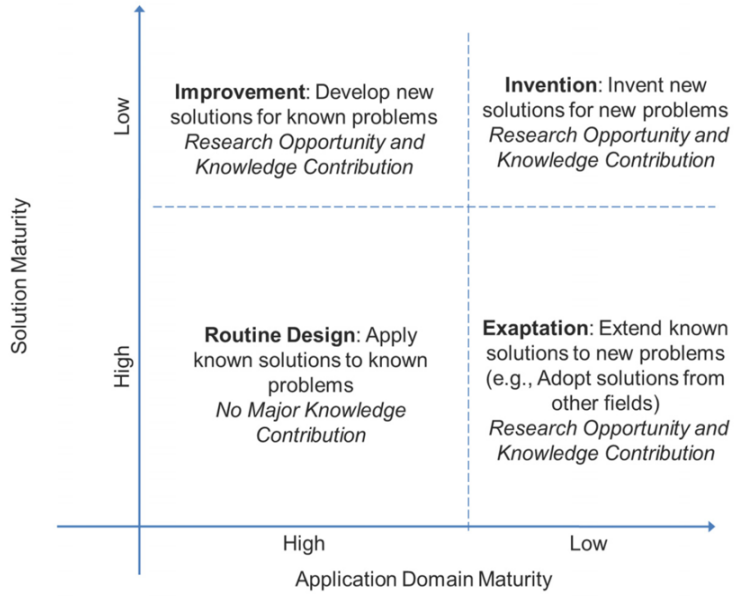


Figure 2.2 DSR Knowledge Contribution Framework (Gregor & Hevner, 2013, pp.345)

In the case of this research, the solution maturity is low, because there is no existing well-documented solution. The application domain maturity is high, since the problem is known in practice and discussed in existing research. Among the four different contributions in the Knowledge Contribution Frameworks (Figure 2.2), our research is within **Improvement** because it aims to develop new solutions (model of information flow) for known problems (poor quality of health care). Clarifying the type of contribution makes it easier to communicate to the right audience. The contributions of this research will be discussed in further detail in Chapter 7.

Gregor & Jones' (2007) "The Anatomy of Design Theory" examines the different perspectives of design theories, and highlights the problems with existing work. Prior work on design research and theory lacks clear, logical progression (Gregor & Jones, 2007). Building upon the work of Walls et al. (1992; 2004) who has expanded on Dubin (1978) and Simon (1996), eight separate components of design theories are illustrated (Refer to Figure 2.3). The

first 6 components should be included as a minimum requirement for design theory (Gregor & Jones, 2007). "The Anatomy of Design Theory," published in Journal of Association for

Component		Description
Core components		
1)	Purpose and scope (the *causa finalis*)	"What the system is for," the set of meta-requirements or goals that specifies the type of artifact to which the theory applies and in conjunction also defines the scope, or boundaries, of the theory.
2)	Constructs (the *causa materialis*)	Representations of the entities of interest in the theory.
3)	Principle of form and function (the *causa formalis*)	The abstract "blueprint" or architecture that describes an IS artifact, either product or method/intervention.
4)	Artifact mutability	The changes in state of the artifact anticipated in the theory, that is, what degree of artifact change is encompassed by the theory.
5)	Testable propositions	Truth statements about the design theory.
6)	Justificatory knowledge	The underlying knowledge or theory from the natural or social or design sciences that gives a basis and explanation for the design (kernel theories).
Additional components		
7)	Principles of implementation (the *causa efficiens*)	A description of processes for implementing the theory (either product or method) in specific contexts.
8)	Expository instantiation	A physical implementation of the artifact that can assist in representing the theory both as an expository device and for purposes of testing.

Information Systems (JAIS) was awarded best article award in 2007.

Figure 2.3 Components Framework of an IS Design Theory (Gregor & Jones, 2007, pp. 322)

Purpose and Scope is the design component where "what the system is for" is described. In other words, the set of goals specific to the type of system the theory applies to be outlined, in addition to its scope or boundaries of the theory. Thus, understanding of the requirements of the artifact and the environment of the artifact is required for this component. Furthermore, when defining the goals of the artifact, other goals are excluded from the purpose of the artifact, allowing the researcher to set the boundaries or limitations of the artifact. By doing so, theory formulation allows for different theories to be categorized in order that they be compared and extended. Finally, motivation should be provided, and the need for change should be significant. (Gregor & Jones, 2007).

In terms of natural science-type theory, this section would provide the boundaries, or meta-requirements (Gregor & Jones, 2007; Dubin, 1978; Walls et al, 1992).

Our purpose and scope is clearly defined in Chapter 1. To provide a validated model of health information communication in Malawi HS in order to contribute towards improving the general standards of health care in Malawi HIS.

Constructs are representations of the entities in the theory, which serve as the basis of any theory. The representations can be the form of a physical phenomena or abstract theory. The terms used should be defined in a clear manner by decomposing design problems into semi-

independent parts. Within design theories for information technology, a construct in a theory can be a sub-system that adheres to its own separate design theory. Breaking down the design problem into semi-independent parts, allows for the complexity to be managed (Simon, 1996). Furthermore, the problem solver (the designer) does not have to know every single part in detail, but rather should focus on the detailed understanding of the specific part in the overall design problem. (Gregor & Jones, 2007).

According to Dubin (1978), this section would equate to units in natural science-type theory.

In order to address the design problem with Malawi HIS, we have separated the constructs into the following sub-systems: Malawi Health System, Malawi Health Information System, and Supporting Life. These constructs, or application domain, are explained in Chapter 3.

Principles of Forms and Function is the architecture that describes an artifact. This component consists of principles that layout the structure, organization and function of the design product or method. Properties, functions, features or attributes that the product consists of are laid out. (Gregor & Jones, 2007).

For natural science-type theory, Principles of form and function would compare to Laws of interaction or meta-description (Gregor & Jones, 2007; Dubin, 1978; Walls et al, 1992).

The organization in charge of the Malawi HIS is the MoH, and the functions of Malawi HIS are explained in IDSR. Therefore, the guidelines set by MoH, WHO, and IDSR are the important architecture of the artifact. These guidelines can be found in 3.1.1.

Artifacts Mutability is a component specific to the nature of IS artifacts that are in constant state of change. Simon (1996) addresses the concept of continuously evolving artifacts by discussing flexibility and adaptability provided by the use of feedback loops, in order to refine the design of an artifact.

Specifying the degree of mutability of the artifact is somewhat similar to a physical system in natural science-type theory (Dubin, 1978). However, Artifacts Mutability deals with not only the changes in the system but also the affect the changes to the artifact, allowing for adaptation and evolution (Gregor & Jones, 2007).

Our targeted artifact is dependent upon constant state of change within the Malawi HS. Therefore, this current artifact could be updated with additional stakeholders or systems. In order to reflect the most updated changes, we will conduct design iterations in Chapter 6 to update the current flow of information to the best of our knowledge and adapt and evolve the model according to information gathered from the field.

Testable Propositions is the component within ISDT where hypothesis about the system or tool is constructed. Testing the hypothesis shows the artifact is capable of working within the proper environment, or to be fixed in such a way that it will be enhanced. (Gregor & Jones, 2007). The following is the general form of such proposition: “If a system or method that

follows certain principles is instantiated then it will work, or it will be better in some way than other systems or methods" (Gregor & Jones, 2007, pp. 327).

Testing theoretical design propositions is done through an instantiation, by constructing a system, implementing a method, or through deductive logic, though this is rare done (Gregg et al., 2001; Henver & March, 2003).

Within natural science-type theory, this component is comparable to propositions or product hypotheses / process hypotheses (Dubin, 1978; Walls et al., 1992).

Our hypotheses, which would be presented in the form of a model of information flow, would be tested via interviews and a workshop with the stakeholders of Malawi HIS. The details of the fieldwork can be explained in Chapter 5 & 6.

Justificatory Knowledge is the component where the justificatory, explanatory knowledge that brings together the goals, shape, processes, and materials. For example, knowledge of human cognition influences the principles of human computer interaction design. This is what Simon (1996) refers to as "micro theories" or what Walls et al. (1992) call "kernel theories." Kernel theories consider design processes and information of design products separate. The theories are a mechanism through which several, if not all of the aspects of the design theory are linked together (Gregor & Jones, 2007). Furthermore, the researcher does not need the whole internal structure in detail, but rather the knowledge about the crucial aspects of the system to enable a concept in the design theory (Ibid). Justificatory knowledge provides an explanation as to why an artifact is constructed as it is and why it works. Venable (2006) states that knowing why something works is not important, but rather that it does indeed work. Gregor & Jones (2007) dispute this statement, by specifying that through understanding the theories and the environment of the artifact, answer the question of why the artifact works, regardless of the full and complete knowledge and understanding entailed.

In order to address the research question of improving the information communication within the problem area of Malawi HIS, we will be using the justificatory knowledge of Information Quality. In order to provide an explanation of why our artifact is constructed as it is and why it works, the explanation should be within theory, in this case IQ, grounding this research in scientific knowledge. The justificatory knowledge of IQ will serve as the underlying bases of this research, and is explained further in Chapter 4.

Principles of Implementation component is concerned with the means by which the design is brought into being. This process is brought to life through agents and actions. Simon (1996) believes that process and product are intricately tied together. Principles vary according to the complexity of the project, skills of the team, and the environment of the artifact. Timeliness should also be considered while developing a policy for an implementation of an artifact. (Gregor & Jones, 2007).

According to Walls et al. (1992) this component is equivalent to design method in natural science-type theory.

The possibility of future implementations of this artifact will be discussed as possibilities of future research in Chapter 7.

Expository Instantiations is the physical implementation of an artifact that aids in representing the theory both as an expository device as well as testing purposes. Hevner et al. (2004) contend that design research should produce an artifact, whether it is in the form of a construct, model, method or an instantiation. However, Gregor and Jones (2007) discuss the inclusion of instantiation within ISDT. Theory in natural sciences has been represented in natural language statements or mathematical notation. For example, the placing of items on a digital screen can be described via screen coordinates. This process is not only wearisome but also give results that are not easy to understand. A replica of the screen would be immediately comprehensible and serve as a getting guideline for others who are in the process of designing a screen. In this case, the instantiation would provide a level of knowledge based on craft discipline.

According to Dubin (1978), this component is similar to hypotheses and empirical indicators in natural science-type theory.

Implementing the Supporting Life Mobile Application would also be part of future and ongoing research for Supporting Life.

2.4 Chapter Summary

Our approach to this research is clear—Design Science. In order to improve upon a current existing problem, which can be defined as clear lack of information flow within Malawi HIS, we must first have a clear detailed understanding of the problem at hand.

As it is important to make a useful contribution, we approach this research by studying the high maturity of the application domain (which will be explained in detail in Chapter 3) by developing a new solution. Therefore, we follow Gregor & Hevner's (2013) definition of DSR by incorporating the design and development of a socio-technical artifact.

Additionally, we will also follow the components of Gregor & Jones's (2007) ISDT, we strive to make a knowledge contribution to the exiting domain (Malawi HIS) in the form of an artifact (model of information flow).

Component	Description	Location within Text
1) Purpose and scope	The purpose is to develop a valid model of information communication of Malawi HIS.	Chapter 1
2) Constructs	Malawi Health System, Health Information Systems, Supporting Life Mobile Application	Chapters 3
3) Principles of form and function	This research should follow the guidelines set by the WHO and Ministry of Health called Technical Guidelines for Integrated Disease Surveillance and Response (IDSR).	Chapter 3
4) Artifact mutability	Design considerations are made through iterations of interviews and workshop meeting with stakeholders and experts.	Chapter 6
5) Testable propositions	Models are tested through interviews and workshop meeting with the stakeholders and experts.	Chapter 5, 6
6) Justificatory knowledge	The approach proposed is based on the theory of Information Quality.	Chapter 4
Additional components		
7) Principles of implementation	One way the model could be implemented is through Supporting Life's mHealth application. However, this must be done in collaboration with the Ministry of Health and the IDSR team.	Chapter 7
8) Expository instantiation	A real-life situation of Supporting Life's mHealth application could provide more hard facts on the implementation, which is work left for future research.	Chapter 7

3 Application Domain

The Application Domain is the component of research that sets the goals, tasks, problems, and opportunities within the environment, by defining the needs of the organization (Hevner and March, 2003). In this chapter, we will address the goals of this research by exploring the problems within the Malawi HS and HIS deeper by defining the context of the problem space, which includes Supporting Life Mobile Application (Hevner & March, 2003; Hevner, 2007).

3.1 Malawi Health System

The WHO proposes a division of organization units in the HS of Sub-Saharan countries (Figure 3.1). The Malawi government implemented the proposed information flow (WHO, 2010). Assuming that all levels of HS are involved in conducting surveillance, Figure 3.1 shows the different roles and levels of the Malawi Health System. Each role plays a surveillance function at each level of the HS (IDSR, 2014).

Community: basic village-level services including HSAs, trained birth attendants, village leaders, schoolteachers, veterinaries or health extension works, pharmacists, and traditional healers.

Health Facility: outpatient and/or in-patient and preventative services such as government, CHAM, private and NGOs

District: local government administration that has responsibilities and decision making powers—the district is where local community needs are resolved with national priorities

Health Zone: responsible for cluster of districts—'Zone Office' provides technical support to district health management team in planning, delivery and monitoring of health services at district levels

National Level: policies are set and resources are mobilized and allocated at this level. Reports priority diseases and uses the decision instrument to report events of public health concern to WHO. Responsible to work closely with WHO/AFRO through WHO and provide information and collaboration on outbreaks/events of public health concern with other member countries.

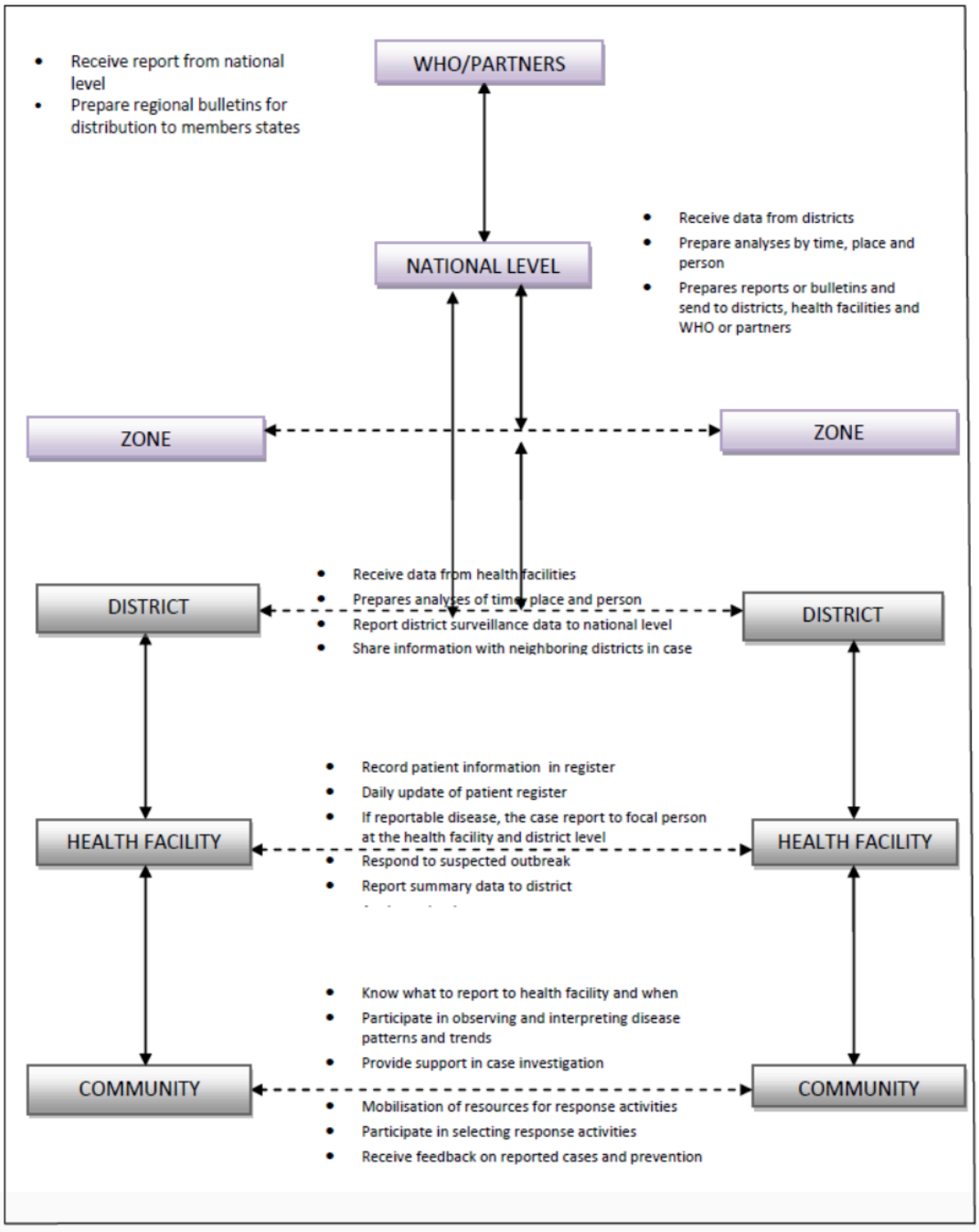


Figure 3.1 Functions and Information Flow at Various Institutional Levels (IDSR, 2014)

3.1.1 Integrated Disease Surveillance and Response Guidelines

The guidelines point out that it is not sufficient enough to just collect, record and report numerical information about illness, death and disability but rather that the data gathered must be analyzed at each level where it is collected. Such analysis of surveillance data allows for:

- Observing trends over time and alerting health staff about emergent events or unusual patterns
- Identifying geographic areas of higher risk
- Characterizing personal variables such as age, gender or occupation that place a person at higher risk for the disease or event.

Additionally, the IDSR states that the use of analysis to improve public health action must be used to: 1) assess whether the situation is improving or not and 2) find what explains the observed situation. Furthermore, the data must be prepared and shared with all stakeholders who need the information. Simple graphs, tables, and maps with a clear description, interpretation, comments and recommendations are key to the summary of surveillance findings. The surveillance data analysis results will allow the stakeholders to:

- Conduct an investigation to find out why there is an increase in the number of cases
- Collaborate with specific disease reduction programs to intensify surveillance if an alert threshold has been crossed,
- Advocate with political leaders and the community for more resources, if lack of resources is identified as a cause for the increased number of cases

What is more, the Technical Guidelines for Integrated Disease Surveillance points out that information sharing is an important surveillance function and a powerful mechanism of coordination across various stakeholders. It will aid the staff that send reports and build partnerships through transparency, which is made available through information sharing. Therefore, timeliness is a key factor is sharing analysis results and providing feedback. (IDSR, 2014).

Figure 3.2 refers to timely reports sent to the WHO from each of the countries in Africa. As can be seen for Malawi, not a single report was sent during the first 22 weeks of 2016. The reports regarding: 1) epidemic prone disease for example meningococcal meningitis, typhoid fever, yellow fever, and measles; 2) diseases targeted for eradication for example, leprosy and neonatal tetanus; 3) other major diseases, for example diarrhea, pneumonia, HIV/AIDS and 4) diseases of international concern, for example SARS and smallpox. (WHO, 2016).

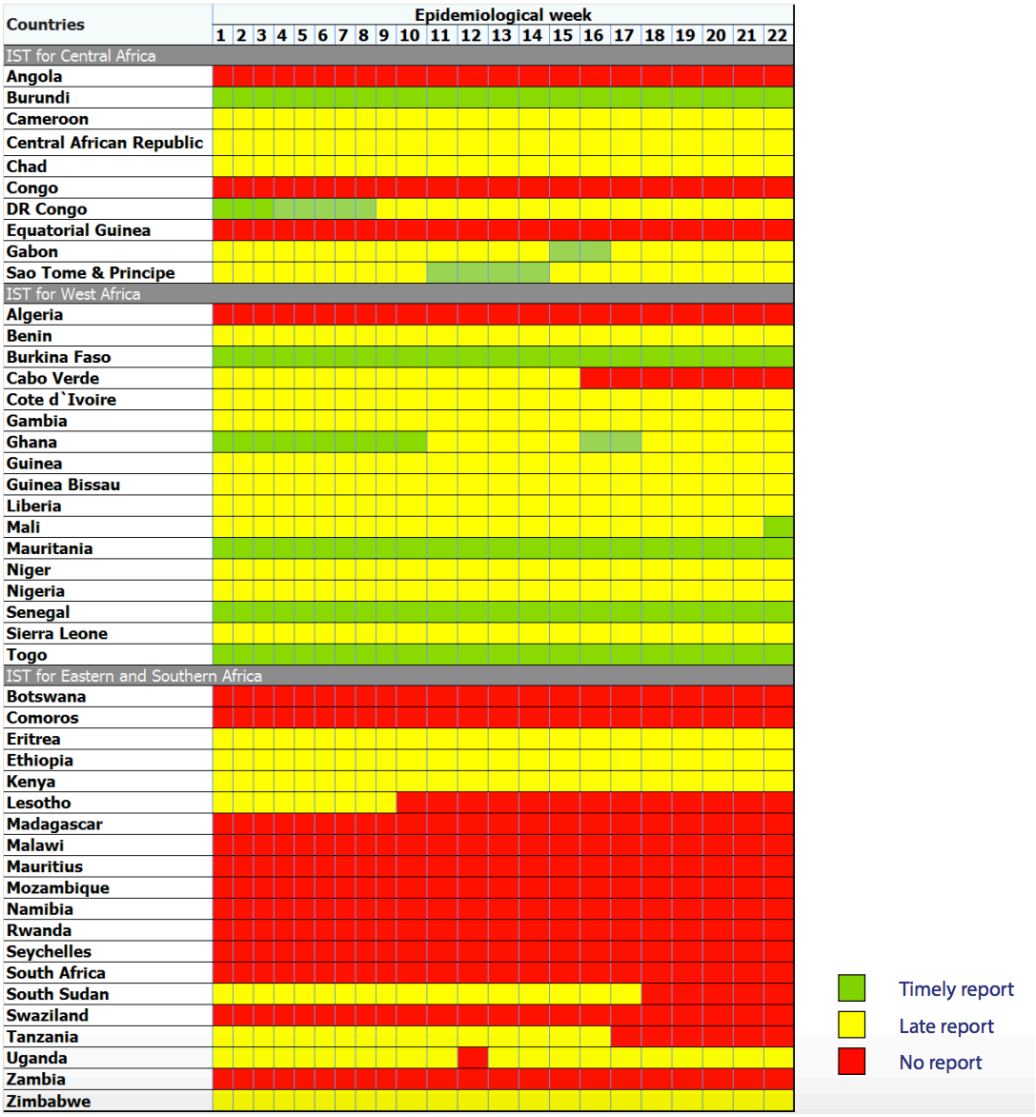


Figure 3.2 Completeness of Reports on Epidemiology sent to the WHO during the first weeks of 2016. Malawi has sent in no reports (WHO, 2016)

3.2 Health Information Systems

The WHO describes HIS as a provider of tools for decision-making in addition to holding the following four key functions: data generation, compilation, analysis and synthesis, and communication and use. HIS collects data from both the health sector as well as other relevant sectors in order to analyze the data and "ensures their overall quality, relevance and

timeliness, and converts data into information for health-related decision-making" (World Health Organization, 2008).

To say that HIS is equivalent to monitoring and evaluation is a reductionist point of view. In fact, the WHO describes that in addition to such essential functions, the IS also serves to provide alerts and early warning indicators, support patient and health facility management, enable planning, permit health situation and trend analysis, and support global reporting. Furthermore, IS allows for communication among various users when it comes to health challenges. As is crucial to any IS, and particular to HIS, information would be of little value if it is not available in the format suitable for the various users of the HIS. The various users include policy-makers, planners, managers, health care providers, communities, and individuals. Needless to say, dissemination of information and communication are critical assets to a HIS. (World Health Organization, 2008).

An effective HIS should bring together all the relevant partners in order to ensure that the users of health information have access to reliable, useable, understandable, comparative data.

3.2.1 Expectations of a Country´s HIS

The various users of HIS also mean that there are various purposes that are expected in order to aid and allow decision-makers at all levels of the health system.

- Individual: Individual level data such as patient information, health needs, and treatments are the basis for clinical decision-making.
- Health Facility: Health facility level data enable health care managers to determine resource needs, determine purchasing of drugs, equipment and supplies and develop community outreach. Data gathered are aggregated from facility-level records and administrative such as
- Population: Population level data are crucial for public health decision-making and for generating information. The information is not only about those who use the health services but also for those who do not use them.
- Public Health Surveillance: Public health surveillance brings together information from facilities and communities. It focuses on defining problems and providing timely basis for action. (World Health Organization, 2008).

Overall importance of HIS as a system with the capacity to generate reliable data is being recognized. Reforms within HS have generated new information needs with new requirement for data collection, processing, analysis and dissemination. Health sector reforms also indicate a need for standardization as well as quality of information (World Health Organization, 2008).

Few developing countries actually meet the aforementioned standards of an effective HIS. New technologies can positively contribute to improving data generation, complication and exchange, which require data quality of high value (World Health Organization, 2008).

3.3 Health Information System in Malawi

A Health Information System is a digital system that enables sharing of health information, which is an important component of the Malawi HS. HIS enables management and provides key input towards decision making in improving the efficiency and efficacy of Malawi's healthcare system. The objectives of the Malawi HIS is to provide reliable, relevant, up-to-date, suitable, timely and reasonably complete information for decision makers at various levels of the Malawi healthcare system. (Malawi Ministry of Health, 2003).

In line with the strategic vision of the MoH and GoM in 1999, the Health Management Information System (HMIS) was presented with the District Health Information Software (DHIS) in order to reform the country's healthcare system process (Ministry of Health, 2014). The HMIS and DHIS, which handle the management of data (Ibid), were initiated because the previous system did not provide important information in a timely and useful manner (Malawi Ministry of Health, 2003).

The Health Information Policy Committee (HIPC) identified and approved 110 health sector indicators in order to plan, monitor and evaluate the health sector. The data dictionary in the DHIS will be updated regularly in order to support the data elements that are identified by the HIPC. Health information data will be collected through different sources—routine data are collect from all health facilities and surveillance reports will be collected from investigations, communities, surveys, and operational research. Management data will be collected from different sources such as financial, logistic, administration, and drugs. (Ibid).

In order to regulate quality and accuracy, their respective committees should certify the data before it is sent to the next level within the system. For example, the routine data gathered from health centers, should not be sent to the district hospital until the data supplier has verified the accuracy of the data. (Ibid.)

3.4 Supporting Life Application

In order to try to provide utility in the Malawi HIS, the Supporting Life project aims to implement a low-cost technological solution. Rather than using paper (Image 1.2), the Supporting Life Mobile Application (SLMA) aims to increase accuracy and timeliness in reporting data.

SLMA is a technological invention that aims to help the country of Malawi with disease control, in addition to lowering the mortality and morbidity rate in Malawi (Supporting Life, 2016). By using technological achievements such as ICT and IT following the guidelines from the Ministry of Health in Malawi, SLMA provides the HSAs with an electronic and

mobile IMCI application for quicker, more accurate diagnosis (Supporting Life, 2016). This would result in better treatment, and overall health care provided in Malawi. The application supports this objective of the project by supporting the local health surveillance agents (HSAs) with features that helps with diagnosis and treatment of ill children.

Furthermore, the SLMA would help the Malawi HIS transition from IDSR to electronic IDSR (eIDSR), which is in line with the goals of the Ministry of Health. Specifically, the application aims to facilitate data collection in a digital manner to provide a more updated statistics on the symptom trends in regions (Supporting Life, 2016). Therefore, the effects of this application could provide large sets of patient data, which would have a significant impact on the healthcare system of Malawi (Ibid).

SLMA serves as an example of mobile computerization, which would affect the information quality and information flow of the Malawi HIS. Therefore, we have chosen to implement SLMA as part of our design consideration for the artifact.

3.5 Health Surveillance Assistants

As explained earlier in 3.1, HSAs are agents and volunteers that provide door-to-door visits or are available at local village clinics. There are approximately 9,000 HSAs, who make up nearly 30% of the health workforce in Malawi (Kok et al., 2016). An HSA receives 12 weeks of training and works with promotion of health and disease prevention (Gilroy et al, 2013; Kok et al., 2016). In fact, HSAs make a significant difference in prevention through immunization and retroviral treatment for HIV (Bemelmans et al., 2010; Kadzandira & Chilowa, 2001).

The Supporting Life project has selected HSAs to be at the “first line of defense” by intending the use of SLMA by the HSAs. In order to better understand the objectives and the intended use of the application, the Figure 3.3 illustrates the workflow of a Health Surveillance Agent using the SLMA (O’Sullivan, 2014).

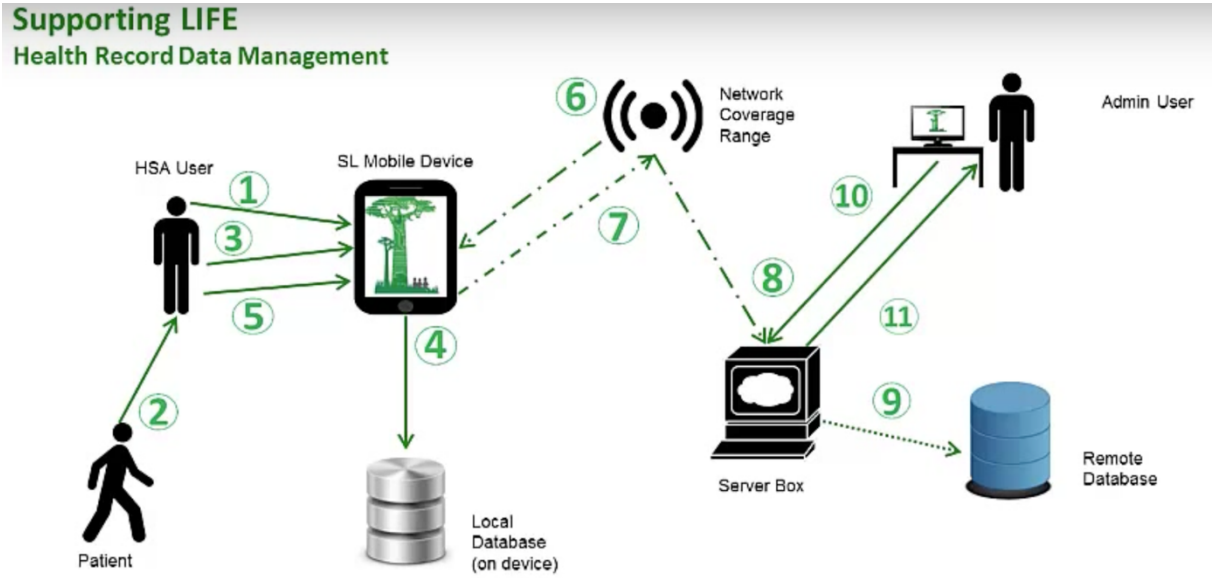


Figure 3.3 SL eCCM App Technical Architecture (Supporting Life, 2016)

1. HSA logs on to app with user name and password
2. Patient is examined
3. HSA fills in the CCM
4. Data is stored on the Local Database (mobile phone)
5. HSA synchronizes data which is uploaded
6. & 7. Data is transmitted to the backend server through the mobile operators network
8. & 10. & 11. Administrators can access the server and data & manage data
9. Backend server stores data

3.6 Chapter Summary

The context problem area within the Malawi HS and HIS is defined in order to address the research question in a relevant manner.

In the current system of Malawi HIS, there are problems of providing timely, reliable, and accurate reports of diseases—which contributes to the overall quality of health care. SLMA implementation would provide opportunities to improve the Malawi HS and HIS.

4 Justificatory Knowledge

This chapter will address the important concepts and provide the theoretical baseline for the design process, which will be explained in Chapter 6. Justificatory knowledge is the underlying knowledge or theory from the natural or social or design sciences that gives basis and explanation for the design. It is otherwise known as the kernel theories (Gregor & Jones, 2007).

4.1 Information Quality

4.1.1 Information Quality Framework

Information quality (IQ) is critical in organizations (Lee et al., 2002). Therefore, for the purpose of our research, we will focus on implementation of Information Quality (IQ) to data sharing. According to English (2009), the cost of poor quality information is a loss to society and to stakeholders. The costs are not simply economic, but also affect the safety, well-being and equal treatment of societies (English, 2009). In other words, if information quality of the Malawi HIS is compromised, it will have devastating effects on its users. In line with the goal of the Supporting Life project, IQ will be a critical factor to consider when coming up with an artifact to address the issue of high infant mortality.

Defining Information Quality

IQ is both a concept and a function. It is consistently meeting or exceeding the knowledge workers and end-customer expectation with information in order that they can perform effectively. Although Wang & Strong (1996) state that the concept of “fitness for use” has become widely adopted in the literature within quality, defining IQ as “fit for purpose” is a misconception according to English (2009). As English claims, information is required to support numerous differing purposes within an organization, and therefore information fit for one purpose may cause others to fail.

High quality information meets the needs of the users and adjusts to specifications (Lee et al, 2002). It is a multidimensional concept with each IQ dimensions (Table 4.1) that are relevant to IS and can be used to evaluate the extent to which the IS produces high or low quality of information (Alkhattabi et al, 2010).

IQ is used as the ultimate tool for companies to satisfy the customer's needs (Michnik & Lo, 2009), this can also be applicable to this paper's context, where the need of the customer here is the needs of the stakeholders in determining the communication of information within HIS.

4.1.2 Information Quality within Information Systems

Within IS literature, information quality and user satisfaction are two of the major dimensions used for assessing the success of the information systems. According to Wang & Strong, some of the Data Quality (DQ) dimensions that are included within information quality and user satisfaction, are: accuracy, timeliness, precision, reliability, currency, completeness, and relevancy. Some additional dimensions include: accessibility and interpretability. (Wang & Strong, 1996).

It is also important to note that the terms DQ and IQ are used interchangeably (Alkhattabi et al., 2010). However, the term IQ is used rather than DQ within contemporary literature due to the following reasons. First off, it has to do with the fact that modern information technology has allowed for information systems to generate not merely data, but also information (Alkhattabi et al., 2010). Since the mobile health apps process the patients' data to generate information to the various stakeholders including healthcare providers, we will for the purpose of this research continue to use the term IQ (Fadahunsi, Forthcoming).

In terms of implementing IQ into Health Information Systems, taking into account the importance of IQ in organizations and IS, it can be said the dimensions of IQ is are critical in the context of Health Information Systems, as the health of the community is literally at stake. What is more, it is important to take into consideration that the need to do more with less is even more eminent in the context of Malawi. As Malawi is one of the poorest countries in Africa (World Bank, 2015), the need to reform and boost the current existing Health Information System in order to generate a social intervention is vital.

4.1.3 Information Quality Evaluation

In understanding if an IS has dimensions of IQ, it is important to first evaluate the existing system.

Good data quality is vital; hence poor data quality (DQ) not only affects society and economy but is also used by firms to improve DQ (Wang & Strong, 1996). DQ is defined as "data that are fit for use by data consumers" (Wang & Strong, 1996, pp. 6). Nonetheless, the focus is too narrow on one dimension: accuracy and points to a broader usage of data quality within the IS field.

In order to improve DQ, Wang & Strong suggest that understanding of what DQ means to the data consumers (who will use the data) first and foremost. Those who we have previously identified as stakeholders will be the data consumers. Therefore, we will conduct interviews with the stakeholders in order to first identify their needs and address IQ within the workflow of the artifact.

This table below is reformulated from Wang & Strong (1996)'s Conceptual Framework of Data Quality (Table 5.1). This list of IQ dimensions will be used during the interview of stakeholders of Malawi Health Information Systems at the workshop and interviews during fieldwork. The relevant IQ dimensions based on the interviews will be address and used to assess the information flow of Malawi HIS.

IQ Dimension	Definition
Accessibility	The extent to which information is readily retrievable
Appropriate Amount	The extent to which the quantity of information is appropriate for the task
Believability	The extent to which information is regarded as true and credible
Completeness	The extent to which information required for the task at hand is not missing
Concise representation	The extent to which information is compactly presented
Consistent representation	The extent to which information is presented using the same format
Ease of manipulation	The extent to which information is easy to use for different tasks
Free from Error	The extent to which information is correct and without error
Interpretability	The extent to which information is presented in appropriate languages, symbol and unit
Objectivity	The extent to which information is not bias
Relevancy	The extent to which information is applicable and helpful to the task at hand
Reputation	The extent to which the source and content of information is highly regarded
Security	The extent to which information is only accessible to authorized user
Timeliness	The extent to which information is up-to-date for the task at hand
Understandability	The extent to which information easily comprehended
Value added	The extent to which information is useful and beneficial

Table 5.1 Adapted from Wang and Strong (1996, pp.5)

High information quality can indicate more usages, more user satisfaction, and positive net benefits (DeLone & McLean, 2003). Vice versa, poor information quality could indicate dissatisfaction and negative net benefits. In the context of the Malawi HIS, the net benefits

could mean improved health care in terms of cost, time, and health benefits to the population of Malawi as a whole, including the health of infants under the age of five.

The objectives of the Malawi HIS is to provide reliable, relevant, up-to-date, suitable, timely and reasonably complete information for decision makers at various levels of the Malawi healthcare system (Malawi Ministry of Health, 2003). Therefore, choosing to identify each of the elements of IQ to assess and come up with design ideas for the artifact is not only relevant to this research, but also important for addressing the purpose of this research.

4.1.4 IQ Framework Stakeholders

According to English (2009), negative experiences with Information Technology and failures and defects in Information System highlight the need for IT sector to become more human-centric in its IS design. In order to design Quality Information Models, database must house knowledge required by all information stakeholders to meet their needs in accomplishing their mission.

The stakeholders of the Malawi HIS include the following: Ministry of Health, Zone, Hospitals, District, Private/NGO clinics, Community and Health Facilities. English (2009) suggests using a business process model in order to assess the current situation before evaluation and improvement.

4.2 Chapter Summary

This chapter defines the justificatory knowledge of Information Quality. IQ has raised significant concern in organizations' awareness about the importance of improving the quality of data for the use of organization's Management Information Systems. Within the context of the Malawi HIS, the cost of poor IQ affects the economy, safety, and equal treatment to the society and stakeholders. Ensuring IQ within Malawi's HIS is therefore critical; consequently, the dimensions of IQ presented in Table 5.1 will be used to assess and improve the information flow of the Malawi HIS.

5 Research Method

According to Gregor & Hevner (2013), research rigor should be the driving goal of the methods selection, which is also explained in Hevner's (2007) Rigor Cycle (Refer to Figure 2.3). In order to add to the Knowledge Base in the form of a design product (model of information flow of Malawi HIS), our research will be based in scientific theories. As Hevner (2007) claimed that a new artifact is based on already existing theories, we began our research by considering the exiting theories used in research on technology within Health Information Systems.

Our theoretical framework, the justificatory knowledge of Information Quality (IQ) is based upon on research on the Information Quality Framework in evaluating existing technology within HIS. After reading up on other research completed on digitalization of HIS, we came across the IQ Framework. We chose to also utilize this framework because IQ is critical to organizations, and has direct impact on the well being of the society. As this research lies within the application domain of health care, we believe that IQ Framework is especially appropriate for this research. Then with the expertise of the stakeholders and through data gathering in the form of workshop and interviews, we will ground our design ideas in order to add to KB.

5.1 Data Collection

Henver et al. (2004) claimed that the goal of DSR is to enable utility. In order to enable utility, the researchers/ designers must understand the context and environment of the research process. Therefore, multiple data collection methods will be carried out at different phases of the DSR process. This process will provide data about the organization, theories, subjects and technological systems that are currently in place.

5.1.1 Primary Data Collection

In order to gain the access to the unavailable data via desktop research, we decided that the best method would be to gather data through fieldwork. We need to identify individual stakeholders of the Malawi HIS (which was not possible) and also find out the actual existing flow or to confirm the one depicted in Figure 3.1. Once on site, we conducted various

interviews and workshop meetings in order to come up with design considerations of our artifact. Fieldwork lasted for a week, where we were able to identify the stakeholders of Malawi HIS firsthand and scheduled as many interviews and a workshop meeting as possible to gather relevant data.

Workshop

With the scarcity of time and information available on the current state of the workflow of within Malawi HIS, we were able to collect critical information by taking part of a Joint IDSR and eIDSR Taskforce Meeting. The meeting took place in the Department of HIV & AIDS conference room in Lilongwe, Malawi. In order to make the most of our fieldwork, we decided that a workshop would provide an effective way to have a group discussion with the important stakeholders. Therefore, at the end of the meeting, we were able to hold a workshop to discuss the current information flow that befits the goals and guidelines set by the Ministry of Health, IDSR, and eIDSR.

Workshops, or focus groups, have been used in research to collect qualitative data. This type of research is economical and empowers social interaction for the participants. Workshops are suitable when the researchers are faced with limitations in the form of time, money and relevant stakeholders. Furthermore, workshops allow for nonverbal data to be gathered in the form of stating similar opinions by nodding or which participants sit or stand together (Onwuegbuzie et al., 2010).

Video Recording

All research is to a certain extent, subjective—researchers look with purpose (Pirie, 1996). In a workshop, a researcher must be careful in not drawing conclusions, or looking for connections that don't exist. In fact, this would be a pitfall or fault a researcher can make during workshop data collection. Therefore, Pirie (1996) advises that one make use of video recording because it allows the researcher to postpone the moment of focusing on decision making. Therefore, we have chosen to make a video recording of our workshop in order that we can analyze the video at a later time. Another benefit of a recording is that it allows us to analyze the content several times. The role of the video recording should be clearly stated, in order to validate the data the recording collects (Penn-Edwards, 2004).

There are six different categories of video recording: observational recording, subject viewing, subject response, subject self-reflection, subject recording and researcher presentation (Penn-Edwards, 2004). For the purposes of our research, we will follow subject recording—a category in which a researcher observes a subject designing and making the video (Ibid). This type of video recording is used when the production of the video recording content may consolidate the understanding and advances problem solving (Ibid). Since we will be collecting data through the video, where we will be discussing the artifact in order to design our artifact.

Interviews

This phase of data collection will be focused on the qualitative understanding of the problem environment. The purpose is: "To understand the world from the subject's point of view and to unfold the meaning of their lived world" (Kvale, 2006, pp.481). Interviews are a method of data collection that is deemed most prominent, according to Schultze & Avital (2011) and Recker (2013). More specifically, we will conduct exploratory interviews due to the uncertainty and novelty of the problem area. According to Recker (2013), exploratory interviews are suitable when proposing new theory constructs and building new theories.

Conducting interviews does not automatically guarantee the stimulation of a useful data collection or meaningful insights provided by the respondents (Schultze & Avital, 2011). Certain issues may be encountered when conducting qualitative interviews, which is often related to language and the skills of the respondent to describe their experiences. Therefore, the researcher must be aware of how to overcome these issues (Polkinghorne, 2005). As there may be some language barriers, we will focus on making the questions as clear as possible and use any examples to make sure that our interviewees fully understand the question. We will also be sure to give examples of what we are asking to make sure that the questions are well defined.

One important consideration for the interviewer is to not anticipate results in mind, but instead listen and try to understand the different concepts and themes that the respondent presents (Rubin & Rubin, 2007). By doing so, the researcher is able to see which concepts are related and then to finally draw results based on the interviews. Therefore, instead of coming up with a list of questions and direct it towards our own preconceived notion, we will carry out the interview by following the topics that are raised during our discussions.

Furthermore, one should be meticulous about accessing data while conducting a qualitative research. The useful information from experiences is not always easily accessed from the respondent. The researcher has to dig deeper in the respondent's experiences to discover the underlying reasons to their experiences (Polkinghorne, 2005). Here, the researcher must be watchful in their intrusiveness and interference of the social setting of the respondent (Myers & Newman, 2007). Due to the fact that our research topic is in health and therefore could pertain to sensitive information, we will be careful in not interfering with private information.

In order to collect relevant, rich data, relevant interview subjects must be gathered (Schultze & Avital, 2011). Therefore, for our research, we have chosen to interview various stakeholders from different levels of the Malawi HIS. Interview subjects are described in section 3.3.1. Respondents should be chosen carefully, and not left to randomness or chance, in order to learn extensively about their experiences (Polkinghorne, 2005). Rubin & Rubin (2007) also advise that finding and choosing experienced interviewees will be critical to having an outcome that is convincing and not seen as random. Therefore, we were careful in

selecting experienced interviewees who have been a part of the Malawi HS for a long period of time.

Additional observations can be conducted when multiple sources of data are available (Recker, 2013). Schultze & Avital (2011) and Rubin & Rubin (2007) refer to this as multiple perspectives. The use of Direct Observation will be conducted as well as having interviews from various levels of Malawi HIS in order to follow the respondents in their natural environment in their daily decision making routine. The observations will predominantly be conducted on the lowest levels of stakeholders of the Malawi HIS, due to the fact that their workflow is primarily unknown and subject to change through the proposed model in conjunction with the Supporting Life Mobile Application. After our interviews are conducted, we will consider additional observations that can be made based on the multiple interviews.

5.1.2 Secondary Data Collection

Documents on Application Domain

In order to generate initial understanding of the context of the Malawi HS, essential documents and reports were researched and analyzed. The main documents of our initial research included but are not limited to the documents mentioned in the following. The National Policy and Strategy document explains the overall strategies that are in compliance to Health Policy Framework 1995 and to the National Health Plan 1999-2004. The Integrated Disease Surveillance and Response (IDSR) document aids in providing key understanding to the context, scope, and purpose of this research. Furthermore, the National eHealth Strategy in Malawi (2014) provided important insight into understanding the goals and strategies of combining health policies and goals of eHealth in strengthening Health Management Information Systems (HMIS).

The Malawi HIS National Policy and Strategy (2003) document explains the Malawi HIS in detail, including information on institutional set up as well as data collection and storage (Malawi Ministry of Health, 2003).

The Malawi HS consists of various organizational structures at different levels of contact with patients. Some areas have Health Centers and Area Health Facilities, and others have District or Regional Hospitals. In order to further understand the organizational structure of Malawi HS, we referred to the Malawi Health Sector Strategic Plan, which also documents the overall plan for the health sector (Malawi Ministry of Health, 2011).

Our desktop research was intended to gain deeper understanding about the health sector, specifically, the role of technology within this sector—for example, Internet of Things (IoT) as a potential enabler of disrupting the future of healthcare. Our focus, for the purpose of this research, was on mHealth, which is an important construct within this research. In order to conduct deep and thorough analysis of the health care sector and the role and value of

technology, future research should be conducted in the outcome and implementation of our artifact in Malawi HIS.

To further gain knowledge of the new advancements in technology in the health industry, we conducted research on the field of mHealth, specifically a study by David Levy (2014), which generated our initial understanding of the workings of mHealth. Additional literature by Malvey & Slovensky (2014) and Norris et al. (2009) were researched to gain further understanding on mHealth. Furthermore, we attended the Vitalis Health Care Conference and Exhibition on April 5th-6th , 2016 in Gothenburg in order to learn about the technological advancements in the Health Information Systems in Sweden.

5.2 On-Site Data Collection

5.2.1 Interviews

During our time on site in Malawi, we were able to interview various levels of stakeholders of the Malawi Health Information Systems.

Suzanne Mwale Health Surveillance Agent at the Area 18 Health Center

Maria Julius Health Surveillance Agent at the Area 18 Health Center

Mayeso Likhala OPD / ART clerk at the Area 18 Health Center

Paul Chunga District Environmental Health Officer

5.2.2 Workshop Meeting with the Ministry of Health

Held on 18th of May, 2016, we participated in a Joint IDSR and eIDSR Taskforce Meeting that involved many of the key stakeholders in the Malawi Health Information Systems. At the end of the meeting, we were able to open up the floor for our workshop. The following key stakeholders and experts of the Malawi HIS were active during our workshop and made significant contributions:

Joseph Wu Luke International, Representative of Supporting Life in Malawi

Dr. Matthew Kagoli Epidemiology Department of the Ministry of Health

Emily MacDonald Norwegian Institute of Public Health

Soyapi Mumba Baobab Health Trust

Setiala Kanyanda IDSR team

Maurice Gombe IDSR team

S. Mumba IDSR team

Maurice M'bang'ombe HIV / IDSR team

Gamphani Phiri Software Programmer Baobab Health Trust

Mgaywa Magafu iTech Malawi

We began our workshop by presenting our model that represents the current flow of information, according to the data collected from the previous interviews with the HSAs, OPD / ART clerk and the DEHO.

Then with the expertise of the stakeholders who were present at the meeting, we were able to clarify and redesign the flow of information according to the best of their knowledge. We have identified the members present at this meeting to be the ones with the most relevance and knowledge to this model; therefore, they are trustworthy sources in deciding the model of information flow within Malawi HIS.

Image 5.1 Workshop with the Stakeholders of Malawi Health Information Systems discussing the current flow of information

5.2.3 Interview with Expert, Joseph Wu

The final stage of the evaluation process will be conducted with our expert, Joseph Wu. We have identified Joseph Wu as an expert specific to this research, due to his deep knowledge and experience of the Malawi Health Information Systems, Malawi Ministry of Health, IDSR, as well as the Supporting Life project, which are the environment upon which the model would be utilized. Joseph Wu is the Malawi country representative of Luke International Norway and has extensive knowledge of the Malawi HS. With an educational background in Public Health and Epidemiology and Health Informatics and Disease Surveillance, his research background and field knowledge makes him the ideal source of information for our project. He is able to evaluate our design ideas and answer our questions. Joseph can provide us with in-depth knowledge of the field and scientific input. Therefore, Joseph Wu's feedback is key to developing a practical artifact. Providing a practical and useful artifact is a key requirement in the evaluation of DSR—utility, quality and efficacy must be rigorously demonstrated through well-executed evaluations (Hevner et al., 2004).

Prior to the interview with Joseph Wu, we were able to create a digitalized version of the flow of information based on the meeting with the stakeholders. During this interview, Joseph Wu provided further insight on digitalized and paper-based information and its flow. In addition to adding further revision and update on design ideas based on his expertise, we focused on discussing the dimensions of Information Quality. Specifically, we discussed how this model in comparison to the current invalidated flow of information would or would not implement the qualities of IQ (Refer to Image 5.2).

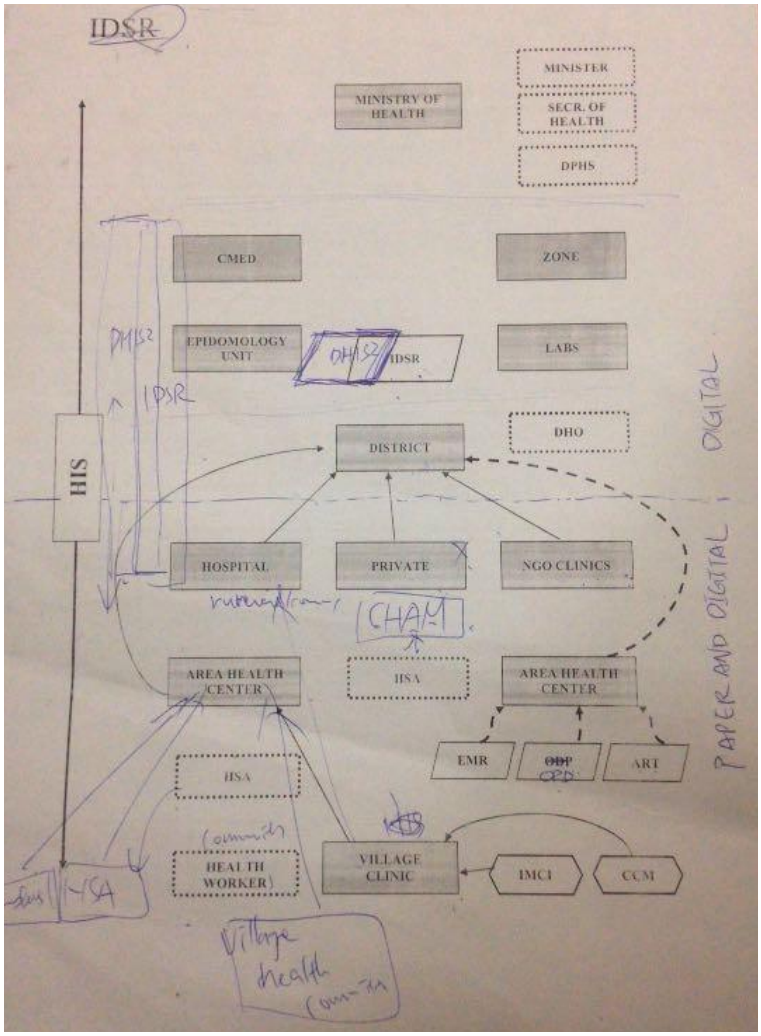


Image 5.2 Discussing Dimensions of Information Quality with Joseph Wu

5.3 Research Quality and Ethics

DSR in IS is viewed as a socio-technical system, not simply an IT artifact. Critical realism is one of the approaches one can follow in DSR. It follows the philosophy that is alternative to the popular philosophy in IS now, and follows heuristic design propositions, design exemplars and patterns, models or frameworks, and stories or narratives. (Hevner & Chatterjee, 2010). Important ethical aspect of the practical sciences is that the knowledge produced can directly affect people's well-being, for instance in the development of safety critical systems (Gregor, 2009). In accordance with Gregor (2009) the system failure can have very real and immediate negative consequence with the outcome of this research. This is particularly true in the case of our research, which deals directly with the health of the population of Malawi.

One of the ways we avoided such negative consequences was through adhering to the rules and regulations set by the WHO. According to the International Health Regulations by the WHO, treatment of personal data must adhere to the following rules. 1) Health information collected must be kept confidential and processed anonymously as required by law. 2) Personal data may be disclosed and processed for essential purpose of assessing and managing public health risks—as long as it is processed fairly and lawfully, accurate and kept up to date and not kept longer than is required. 3) WHO shall provide individual with personal data in an intelligible form and allow for correction.

5.3.1 Interview Ethics

Bhattacherjee's (2012) ethical principles of voluntary participation and harmlessness must be followed while conducting interviews and workshops. Subjects must be aware that their participation is voluntary and that they have the freedom to withdraw from the study at any time without any unfavorable consequences (Bhattacherjee, 2012). Informed consent form will be used to describe such rights of the participants.

We will also be obligated to disclose information about our own study before the data collection will begin to allow the subjects to decide if they want to participate or not. We will also be ethically obliged to reveal to the scientific community how the data was analyzed and reported in the research process. Unexpected or negative findings should be fully disclosed even if it casts doubt on our own research design (Bhattacherjee, 2012).

5.4 Chapter Summary

This chapter discusses the Research Method—our primary method of data collection was through field research in the form of interviews and a workshop. Additionally, we conducted literature review in preparation for the interviews and workshop on site in Malawi. Due to our limited time there, we chose to conduct a workshop because it was most economical in the sense of time and limited stakeholders. Details of our interview and workshop methodologies are discussed.

6 Design Proposition

Here we will show the design process of a model, which is the design proposition of this research. The design process is based on justificatory knowledge, application domain, knowledge and evaluations, which will be provided by the stakeholders of Malawi HIS. The result of our design proposition is the final model and artifact of this DSR.

6.1 Iterative Design Proposition

The iterative design process is utilized in order to increase the relevance of the design and quality of information in our artifact. After our initial design is proposed, we will interview and discuss to find out the most accurate and 'fit for purpose' model for the various levels of Malawi HIS. The interviews will be conducted to with the intended actual end users themselves. Their feedback will be critical to the design process. The evaluation process generates essential feedback that will ensure that the artifact will be developed into a useful part of the system or context (Malawi HIS). Therefore, this evaluation through interviews serves a crucial part of DSR (Hevner et al., 2004).

The final stage of the evaluation process will be conducted with our expert, Joseph Wu. We have identified Joseph Wu as an expert specific to this research, due to his deep knowledge and experience of the application domain as is explained in 5.2.3. Providing a practical and useful artifact is a key requirement in the evaluation of DSR—utility, quality and efficacy must be rigorously demonstrated through well-executed evaluations (Hevner et al., 2004). Therefore, by validating the model with an expert in the field would provide a well-executed evaluation.

Hevner's (2007) Three Cycles of DSR, discusses the Design Cycle as the heart of a DSR project (Refer to Figure 2.3). The Design Cycle focuses on generating and evaluating alternatives toward the requirements that are determined by the context and problem area (Simon, 1996). This cycle should proceed until a satisfactory is achieved (Ibid), and our final model is aimed to general the best possible model based on the data collected.

6.1.1 Starting Point – Organizational Units & Information Flow

The model shown in Figure 3.1 serves as our starting point. Found in the 2014 IDSR package, the model explains the structure, functions, and communication between the levels. Each of the arrows are pointing both up and down, indicating that the information is shared among the levels. However, after our initial interviews with the HSAs and the OPT / ART clerk, we quickly realized that there is a lack of information quality within the current information flow of Malawi HIS and that Figure 3.1 is an idealistic view of the current state of the Malawi Health Information Systems. In fact, we believe that this figure is more of a guide for the future of Malawi Health Information Systems rather than an accurate model of its current working state. This did not come as a surprise, considering the lack of IDSR reports made to the WHO from Malawi (Figure 3.2).

Additionally, it is important to distinguish the difference between the terms 'community; and 'village' as is used in Africa (Menkiti, 1984). The IDSR package refers to the lowest level of the information communication as 'community.' This term is used in Africa to indicate an identity; in fact, his or her community defines a person more than their own individuality (Menkiti, 1984). For the purpose of discussing the location of living in which the Western world generally refers to, this term should be distinguished as a 'village.'

Therefore it can be concluded that Figure 6.1 is not only an idealistic state of information flow in Malawi HIS, but also that this figure lacks **Interpretability** (IQ dimension) for the stakeholders of Malawi HIS. In order to improve upon the "presentation of appropriate language and unit" (Wang & Strong, 1996, pp.5), we will refer to the areas at the lowest organizational structure of Malawi as villages, not community as shown in Figure 3.1.

6.1.2 Second Iteration – Stakeholders and Governance

During our visit to Malawi, the first interview was held at the Area 18 Health Center. We identified the first stakeholders as Suzanne Mwale and Maria Julius, Health Surveillance Agents (HSAs). Maria Julius informed us that she visits various communities three times per week to provide medicine and reports the number of cases for children under five. The children are tracked through their parent's names and boys and girls have a Health Passport. The Health Passport contains information regarding the child's immunization record as well as family medical information. For specific cases such as tuberculosis, malaria, diarrhea, and HIV, these numbers are reported to the hospital. The HSAs informed us that in order to restock on medications, each health center has to provide their own transport, which takes place three times per month.

Then, we held an interview with Mayeso Likhala, OPD / ART Clerk at the Area 18 Health Center. Information gathered at the Health Center is digitalized and shared with the Ministry of Health. Every Tuesday, Wednesday and Thursday, the Electronic Medical Records (EMR)

is stored through the Baobab Trust. The server that stores the information to Baobab and the Ministry of Health is on site at the Area 18 Health Center. The EMR consists of Outpatient Department (OPD) and Antiretroviral Therapy (ART). The OPD consists of medicine prescribed for all diseases, while the records for the ART consists only with HIV. As far as Integrated Disease Surveillance and Response (IDSR) is concerned with information regarding OPD. The District Health Information System (DHIS) and IDSR is a term that can be used interchangeably.

Additionally, we held an interview with Paul Chunga, the District Environmental Health Officer. First, we discussed the purpose of the IDSR, which is to track outbreak, to take action, and to report to next level.

Currently, each Health Facility reports to the District Hospitals who then report to the District Health Office (DHO). While the DHIS is checked monthly, the IDSR is checked weekly. Once the numbers gathered are counted up, there exists discrepancy. This raises a concern on the quality of information in the current processing of information. Paul Chunga stated that the issue is attributed to lack of human resources and a lack of training.

IDSR sends reports on 17 conditions every week, month, and quarter.

Issues with paper-based information are: 1) reports go missing while being transported 2) shortage of registers 3) changes in immunization is not updated.

The current process of ordering drugs is such that individuals from Health Facilities are in charge rather than a team in place who is responsible. What is more, information regarding children under 5 is collected via paper passports from the HSA. In order for this information to reach the DHO, it takes four months who is in charge of 47 health facilities to then report to the Ministry of Health.

Paul Chunga also placed his concern on the fact that data is not being used at each level, and there needs to be more trained staff.

Later, we discussed how much of the information is processed by paper from the village and community level (refer to Image 1.1 and 1.2).

Based on this set of interviews and data gathering, we identified the following problems in Information Quality:

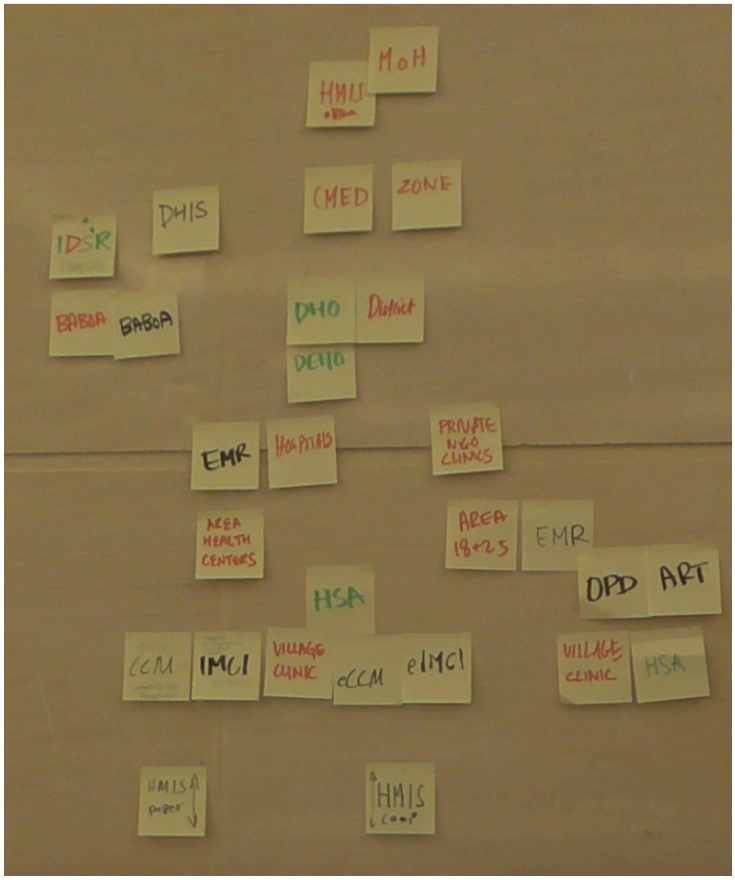
Completeness: “information is not missing” reports go missing

Free from Error: “information that is correct and without error” Sometimes numbers between DHIS and IDSR do not match

Timeliness: “information is up-to-date for task at hand” – immunization records are not updated with the current use of Health Passports. DHIS is checked monthly, the IDSR is

checked weekly. Takes four months for information from Health Passports to be passed to the Ministry of Health

Additional component not mentioned in the IQ dimension: needs to be more trained staff. However, the artifact alone cannot address this aspect. This is an external factor that must be addressed by the HS.



Red – Business Units

Green - Roles

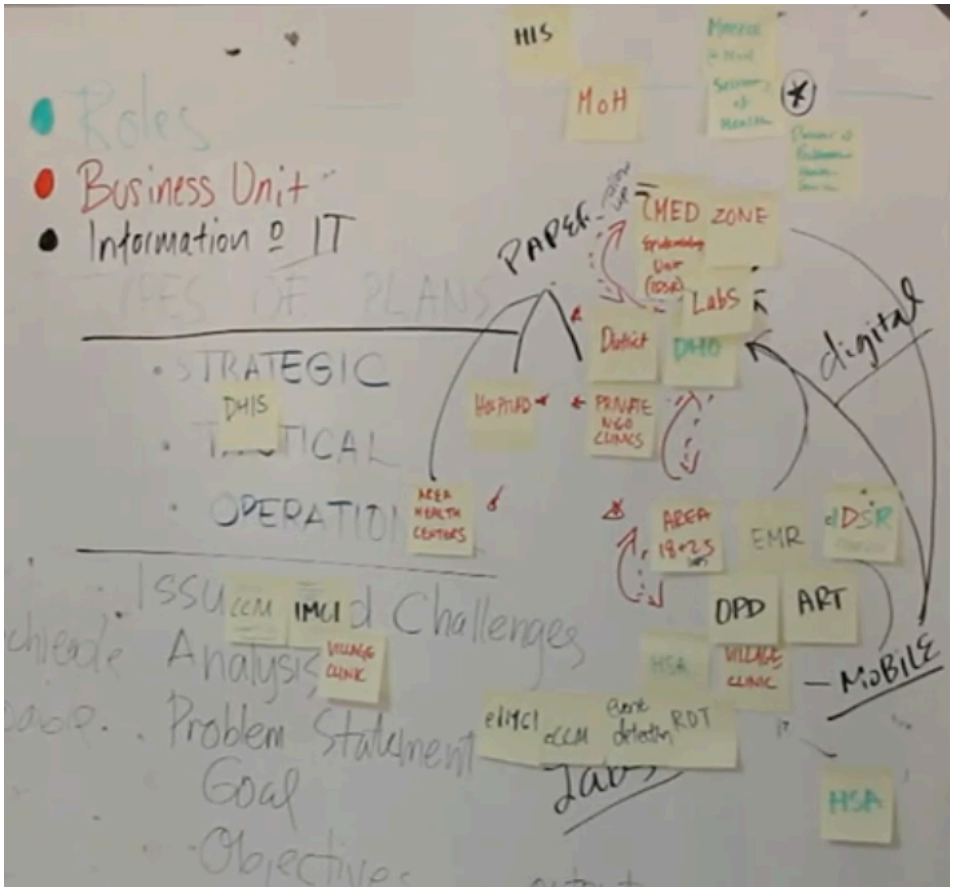
Black – Information / IT

Figure 6.1 Brainstorming Various Levels of Information Flow

Here in Figure 6.1, we started brainstorming the various levels of governance based on our primary set of interviews with the HSA, OPT / ART clerk and the DEHO.

6.1.3 Third Iteration – Revised Structure and Information Flow

During the workshop with the stakeholders of Malawi Health Information Systems, we discussed the model that we sketched up in Figure 6.1 and discussed any revisions that should be made.



Red – Business Units

Green - Roles

Black – Information / IT

Figure 6.2 Result of Workshop with Stakeholders on HIS Information Flow

Additional units and individuals are clarified during the workshop. The key takeaways from the workshop were validation of the stakeholders of the Malawi HIS and understanding the current flow of information as well as the validation for the information flow of the eIDSR, a system of electronic IDSR provided by digitalization.

6.1.4 Fourth Iteration – Digitalized Version

Figure 6.3 represents the digitalized version of the Figure 6.2. This digitalized visualization of information flow of Malawi HIS will be used for the final interview with Joseph Wu, expert with a detailed analysis of the IQ dimensions.

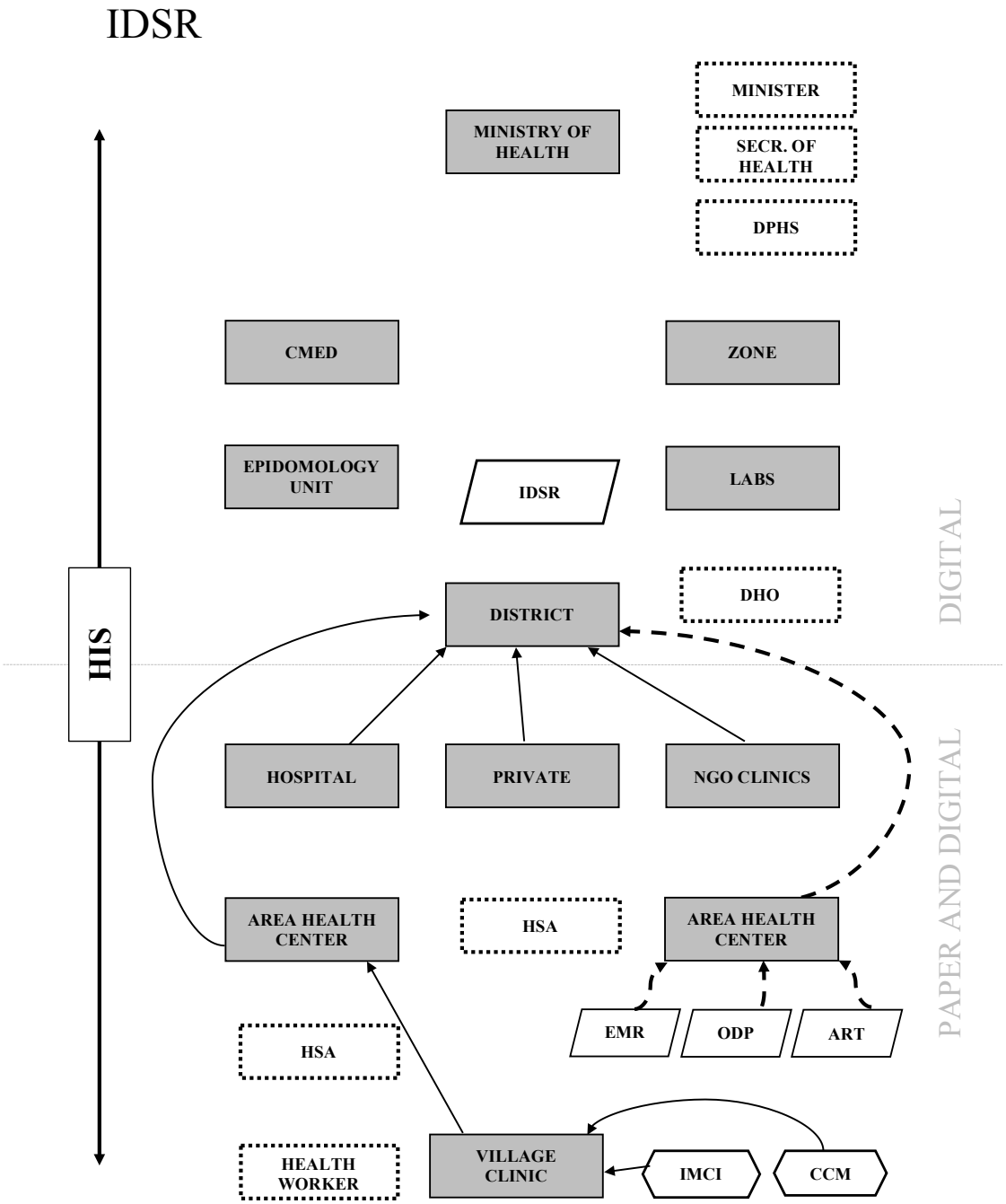
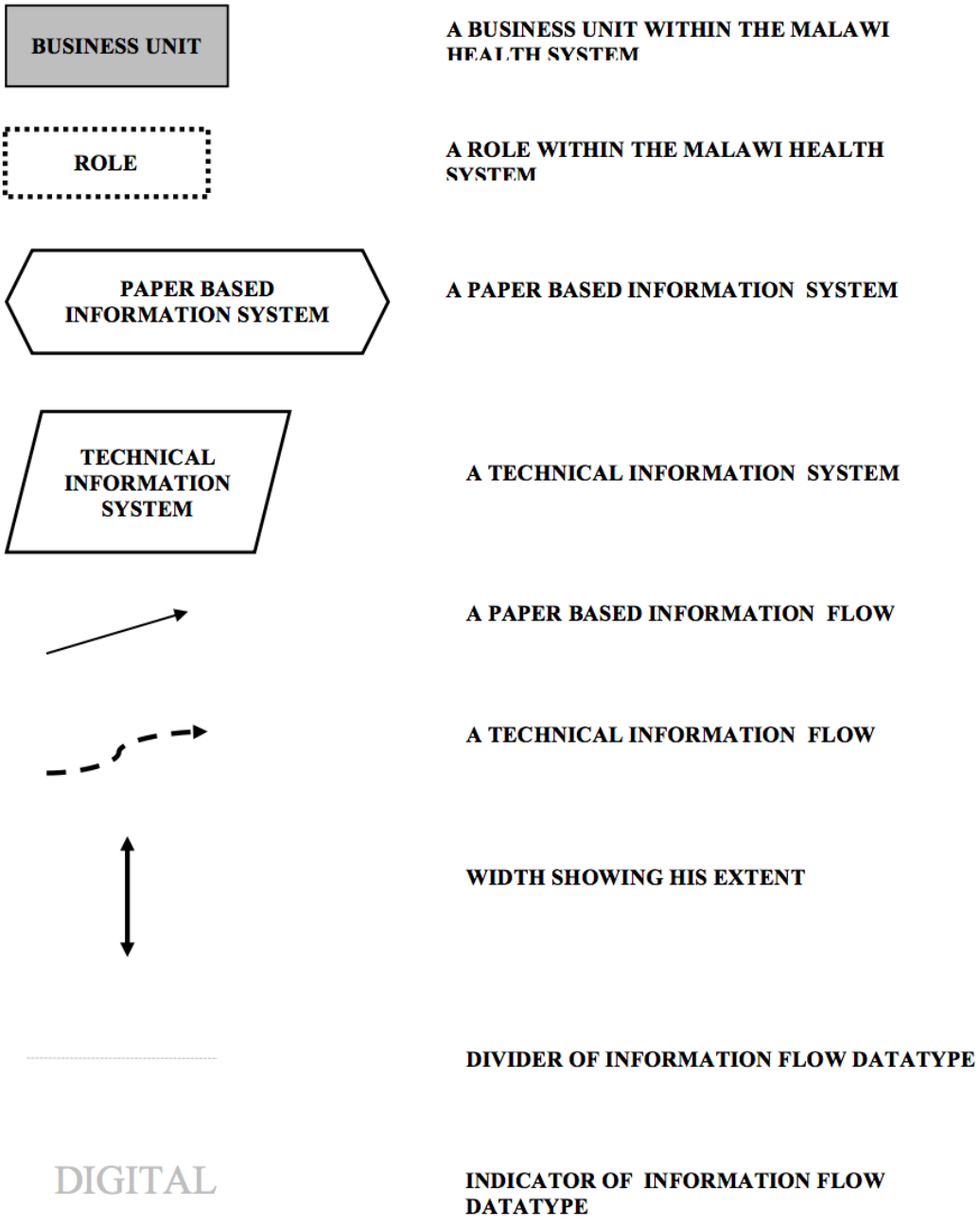


Figure 6.3 Digitalization of Information Flow Based on Workshop



6.1.5 Fifth Iteration – Interview with an Expert

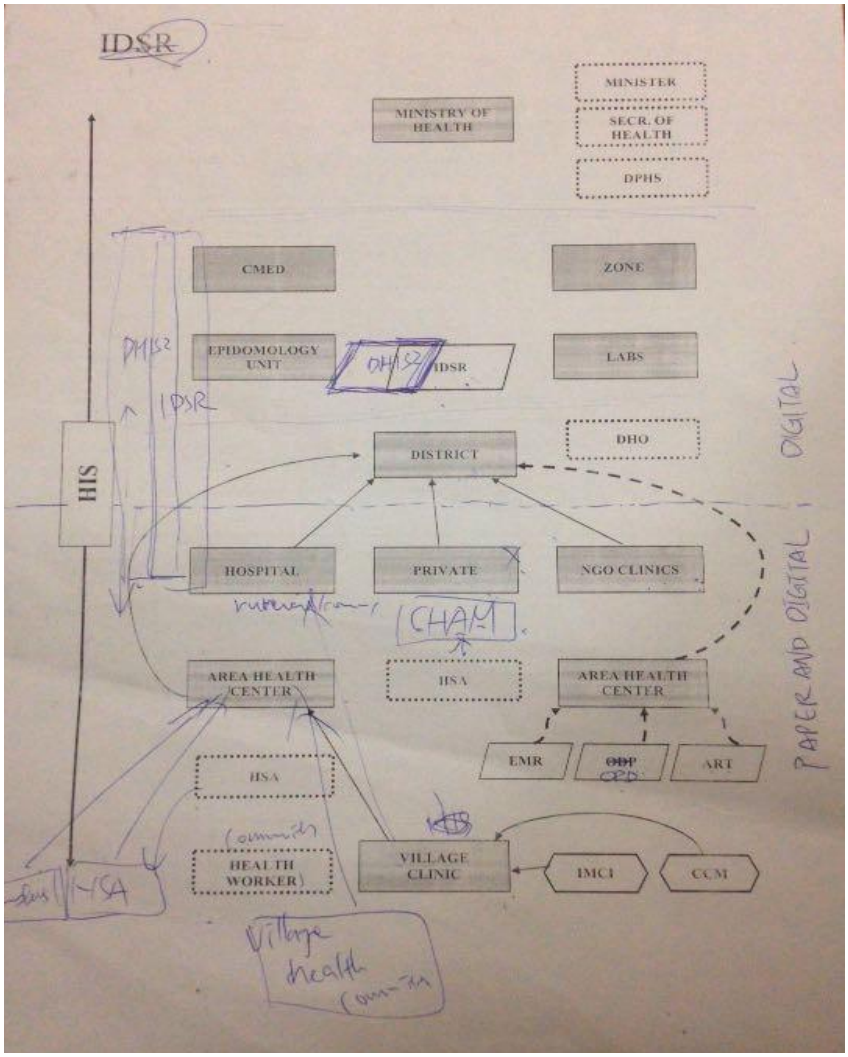


Figure 6.4 Markups on Digitalized Information Flow with Joseph Wu

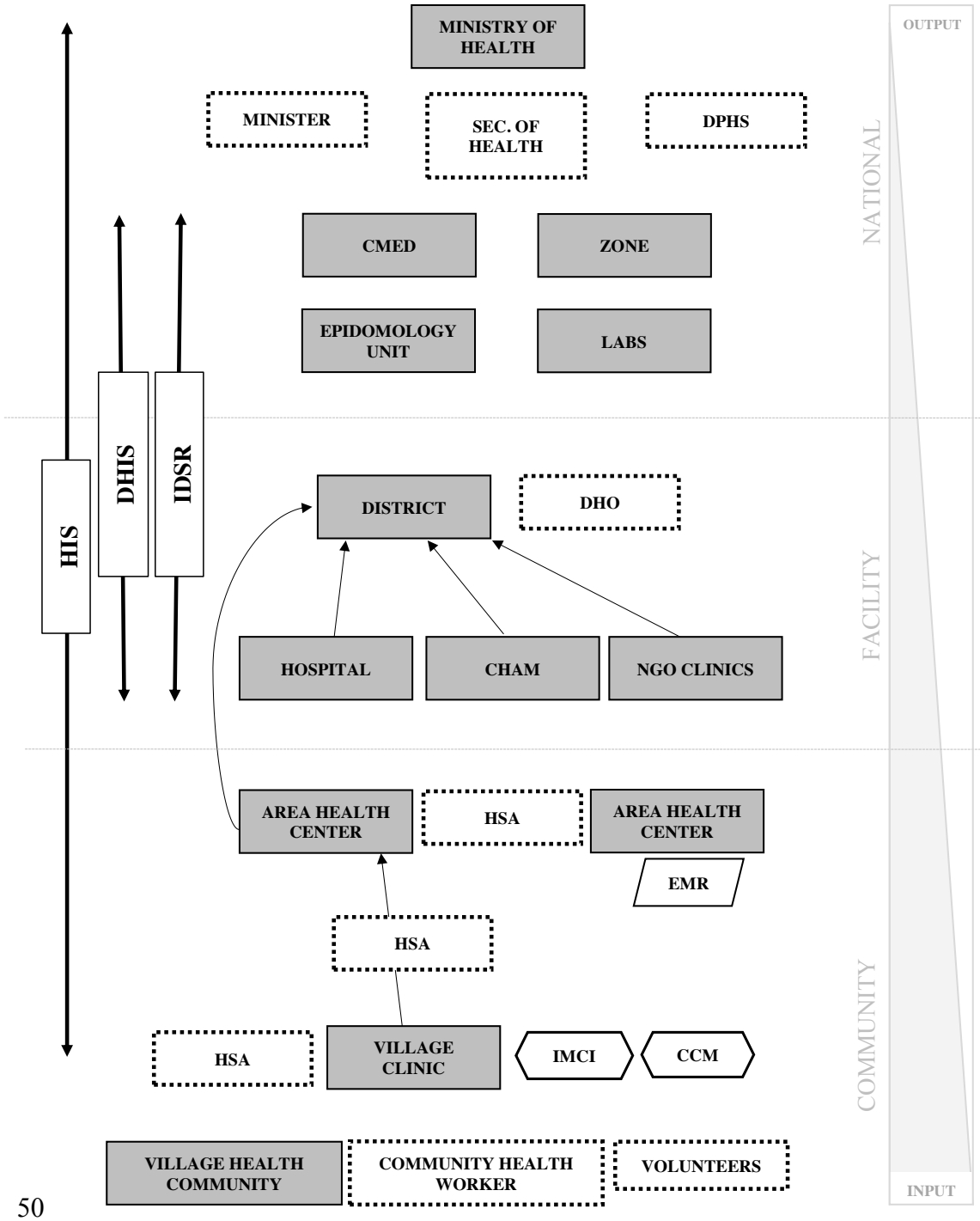
This method of gathering data in combination with the findings from the interview has the following implications on the aspect of IQ.

Dimensions	**Results**
Accessibility	Digitalization would allow for more accessibility in terms of being able to consume the data from more than one location. If the SLMA were to be implemented by the HSAs, then data could be gathered (Figure 3.3) and used for the purposes of IDSR.
Appropriate Amount	Through aggregation, reduction would be achieved in the amount of information received via paper at the district level.

Believability	Yes, but the artifact is not sufficient. Feedback is needed in the later stage of the developed system.
Completeness	Would reduce the risk of papers going missing; therefore, completeness would be increased.
Concise representation	Yes
Consistent Representation	Yes, but this is not an area of concern at this stage in the research.
Ease of manipulation	Would be easier to aggregate data via SLMA than it is when aggregated via paper.
Free from Error	Unclear the results based on the current model of information. Further research is necessary through implementation of the SLMA. However, a digital platform could reduce errors.
Interpretability	Not applicable
Objectivity	Not applicable
Relevancy	Not affected at this stage of the research
Reputation	Not clear
Security	External factors / not affected
Timeliness	Timeliness is important for IDSR, and would be achieved through eIDSR. Currently outbreaks occur and end naturally. Digitalization would allow for a certain response if the data is gathered in a timely fashion.
Understandability	Not affected
Value Added	Not completed solved by the artifact. Further feedback is necessary from future end users once SLMA is implemented.

6.1.6 Final Model

MODEL OF INFORMATION FLOW OF MALAWI HIS & INTEGRATED DISEASE SURVEILLANCE & RESPONSE



This final model is based on the edits made with Joseph Wu in 6.1.5. The final compilation of the changes made in IQ dimensions is as follows:

Dimensions	Results
Accessibility	Digitalization would allow for more accessibility in terms of being able to consume the data from more than one location. For example, if the SLMA were to be implemented by the HSAs, then data could be gathered (Figure 3.3) and used for the purposes of IDSR.
Appropriate Amount	Through digital aggregation, reduction would be achieved in the amount of information received via paper at the higher levels.
Believability	Yes, but the artifact is not sufficient. Feedback is needed in the later stage of the developed system.
Completeness	Would reduce the risk of papers going missing, therefore, completeness would be increased.
Concise representation	Yes, refer to Image 1.1 & 1.2
Consistent Representation	Yes, but this is not an area of concern at this stage in the research.
Ease of manipulation	Yes, information would be easier to aggregate.
Free from Error	Unclear the results based on the current model of information. Further research is necessary through implementation of the SLMA. However, a digital platform could reduce errors.
Interpretability	Improved through accuracy of stakeholders and understanding of the levels of stakeholders (6.1.1)
Objectivity	Not applicable
Relevancy	Not affected at this stage of the research
Reputation	Not clear
Security	Dependent upon external factors
Timeliness	Timeliness is important for IDSR, and would be achieved through eIDSR. Currently outbreaks occur and end naturally. Digitalization would allow for a certain response if the data is gathered in a timely fashion.
Understandability	Not affected
Value Added	Not completed solved by the artifact

IQ stakeholders of a digitalized Malawi HIS, specifically eIDSR, are the ‘information users’ or ‘information consumers.’ With this final proposition of information flow in Malawi HIS, the transition towards IDSR would be made. Implementing dimensions of IQ would allow for the content within Malawi HIS to be “correct, well written, and relevant to the goal” of HIS and IDSR as mentioned in Chapter 3. The SLMA would allow the HIS to meet its individual goals set by the WHO to provide data for patient health needs and treatment for clinical decision making. The health facility would be enabled to determine resource needs, as data

would be aggregated digitally and in a timely fashion. The population level would allow for public health decision-making and generate information for members of the MoH to take action and come up with response to disease outbreaks, and for the WHO to utilize the information. Finally, public health surveillance would bring together the information from lower levels and focus on defining problems and provide action to increase the overall health care in Malawi.

Therefore, the effectiveness of transitioning from a paper based HIS towards digitalization through SLMA is studied by the dimensions of IQ. This research indicates that this transition would provide not only a positive outcome, but also that an effective management system could have far reaching consequences. Just as IQ dimensions affect the economics and the well-being of societies, the final model suggests that the country would meet expectations of a country's HIS and begin its IDSR.

6.2 Chapter Summary

In this chapter we have completed 6 rounds of design iterations, through process of interviews and workshop, we have validated our artifact in terms of its utility and improvement of IQ dimensions. More specifically, we identified IQ dimensions during the initial round of interviews as well as at the workshop and discussed them during the final interview with Joseph Wu. Finally, we present our final model of information communication within the Malawi HIS in accordance to the IDSR. This final model shows the implementation of digitalization supported by SLMA.

Based on the first set of interviews, dimensions pertaining to accessibility, completeness, concise representation and timeliness are identified as problem areas. These dimensions are affected and improved in the final design proposition. Dimensions of appropriate amount and ease of manipulation are likely to be improved. Finally, dimensions of believability, consistent representation, relevancy, reputation, and value added are future considerations to be made after the implementation of the SLMA. Finally, dimensions of objectivity and understandability were not of important considerations for the purposes of this research.

Based on our final interview of the model, the final model would improve the flow of information within Malawi HIS as discussed before. The consequences of this research would affect not only the society, economics but also improve IDSR and the overall health care by meeting the expectations of a country's HIS.

7 Discussion and Conclusion

This is the final chapter of our thesis, which includes the discussions and implications of the design proposition. This study describes the development of a model that displays how information quality is used to support communication across the different levels of a Health System. Our research adheres to Gregor & Jones's (2007) ISDT, in order to make a knowledge contribution to the existing application domain in the form of an artifact.

Research Question: How can information quality be implemented to improve and support the information communication within Malawi HIS?

Motivation of our Research: To contribute towards improving the general standards of health care in Malawi HIS.

Purpose of this research: To provide a validated model of health information communication in Malawi HS.

This research identified problems within both knowledge and technology. The problem in knowledge is identified as a lack of a valid and up-to-date model that displays the information flow in Malawi. In addition, the technological problem lies in the fact that there is a poor data quality within the current HS due to its paper-based communication.

Therefore, we fulfill the purpose of this research by providing a model that has been validated by the stakeholders and experts of the Malawi HIS. At this stage in the research and improvement of the Malawi HIS, it is difficult to implement all of the dimensions of IQ. The information quality implemented through this research is contributed through our artifact. Future research is needed in order to fine-tune the qualities of IQ into the information flow of Malawi HIS.

The development of this model is based on design science research and is supported by empirical evidence. The final design proposition is the most significant contribution of this research. This model of health information communication can be used to support HIS implementations.

In reference to Gregor & Hevner's (2013) DSR Knowledge Contribution Framework (Refer to Figure 2.1), our research paper contributes to the Improvement domain. The Improvement domain is relevant to Design Science Research of developing new solutions to known problems—by providing a validated model of information flow we have addressed a new

solution to the problems of information communication and quality of health care provided in Malawi.

7.1 Practical Implications

The main contribution of this research is to provide a validated model of health information communication in Malawi HS. Our research adheres to Gregor & Jones's (2007) ISDT, in order to make a knowledge contribution to the existing application domain in the form of an artifact. In Chapter 6 we have answered the research question by using interviews and workshop to raise questions of various dimensions of IQ and implementing them to the flow of information within the Malawi HIS. The results indicate that taking these dimensions into consideration allows for an overall improvement within the flow of information in addition to possibly having additional benefits of improving the overall quality of health care in Malawi. Therefore, we have addressed the purpose, by coming up with an up-to-date and validated model of information communication; addressed the motivation by possibly improving the overall quality of health care in the future if the design ideas were to be implemented in the future.

7.2 Theoretical Implications

In the process of validating a working model of communication for the Malawi Health Information Systems, we discussed the various Information Quality Dimensions (Table 5.1). IQ was a useful tool in improving the model of information flow. Considering each of the dimensions on the list helped us consider the validity of the model.

Considering the scope and the maturity of the research application domain, and the low maturity of developing the solution, the dimensions of IQ most relevant pertaining to this research was: accessibility, completeness, concise representation and timeliness. Dimensions of appropriate amount and ease of manipulation are likely to be improved, however was not the most area of concern from the earlier models. Additionally, dimensions of believability, consistent representation, relevancy, reputation, and value added are future considerations to be made after the implementation of the SLMA. Finally, dimensions of objectivity and understandability were not of important consideration for this research.

7.3 Limitations and Future Research

According to Simon (1996), the design process is concerned with finding a satisfactory design rather than to seek an ideal one. Therefore, with the approval of the stakeholders and the experts, we believe our final model is satisfactory.

In addition, information about the private sector facilities and rural and remote areas of Malawi has been excluded for the purposes of this study. This is due to the fact that there is lack of information in addition to the fact that they use their own channels of communication. According to the officials of the Ministry of Health, this is a minor factor to take into account.

Some gaps and ideas for future research that we have identified in accordance to the stakeholders and experts are:

- Results of actual testing of data gathered from the SLMA when used by HSAs?
- What would be the result of testing the long-term benefits of this mobile health application artifact—how does it shape the HIS?

Appendix 1 Interview Transcription

Interviewee: Joseph Wu - Expert

Interviewers: Min Young Kang, Robin Schönström, Bo Andersson

April 5th 2016

Min Young Kang	Um, because I was asking yesterday, like you have the EMRs in place no, but there it is connected to the DHIS?
Joseph Wu	Mm..
Min Young Kang	But it is not being used for surveillance of diseases right?
Joseph Wu	Um, practically, it is not yet connected to the DHIS tool
Min Young Kang	Huh, it is not connected to the DHIS?
Joseph Wu	Yeah, I think that line (dotted line which goes from EMR to Area Health center) technical information flow... where should we start?
Robin Schönström	Yeah, that's a good idea. So, um, Bo you can listen to. Here in the middle with the dotted line that Joseph has done, there should be a gray line but it is not visible due to print.
Bo Andersson	Um, okay, mm.

Robin Schönström	The text says Paper and Digital (lower section) and Digital (upper section), just to have that clear. And on this paper (showing the Legend paper), are all the different symbols you can see. And to go through the different symbols, we first have the gray ones, straight and gray which is different business/ organizational units that we have been able to identify.
Min Young Kang	And we talked to Baobab yesterday.
Bo Andersson	Do you have it on screen?
Robin Schönström	Yes, we have it on screen. And then the next one (boxes with dotted line and curved corners) is the different roles that people has on different levels. Yes, and so on, like the next one is the paper based information which is the different ledgers (boxes with solid line and arrows on ends.) The next one is the technical ones (boxes with solid line and slight tilt to the right), which is the EMRS and um ODPs.
Bo Andersson	That would be some sort of computerized?
Robin Schönström	Yes, I´ve written technical information systems, could be digital maybe…
Bo Andersson	Computerized
Robin Schönström	Yeah, um.
Min Young Kang	Is it advocated here?
Joseph Wu	Um, okay

Min Young Kang	Just so we know, this is more or less the model we had yesterday and the hospital, the private NGO and Area Health centers. They all send their paper trails to district level.
Joseph Wu	Yeah
Min Young Kang	And then it is aggregated there and (pointing to District business unit symbol) and computerized there and then it is sent up?
Joseph Wu	Um, yes.
Min Young Kang	And these are in place?
Joseph Wu	There is no interface, between EMR and linked to the DHIS tool yet.
Min Young Kang	Okay so this goes to Baobab?
Joseph Wu	Yeah, it is still ech EMR site is still independent.
Min Young Kang	They are all independent?
Joseph Wu	Yeah, but ah Baobab is still developing connectivity backbone.
Min Young Kang	Mm..
Joseph Wu	So, few sites can actually be connected. Like in Lilongwe, it is connected. But the report from the EMR sites, to the district, this interface is not yet finished.
Min Young Kang	Ah alright
Joseph Wu	Yeah, it is the coming working agenda, on the different projects like CDC and we are writing a gates proposal, which will cover that.
Min Young Kang	Mm, and when you say that it is connected, what do you mean, where it is connected to?
Joseph Wu	From Baobabs office it is possible to access the server.

Min Young Kang	Okay, so does the district have access to that?
Joseph Wu	No, only the technical partners have access. So similar to Lin, we have the privilege to connect to the EMR sites within Mzuzu. And we can access the server to the network, but yeah, in terms of information it is not interface yet.
Min Young Kang	Ah I understand. So, our next question is: We kind of briefly talked about how the SL apps will be used at the village clinic in addition to the IDSR. Oh yeah and could you quickly clarify the case report and line list, and RDT.
Joseph Wu	Case report form is mainly to register the individuals at the beginning of outbreak.
Min Young Kang	For specific diseases?
Joseph Wu	Yes, the initial stage, but when the outbreak becomes large in terms of the patient number then at the treatment center it can be. Health facility, it can be treatment center in a hard zone, they were start using the line list, to register, it is the most simple compared to the case report form.
Min Young Kang	Okay, and this is done paper based now?
Joseph Wu	Yes, at the moment it is all done paper based.
Min Young Kang	And we want to digitalize that using SL as well?
Joseph Wu	Yes, exactly.
Min Young Kang	And I just want to make sure that we send the information to the server, does the Area Health Center want to access the information that is sent from the Village Clinic? Or the hospital, do they want to share the information to the village clinics as well?

Joseph Wu	How do you mean?
Min Young Kang	So we are going to digitalize this part right (pointing at health worker, HSA, Village Clinics.
Joseph Wu	Yeah, mmm.
Min Young Kang	And when they become also connected, together with hospital, do they all want to be connected to the HIS?
Joseph Wu	Yeah, definitely, because there has to be a feedback loop, between the village clinic, community, and here at the facilities
Min Young Kang	Yeah, because the focus of our thesis is to improving the information quality, and do you think that we change it to digital and you change it to digital, will the district benefit from that?
Joseph Wu	Yeah, definitely, I think that data quality will be improved and for sure, or not for sure, it is a assumption, and also the timeliness. Because the digitalized system that means that they are sending reports as long as they have connectivity. That will be much easier. For the challenge, like the reports from the community to the district facility, is because it is paper form. And they have to wait until there is someone who can be the transportation and they can bring the report, otherwise they will not be able to do. But what they said is that the HSAs has been trained and oriented, so if any important event occur, they should use any means to communicate to the facility.
Min Young Kang	So the information can be more accessible?
Joseph Wu	Yes
Min Young Kang	To the stakeholders? And more secure? The accessibility to the information.
Joseph Wu	It is secure from which perspective.
Min Young Kang	Um, so the information is visible only to the authorized members?
Joseph Wu	Yes

Min Young Kang	Is that a big concern currently?
Joseph Wu	I think it is not an issue
Min Young Kang	Ah um, and will it be more concise?
Joseph Wu	Yes
Min Young Kang	Ok, so these are some of the different dimensions of information quality that we are concerned with… And we think that accessibility.
Joseph Wu	Is that the framework, from which paper?
Min Young Kang	This is Wang and Strong's framework of Information Quality which they divide in these four categories with all different individual dimensions. And we are trying to identify which ones are being improved, which ones more relevant to HIS
Robin Schönström	Because there is a lot so we try to figure out some of them is more…
Min Young Kang	Yes, so this is the IDSS model, of information quality and we believe that by improving information quality can help the purpose of the Health system. And also aid the users, and also lead to other great things. Or if it is bad (IQ), it comes up to bad things.
Joseph Wu	Aha, mm. Mm. Yeah, okay. I think you can look on this "Framework for UN Health Information System". So if you can adapt that, to see that village clinic is under the community level.
Min Young Kang	It is under the community level?
Joseph Wu	Yeah, it is under the community level

Robin Schönström	Okay.
Joseph Wu	But at the same time, there is some fusion between cognivity and patient because they serve as the breach. And this because they are the ones who identify the normal population of the community then all this treatment you need, or health facility's, they are for the patient under the city level. And each organizational unit is actually doing aggregation work.
Min Young Kang	They are doing aggregation work?
Joseph Wu	Yeah, because under this line, it is all individual data. And the report they usually send is all aggregated. That is most of the Management health information systems all report, but disease surveillance is unique because is dealing with disease where it need to do response. So, if I may show you, this is the "HIV Related Program Architecture", that we draw, so it is very similar to disease surveillance at the community level they are different organizational unit, that provide service and concerning about disease prevention and care treatment, and this is basically how patient or individual they move, if they are negative they will remain in the community, they are positive then they to the facility and they will move in between the community and facility, and there is also some team that will do some follow up. Yeah, so for the EMR here, ah EMR is a encompass concept in Malawi, we use the term National Electronic Medical System, as a hat to describe the different modules.
Robin Schönström	Yeah.
Joseph Wu	So there is the OPD Module, the ERP module, ANC module regarding HIV, TP module or NCP. So these are modules.
Min Young Kang	And just to clarify, the DHIS2 is for the e-IDSR to right?

Joseph Wu	Well, the DHIS2 is what government is hoping and moving towards that to use this as national platform for all the HMIS. So, it should look like this (drawing boxes and arrows on the left of the model), yes so there is some overlap there. But what we are trying to do now for e-IDSR, we see this gap between DHIS2 and eIDSR, mainly it is related to response, and when we are talking about response. That means that timeliness is important, the epidemiology need and also the district rapid response team, they should be able to do timely response. And the DHIS2 is mainly looking at the management purposes like health policy, etc. So they don't require to highly timed data so, that is the gap, or the reason why we need to have sort of separate function of eIDSR.
Min Young Kang	So currently they are using DHIS, there is no 2 there, as of now.
Joseph Wu	Yes, they do.
Min Young Kang	So they are using DHIS2?
Joseph Wu	Yes, this has been used for quite some time, and I can see if I can login to see if they are using before I say that they are using it. Using DHIS2 for eIDSR, I can login to the system and see. Last year they where to be trained to do the report through DHIS2.
Min Young Kang	Okay.
Joseph Wu	Yeah. Otherwise before they all sent in the paper form only.
Robin Schönström	So it is not going to be used in other levels, just the National level? Or?

Joseph Wu	District, from district level. So DHIS2 is like covering from the facility level where they can start enter in data as long that they have HMIS officer the one who can enter data. Then they will do the report, but only focus in the facility, and then the District Health Officer, will be able to enter some data for some paper form, and also to view all the Health Facility data within they district and then for Zone they can view all the data for the country using CMED or Epidemiology means… So they should be like, epidemiology should be above the DHIS, and the labs as well. I think for the DHIS2, it would probably be better like if it covers from here to here (drawing the box in the middle overlapping IDSR box) with box DHIS2, and partially they will overlap with the IDSR. This is the portal (showing a software interface on his computer) So we can go back to the variations of criteria.
Min Young Kang	Yes, that would be really, really great. So, yesterday we talked about that there are mistakes or errors in the system, ehm, is that a concern? And do you think that this is more a concern with the digital one than with the paper one?
Joseph Wu	Aha, mm. In the concern of Data Quality?
Min Young Kang	Eh, EMR and just focusing on errors
Joseph Wu	The errors?
Min Young Kang	Yes, if the data is correct
Joseph Wu	Not so clear… hahah.
Min Young Kang	Hahah not so clear yet.. Haha.
Joseph Wu	But I think with the digital platform, it can reduce the errors. That is our assumption and our goal as well. Cause then we will be able to set up some logic or reasonable data range to set up as a threshold or alert that if they enter something ridiculous, the system will tell and alert, with a popup something like a message to tell them to verify. Yeah, or totally not reasonable this error, the system can block it using algorithm that we set up.
Min Young Kang	Yes, okay, um and with the information that is sufficient

	involved with what they want to do with IDSR?
Joseph Wu	Yeah.
Min Young Kang	Great!
Joseph Wu	Um, because we´re doing the whole context analysis like the workshop yesterday is in order to help us, as a researcher and as a practitioner. To get to know what are the real problems that they have yeah. So basically the solution to with everything, the IDSR is to take all these challenges to reduce or solve them.
Min Young Kang	And we believe that way of information will be easier to aggregate and the information will be complete, formatted compatibly and that it will be easy to interpret.
Joseph Wu	Aha, yes, um… Yeah.
Min Young Kang	Ah okay great, we just go with these…That the information is believable?
Joseph Wu	Yeah, um. But I think in order to achieve those, by the system itself, it is not enough,
Min Young Kang	By what?
Joseph Wu	By the IDSR system, the artifact itself is not sufficient, mm, the mentor to the user and the training also, and also they need to be retrained of the mentors. It is a new system, so then they need to retrain themselves. It is just like immune system after a vaccination, after some time, you have to boost it… And then you boost it, yes, and regular, really use the data to provide the feedback. Those are the issues and concerns taken into account when developing the system
Min Young Kang	Yeah, yeah. Mmm. So that it actually adds value?
Joseph Wu	Yes
Min Young Kang	Mm okay so that's another key concern. So, overall, your feeling with the new IDSR, the biggest concern is with data quality and timeliness, that data is complete and

	consistent and working toward free from error
Joseph Wu	Haha, toward free from error, because there will be type1 error and type 2 error, hehe, if you use the statistical term. Some is random.
Min Young Kang	And also another major concern is to add value.
Joseph Wu	Yes.
Min Young Kang	Okay, and that is not complete solvable by just the system but also the X factors?
Joseph Wu	Yes
Min Young Kang	Okay, Great! Haha, we have been looking forward to gathering data, haha.
Robin Schönström	One question um, are these criteria important at all the levels within the system or just on a national level or a district level, are their differences in importance?
Joseph Wu	Yes, that one, cause um, currently we are standing at the national or district level to see the needs or the expectations, and we have not interviewed the End user to see what would be the expectations or in terms what kind of benefit it would bring to the end user. Yeah, that puzzle is still missing, we have not collected any data yes, so that would be a good to come another time to interview the HSAs.
Robin Schönström	Is there problem today with accuracy or liability with the paper based from the HSAs.
Joseph Wu	Currently with the paper based it is a big concern, and I think yesterday Emily tried to show the real data how the write it.
Robin Schönström	Yes so, the problem that occurs today with the paper based from HSA´s and health care workers

Min Young Kang	But they are at village level, they are not collecting information there correct? They only collect information for children under 5 with the passports?
Joseph Wu	Um, in turns of the clinical service delivery and the patient level data, currently it is only under 5. But what they said, is that that currently the health workers, HSAs or the volunteers has been sensitized to be able to detect the community level case. They use a term called, um, Community Standard Case definitions for disease surveillance, and these simplified ones, and they will look at sudden death, unknown death, and they are written in guidelines.
Min Young Kang	I have taken this in a different direction, going back to our main concerns in information quality - What is outcome now? What is the result having the information not be in a timely manner.
Joseph Wu	The most severe outcome is that when outbreak occur is that response is delayed and the outbreak is ended naturally. And fortunately enough there is no severe hemoroidic fever disease outbreak in Malawi otherwise we might have there would be severe mortality and morbidity regarding certain disease commission yeah. And also when conducting the response, because the data is not timely enough, and the information is fragmented, so the response resource can not be put in place in time and so many would be affected because of the response part.
Min Young Kang	And, the current state of where the DHO collect all the data, and they have to go back to different hospitals or the clinics and ask like: Why is this number so high? And like sometimes numbers is wrong
Joseph Wu	That means it trigger false alarm, but um, I don't think they see false alarm as a big concern. The main concern is the delay of response, um.
Robin Schönström	Is there problems with the amount of resources needed?
Joseph Wu	Yeah, you know resources, the response resource, as well as the time to response is also being delayed.
Robin Schönström	Are these subjects being discussed right now at a national level,

	do you know? Like these timeliness problems.
Joseph Wu	Yeah, it has been discussed quite a long time.
Min Young Kang	And one last question, about the value added, of the concern of adding information that is useful and beneficial, what do you think will be the benefits of E-IDSR? Especially on the village level.
Joseph Wu	The greatest benefit we are trying to gain is the early detection, so we are hoping that if there is any unusual activity happening, we are able to push the whole detection time, the timeliness of detection, to early stage, of outbreaks.
Min Young Kang	Of outbreaks?
Joseph Wu	Yes
Robin Schönström	I just want to go into this model again, I'm just going to make sure, these paper based information flows, are they such today as they are presented here?
Joseph Wu	Yes, this is what is happening.

Appendix 2 Workshop Meeting Transcription

Joint IDSR and eIDSR Taskforce Meeting:

Workshop with the Stakeholders of Malawi HIS

April 4th 2016

Min Young Kang	They report to secretary of health?
Dr Matthew Kagoli	Yes.
Maurice Gombe	This one and this one is the same, pointing to HMIS and CMED, and Epidemiology unit is a part of CMED. And remove the DEHO, from DHO.
Emily MacDonald	You are missing labs though.
Min Young Kang	Labs? Ah okay, are they in the health centers?
Maurice Gombe	Ah no. No, in only some health centers is there body lab like clinics.
Dr Matthew Kagoli	Yeah, it is so that the epidemiology center has the labs.
Setiala Kanyanda	It is not that the whole epidemiology unit is in the CMED, it is only the IDSR of the Epidemiology that
Dr Matthew Kagoli	Here we are looking at IDSR
Maurice Gombe	So if we are talking about the IDSR, IDSR and we are talking about the Lab. They are connected like this.
Min Young Kang	Okay, so our question is if this information (mobile data) is gonna go through the Baobab and further to the DHO, or is information going directly from Village clinics to DHO?

Robin Schönström	Yes, is the data going from Village to Baobab servers and then to DHO? Or directly from Village to DHO? Where will the data go?
Maurice Gombe	Yeah, so information from the app it goes here (pointing to DHO) and also to here (pointing to CMED and Epidemiology IDSR)
Min Young Kang	Okay, so this data goes here (to DHO) and also to here (drawing a pointer to CMED).
Min Young Kang	And, and so this is not connected to the Baobab servers?
Maurice Gombe	That is what we are trying to discuss, how we can solve this thing.
Dr Matthew Kagoli	It has to be an understanding that Baobab is a partner to the Ministry of Health. And so when we are talking about this thing with the village clinics and health facilities, we have some challenges and Baobab is helping with this.
Soyapi Mumba	Yes you can remove Baobab from the EMR.
Maurice Gombe	Yeah, Yeah remove that
Dr Matthew Kagoli	Yeah, yes.
Min Young Kang	Okay okay, ah okay (removing the sticker with Baobab)
Dr Matthew Kagoli	It is eIDSR also, it is e! IDSR. So so, write an eIDSR next to the EMR.
Min Young Kang	Ah okay, yes.
Soyapi Mumba	Yeah so, we have different models, so we have the reporting structure of the Ministry of Health. Like, this unit reports to this and that reports to that. That is the reporting structure. Then there is the flow of information. Those two are mixing here. So, that's why the model is a bit confusing.
Joseph Wu	And ideally, what we discuss is that there has to be a linkage between the community and the facility level. And that information has to be valuated, because for HSA and I think because everyone's here so we can get a clearer picture, my

	understanding is that HSA is not provide clean cost service? They don't see a doubt patient?
Maurice Gombe	They do, but you have to see that it takes months to see a HSA in Malawi.
Emily MacDonald	But the HSAs provide service at the village clinics?
Maurice Gombe	The village clinics and HSAs so, which means the eager to tend to the patient.
Maurice Gombe	So when a kid is sick, you talk to a HSA.
Dr Matthew Kagoli	HSAs don't see other patients.
Joseph Wu	Okay, so if an outbreak occurs, or there is an alert, the HSA is informed from the DHO to investigate? That is the main road of response?
Dr Matthew Kagoli	Who´ll have noticed it first!
Joseph Wu	Okay, so who, who will trigger the action?
Setiala Kanyanda	Depends on the case…
Maurice Gombe	Okay, am, if it is at community, like here (pointing to village clinic), the HSA who is here, if they see somebody having signs of cholera, immediately reports it to the nearby health center. And the health center immediately reports to the DHO. And DHO reports to us (pointing to CMED). And for us, what we do is a follow-up report, like - what have you done? Have you done a report? - Have you done an investigation? And then we´ll go back to DHO, who will go back to the Health center, asking like -what have you done? Which means that the DHO will come in to assist in the investigation.
Maurice Gombe	So so, what we do in Blantyre is that more or less the same only that when they (HSA) suspect something, we have what we call RDT for cholera. So, the HSA usually take some sample, and it shows positive, that information will immediately go to DHO and this will immediately go to CMED and epidemiology unit at the same time.

Robin Schönström	At the same time?
Maurice Gombe	Yeah, the same time, and this one (pointing on CMED) will call DHO, which will in the same time call the health center.
Joseph Wu	So so, that detection, will happen, like disease detection, will happen here (pointing on Health Center) and it can be detected here (pointing on HSA)?
Maurice Gombe	Yes exactly.
Emily MacDonald	Or at the district as well.
Maurice Gombe	Ah, well the district is within a area so that is the same as the health center in that area.
Joseph Wu	So so, how would a HSA at community level detect an event, because at Health center is so much easier?
Maurice Gombe	Ah, this people (HSA) stay at their community, and all the community know that there is cholera. So is somebody shows signs of cholera or tymphon, they immediately report to the HSA in the village. The HSA can ask, have you taken the person to hospital? No we haven't taken him to the hospital, then the HSA can send the information to the DHO.
Setiala Kanyanda	**Can not hear what is said**
Soyapi Mumba	A patient goes to Health Facitility, they reports to DHO and MoH
Setiala Kanyanda	HSA is based in their community, and the aim of that is to do disease surveillance, and they also use community structions and volunteers, and when they come across a u know like a village, a community, in household X we have a individual who is ill, so this community volunteers reports to the HSA saying like "-in this community and household X we have this case, can you come?" so HSA goes to the village as part of disease surveillance, and the HSA use a device and also check the history of what could be the possible disease. Then at the same time reach out to the nearest facility (meaning health center) that is why it is called surveillance assistance because the primary purpose is to do disease surveillance at community level. Then when they report that case, the HSA will do a follow-up to that

	facility getting the findings or results. And when that case is threated, comes back to that community, the HSA will also do a follow-up on that case in case of treatment.
Setiala Kanyanda	So, take for example TB (tuberculosis), when come across a certain sign at community level is seen, say coughing, HSA will suspect this to be a TB disease. So you could see that apart from the village clinics, we have these HSA and community volunteers to support HSAs, so we could say they do active case finding. So that's why we say that we can use the HSAs to support to report. But now some HSAs are in hard areas to reach were to collect village clinics, it is supposed to disease surveillance, you know as a part of the treatment you can also reference some of the cases. And also the same data of village clinic goes at the facility, so for malaria it will also combine with the malaria cases at that facility, so it is also a point for disease surveillance, so that's why HSAs are crucial in detecting.
Joseph Wu	Yeah, so what is the event detection criteria or guideline here (pointing to disease detection by HSA) they are applying to do case finding or detection?
Soyapi Mumba	Standard case definition
Maurice Gombe	Yeah, community standard case definition, who is different from health facility standard case definition. We either have to case definition for each disease in the IDSR, we have Ray-matistic recognition which we usually which we train the dias (?) and committee, they use that case definition case definition, we called standard case definition which healthier path to use it is to what is using by definitions sometimes by the HSA.
Joseph Wu	Oh, so that is a written guideline?
Maurice Gombe	Yeah that is all this in the IDSR, you can find all this in the IDSR
Min Young Kang	Okay so this is in the IDSR (writing on the event detection post-it), because yesterday we talked to the area health centers where they are sending HSA´s to the village clinics, they weren´t sending any information.
Setiala Kanyanda	For … (can not hear) ?

Min Young Kang	So, we talked to Area 18 where they use EMR´s, and they are sending out HSA´s three times a week, and this information that they get here (pointing to village clinic) like they weren´t doing any sort of testing they said.
Maurice Gombe	Village will be testing.
Joseph Wu	So, RDT is only some kind in some sites?
Maurice Gombe	RDT is the blood type.
Setiala Kanyanda	I think it is just better to remove the RDT, ..(Many people talk at the same time, not able to hear)
Dr Matthew Kagoli	Let me explain on that one, yes yes, Malaria and OPD is …(not able to hear), but what they are doing now in the village clinic to avoid the consumption of

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