Identifying the information communication to improve decision-making

Development of a model to support decision-making in the Malawi Health System

School of Economics and Management

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Abstract

Health Information has a great potential to support decisions in the Health System. Making a decision in Health System (HS) can no longer be seen as a problem owing to technical advancements in computing and telecommunications. This is due to the harnessing of the effective decision-making process in order to leverage information flow. However, how the information flow in Malawi supports decision-making is unknown. In addition to that, problems with data quality and data currency occur due to paper based standards. This adds to the problem of mortality and morbidity which has not only been one of the biggest challenges that are faced by Malawi HS but also developing countries. For supporting the decrease of this rate, Health Information System (HIS) has been identified as a potential means, thus there have been various projects initiated in order to improve HIS in different countries. The main purpose of this study is to provide an artefact which serves as a model of Health information communication in Malawi HS. This leads to more efficient decision-making in Malawi HS. To achieve this purpose we employed design science research approach. Using this as a means to achieve the goal of our research, we collected data by interviewing HS experts specialising in the research of HIS. Also, data was collected from various sources and different levels of the Health System (HS) in Malawi. These sources of data collection, in conjunction with feedback's from our experts, provide us different stages of decision-making in HIS which are conspicuous in the iterative design process. This leads to the evolution of the artefact of this research and our design proposition which is a Model of Health information communication. This model aims to support implementation and further development of the particular HIS and to support decision-making process. In conclusion, by having the clear blueprint of the information flow and increased awareness of how the information is used in the decision making process, the information delivery can be optimized thus; the decision making points will provide the required accurate and timely information.

Keywords: Health Information System, Malawi, Health System, Organizational decision-making, Decision-making, Design science research

Final Seminar 2014, June

Acknowledgements

A few months ago we were lost trying to define the objective of our thesis. It seemed like we were in front of the mountain and that we needed to find our way to its peak, which was hidden in clouds. It felt like mission impossible, but now we are on the top of the mountain and we can look back and see our path and its curves, ups and downs.

Our kind professors and contributors helped us get on the correct path and guide us with their comments, suggestions and opinions regarding our research. We were lucky to receive invaluable and unflinching support from our professor, Sven Carlsson, who initially helped us start working on this project along with professor, John O´Donoghue, from Cork University. Both of them, as experts in the area of our research, played not able roles in our thesis writing while establishing friendly and trustworthy relation.

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Stojanka Erdevicki, Anthony Ezeh, Jerrold Stolk

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Glossary

CBDA	Community Based Distribution Agent
CCM	Community Case Management
CHAM	Christian Health association of Malawi
CMED	Centre for monitoring and evaluation division
DHIS2	District Health Information System 2
DHO	District Health Office
DSS	Decision Support System
HC	Health Centre
HIS	Health Information Systems
HMIS	Health Management Information System
HS	Health System
HSA	Health Surveillance Assistant
IMCI	Integrated Management of Childhood Illness
MoH	Ministry of Health
ODSS	Organizational Decision Support System
TBA	Traditional Birth Attendant
UNICEF	United Nations Children's Fund
VHC	Village Health Committee

1 Introduction

This thesis describes the design process of a model which delineates the communication flow of Health Information across the levels of the Malawi Health System. The model is built based on the justificatory knowledge about decision-making, experts' insights in the form of qualitative data and data from governmental reports.

In this chapter we are describing the background of the research area along with the problem area, the purpose and the limitations of the research. Finally, a blueprint of the structure of our thesis is presented.

1.1 Background

Making the right decisions in Health Care is critical, since it aims to improve the health outcome. The importance of this is emphasized by Virgil: "The greatest wealth is health". Health Information Systems (HIS) aim to improve this decision-making, it is concerned with "the production, analysis, dissemination and use of reliable and timely health information by decision-makers at different levels of the Health System" (World Health Organization, 2007). HIS is crucial for strengthening the health system (Lippeveld et al., 2000) which leads to a decrease in mortality. More specifically, improving the Health System will improve health and efficiency, increase responsiveness and protect against social and financial risk (Lippeveld et al., 2000).

In the context of HIS, making a decision is no longer a problem, due to technical advancements in computing and telecommunications, the challenge is instead how an effective decision-making structure could be harnessed in order to leverage information flow (Kiesler and Sproull, 1992, Poole et al., 1993). Effective decision-making is highly related to the level of health care, the supply and demand in decision-making differ along the levels of a health system (AbouZahr and Boerma, 2005).

When implementing a Decision Support System in a Health System it is important to understand the system. Gorry and Morton (1971) argue that the managerial activity is a prerequisite for systems design and implementation. Before developing a Decision support system for a specific decision class, the prerequisite is to identify how those decisions are made (Remus and Kottemann, 1987). Information is a key concept in decision-making, and is related to the level of decision-making (Gorry and Morton, 1971). Decision Support Systems (DSS), dedicated to improving the performance of knowledge workers in organizations through the application of information technology (Sprague, 1980), can be related to these HIS.

The Motivation of our Research: Improving the decision-making which leads to decrease in mortality and morbidity.

1.2 Problem area

One of the initiatives within HIS is the Supporting LIFE project. It is funded by the European Union, and is led by Cork University in cooperation with different Universities in Sweden, United Kingdom and Malawi. This project aims to reduce mortality and morbidity among children in Malawi by providing an electronic diagnostic application to improve the quality of the diagnosis and allow data collection about health status (SupportingLIFE, 2013). Moreover, it tends to support the healthcare workers at the patient point of care. Finally its goal is utilization of the established technology such as mobile telecommunications network, vital sign sensor technologies and decision support systems in order to compensate the lack of health care infrastructure (SupportingLIFE, 2013).

The lowest level health care services available to most sick children in developing countries are mostly run by local health care surveillance assistants (HSAs). The major causes of the underage child mortality are malaria and infantile diarrhoea, pneumonia, measles and meningitis. Due to the lack of health infrastructure, only one in three children is taken to a health facility. The majority of deaths could be avoided by prompt diagnosis and appropriate treatment. Thus Supporting Life's goal is to be applicable in recognition of children with serious infection such as malaria, infantile diarrhea, pneumonia, meningitis and sepsis (SupportingLIFE, 2013).

One of the objectives of SupportingLIFE (2013) is: Providing digital data collection of children's health status and real time statistics locally by observing symptom trends centrally. This would improve decision-making across all the levels of HS in Malawi and enable the Ministry of Health (MoH) to improve public health initiatives. However, there is no current and accurate description of how the information supports decision-making in Malawi. In relation to that, HIS research lacks insight in decision-making within Health Systems (Lippeveld et al., 2000). This indicates a clear knowledge problem: *A lack of insight in the information communication that supports decision-making in Malawi.*

The current Health reporting system in Malawi is partly paper based. This provokes information exchange delays among the different levels, which are, according to the Supporting Life project Coordinator, currently measured in months. The Healthcare workers are not able to act upon the actual data nor are the decisions grounded on real time data. This indicates a technology problem: *Problems with data quality and currency due to ineffective data communication.*

This lack of insight and problems related to Health Information Communication is our problem area; our research question to identify these problems is thereby:

Research Question: *How does the information flow in Malawi Health System support decision-making?*

1.3 Purpose of the thesis

This research aims to identify the information flow in the Malawi Health system, thereby answering the research question. This will be presented in the form of a design, visualizing how decisions are supported with information.

Eventually, designing the model of information communication flow of HS in Malawi will identify different levels and the decision-making points in HS. This model will provide a clear information delivery flow from the lower levels to the MoH. Likewise, this will result in more efficient decision-making in Malawi HS, adhering to the motivation of our research. This thesis will aid the knowledge problem by providing the information that is now not available. Furthermore it will identify opportunities for improvement, thereby aiding the technical problem.

The Purpose of the thesis research: To provide an artefact, a model of Health information communication in Malawi HS.

1.4 Limitations of the research

Our research area of the Health System in Malawi is a broad subject to deal with. Nevertheless, it could be manageable when viewed from the context of HS in Malawi on the high level of abstraction. From this perspective, limiting the scope of the research has been considered necessary. As such, this study will deal specifically on the decision-making that has been grounded and facilitated by identifying information communication flow across different levels of HS in Malawi.

The main limitation is the remote location of the researchers from the actual environment in Malawi. Inaccessibility of data and inability to interfere personally on site with the employees from the Malawi HS facilities causes a constraint to observe the system from different perspectives. Due to the physical distance, interviews cannot be held face-to-face. Skype calls overcome this problem, although the distance is still considered as a limitation caused by infrastructure.

1.5 Disposition

In selecting a reporting style for any study, taking cognisance of the expectations and needs of the report's audience is very imperative (Kvale and Brinkmann, 2009, Creswell, 2007). To adhere to these needs this disposition will provide a basic understanding of the content and structure of this report.

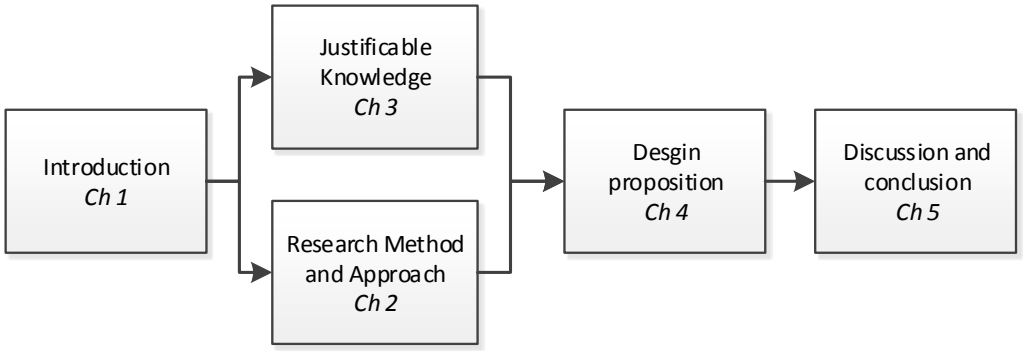

Figure 1.1 – Disposition of report

The next chapter, chapter 2, introduces the Method and Approach for this Research. Firstly Design Science is discussed and motivated followed by the design science in Information System (IS). Secondly, the iterative approach is described. The context is introduced in the application domain.

Presenting the knowledge that supports this research is the logical next step. In this part, Chapter 3, the theory is discussed that will be used to base the model on. Different concepts of decision-making are introduced, with a focus on organizational decision-making. Decision Support Systems are discussed and former HIS research is presented.

The design of the model and the process of designing are presented in Chapter 4, the design proposition. In this chapter the iterative design process is described. The propositions that resulted from these activities are formulated, following by an exposition in which the functionality of the artefact is displayed.

Both the resulted model and the process are discussed in the 5th chapter. Firstly the contributions of this study are discussed. Secondly, the means of ensuring Research Quality are presented. Followed by limitations and future research, our thesis ends with a conclusion.

2 Research method and approach

In this chapter, Design science is being introduced to readers as the main influence to our research approach. Moreover, we provide an outline and motivation for choosing the particular research approach, which is mainly influenced by design science. The data collection method is described and motivated accordingly. Finally, the application domain of our thesis is introduced to set the scene for this research.

2.1 Design Science

2.1.1 Design Science as a research approach

The research presented in this research is underpinned by a design science approach due to the utility aspiration for the outcome of our research. That is, there is an assumption that design science is meant to yield research that are more relevant for practice than more traditional approaches which risk being too reductionist, too broad or too trivial to be of any practical relevance (Aken, 2004). Although it has been used in research for a long time (Simon, 1969), design science is argued as being relatively new in the information system discipline (Hevner et al., 2004).

In the past decades, interest has increased and voices have been raised concerning the correlation between design science and natural or social sciences as well as the question which pertains to whether major perspectives of natural or social are useful when dealing with design as a scientific discipline, see for instance: Archer (1979), Gregg et al. (2001), Kuechler and Vaishnavi (2008) and Nadler (1980). On this premise, an account of design science is given as an alternative to more traditional approaches, a section that a specific rationale owing to the current debate on this topic, see for example: Agarwal and Lucas (2005), Lyytinen and King (2006) and Weber (2003).

In the seminal work *The Science of the Artificial*, Simon (1969) argues that there is a need for a specific science of design. The indispensable notion in design science is that it is constructive, while natural or social science is analytical. This gives rise to the design science with a “how to” or “how things ought to be” perspective; instead of the “how things are” perspective in natural and social sciences (Simon, 1969). In this context, design science could be conceptualized in the sense which is geared towards the realization of new things as well as the planning, invention, and construction of artefacts. Its language is modelled and it has its own specific perception of things to know, ways of knowing them, and ways of finding out about them (Cross, 1982), or as Archer et al. (1977) state, it is the art of planning, inventing, making, and doing, and this is the root of the discussion on the appropriateness of applying perspectives from natural or social sciences to design-related research.

In accordance with Simon (1969), design science ought to borrow concepts from both natural and social sciences in order to ensure rigour and scientific credibility. But here lies the paradox: if it is true that design science is different from natural and social sciences, then why will researchers strive so hard to superimpose the values of natural and social sciences on design science? This view on design as a science is questioned, and arguments are raised that design as a research topic should not endeavour to strive for the ideals of natural or social sciences (Cross et al., 1981). The supposedly need to impose values from natural and social sciences resurfaces in the discussion on information system design research which will be reflected in the specific section of this research.

Furthermore, some scholars have questioned Simon's view on design science for being positivistic, rational, and only dealing with tame problems. For instance, Schön (1983), argues that design is a complex process analogous to art, and with a departure from constructivism rather than positivism the focus ought to be on design thinking research, the reflective practitioner, and wicked problems – a view that has gained considerable support and attention, asserting that design is a discipline more than a science, see for example: Cross (2004), Cross et al. (1992), (Goldschmidt and Porter, 2004) and Lawson (1980). On this premise, one can argue that Simon and his supporters are much more focused on the process of design.

However, both the product and process are part of design, and one can decide to focus on the product, or the process, or to encompass both product and process when studying (Cross, 1982, Mckay and Marshall, 2007, Walls et al., 2004). If studying the process, the focus is usually inwards to the designer, based on how the designer thinks and acts and leaving out parts of the properties of the material. On the other hand, when studying the products, the properties of the material are foremost and the designer's thoughts and internal processes are downplayed.

However, this does not rule out the reflective practitioner as a concept. The reflective practitioner also needs information on the material culture to be able to reflect on actions. In this research, the artefact, its properties in the shape of factors and how to manage those factors are in focus, while the designer's thoughts, mental processes, and so on are downplayed. In line with this, valuable insights can be gleaned from Cross (2004). He argues that in design science one can study the actual products (i.e., the application), or the process of developing it, or the intertwining of the product and the development process. In this research, it is argued on the need which is based on the evolution of design that stems from an artefact development of a model that support decision-making in Malawi Health care system.

2.1.2 Design Science in Information Systems

Design science is pertinent in most areas of the artificial, for example, architecture, engineering, or information systems. One thing common is that each of these areas has its own problem domain; with specific materials and outcomes; and methods and means for verification. What is the material in information system design? In other words, what are the phenomena of interest in Information Systems (IS) design science activities?

Two major strands have emerged in information system research: information systems design theory (Walls et al., 2004, Walls et al., 1992) and design science research (Hevner et al., 2004), and the common agreement is that they both focus on the IT artefact and downplay the socio-technical aspects. A third school of thought is suggested, which encompasses the human as an important part of the information system field (McKay and Marshall, 2005). A school of thoughts in line with the unit of analysis in this study and the perspective on information systems design will be applied in this study.

In this research, the following characterization of artefact is investigated: they may be *instantiations*, *abstract artefacts*, or *human understanding of artefacts*. Appropriating these characterizations in our research, we were poised with a view to finding common ground to base our motivation as regards the choice of design science as a means of achieving the purpose of our research. Instantiations are artefacts that have a physical existence in the real world. It may be a specific development process applied in a system development project. Abstract artefacts are by definition not present within a physical representation; instead they must be conveyed by other means. It may be by words, models, diagram, design principles, or likewise describing something that may be instantiated. Human understanding of artefacts conceptualizes and describes artefacts in abstract and general terms. In Figure 2.1, there is a depiction as to how humans both create and use instantiations and abstract artefacts which are set of relations between these categories. In addition, design principles can be derived from observations and interaction with existing artefacts (Gregor and Jones, 2007).

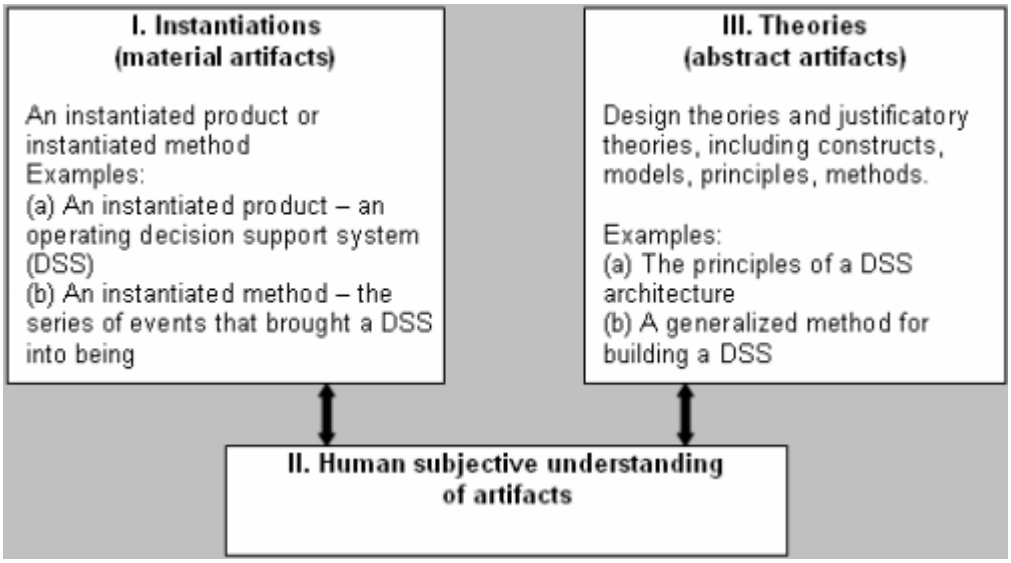

Figure 2.1 –The possible outcome of design research and their relations (Gregor and Jones, 2007, p.321).

Once again, instantiations are real world artefacts. From this perspective, abstract artefacts are for example models, process descriptions and theories. Human understanding of artefacts and the relation to the other outcomes which depicts that human may study an instantiation and understand the artefact. This provides a backdrop for the application of abstract artefacts with a view building instances. The figure in question is adopted from Gregor and Jones (2007). At this juncture, we fully agree with (Gregor (1995)), Gregor and Jones (2007), and Venable (2006) that design principles can be obtained from observations of, and interactions with,

artefacts. Nevertheless, many researchers have argued for the need to be aware of references or kernel theories from psychology, mathematics, and so on in the course of the execution of any design science research project (Hevner et al., 2004, Simon, 1969, Walls et al., 1992). On this heel, we argue that if we do not appreciate observations and interactions, or other design research, then a lot of vital and valuable information will be lost. For instance, findings regarding the usage of the existing model in the Malawi Health care before the actual development were of vital importance. This has also been in the observations, without the application of natural or social science theories (Calder et al., 1981, York and Pendharkar, 2004). If the knowledge regarding field use conditions is not considered as appropriate owing to the lack of natural or social science theories informing this condition, or "paying tribute" to kernel theories (informing the kernel theories), then design science will amount to nothing more a laboratory for natural or social sciences, a standpoint also supported by Weber (2003).

2.1.3 Motivation for using Design Science Research

The motivation for the adoption of design science in our research work is attributable to the prescriptive knowledge which pertains to artefacts designed by humans with a view to improving the natural world (Gregor and Hevner, 2013). Prior to the commencement of this research, we were confronted with the challenge to provide an IT artefact (Hevner and Chatterjee, 2010, Carlsson et al., 2011, Kuechler and Vaishnavi, 2007), which is non-existing.

Several forms of approach were taken in order to provide an IT artefact which stems from the model development that supports decision-making in Malawi Ministry of Health. This paper takes the form of a qualitative strategy (Carlsson et al., 2011), using the interpretation of data along with an iterative reflective inquiry (Hevner et al., 2004, Gregor and Jones, 2007). Design science research and qualitative strategies are profoundly suitable for research in novel areas, due to iterative and exploratory nature of both strategies where knowledge may be gradually and collaboratively developed through the design process (Kuechler and Vaishnavi, 2007, Carlsson et al., 2011, Gregor and Jones, 2007). Consequently, this provides a base through which the structure of our research was built upon. In addition, this strategy did enable us to iteratively assess and revise the design artefact to fit with the specific needs of the Malawi health workers and other associated stakeholders who know much about the domain knowledge. Another form of approach that we considered in the choice of the right means to achieve our purpose is due to the fact that the need for organizational intervention is secondary (Hevner et al., 2004).

In design science research, the focus is on the research process rather than the organizational intervention which is secondary. This is unlike action design science research where the recognition of the organizational setting from which the need of an IT artefact is born (Sein et al., 2011). Also, action design research aims at building innovative artefact in an organizational context and learning from the intervention while solving a problem (Sein et al., 2011) . We would have chosen an action design research approach as a means of achieving the purpose of research had it been that we focused on the organizational context. However, we did employ the design science research approach instead of action design research because

there is need to develop an IT artefact to address a definite problem. Another reason is that we were not physically present at the Malawi health ministry in order to study and understand its organizational settings. Thus, it is incumbent on us to use design science research as a means of realizing our goal.

Furthermore, design science research is characterized by its intention of improving the state-of-the-world information system enabled initiatives, for example improving the efficiency of an organization (Hevner et al., 2004, Carlsson et al., 2011). We were influenced to follow the design science research methodology as described by Hevner et al. (2004). This method has received much attention in recent years and has been successfully applied in several research projects (Hevner et al., 2004). For instance, Gavish and Gerdes (1998) used this method to design and implement anonymity in group decision support systems (GDSS). Also, Aalst and Kumar (2003) employed design research to create a Workflow Language for Inter-organizational Processes.

2.1.4 Reporting our research

Here comes the discussion of the outcome of our design process. The research process results in an artefact, being the model. However, as (Simon, 1996) argues, a design should be formalizable. That is, it should contribute knowledge to be used by other practitioners. The ultimate mission of a design study is to develop *"knowledge that can be used in designing solutions to problems in the field in question"* (Aken, 2004, p.225). In order to communicate the knowledge encapsulated in our model we will follow the structure as presented by Gregor and Jones (2007). Their framework of design science outcomes consists of six core components and two extended components, these components are explained in Table 2.1. However, a more detailed description of our perception on the components is described as follows.

Purpose and scope relates to understanding the artefact requirements in terms of the environment in which it is to operate (Gregor and Jones, 2007). This relation between purpose and environment is important, only if the artefact matches the outer environment, the artefact will serve its intended purpose. Besides, 'what the system is for', this component should mention the context for intended use.

The *constructs* are the representations of the entities of interest. Constructs deal with complexity by decomposing design problems into semi-independent parts (Gregor and Jones, 2007). Constructs can be described indicative, rather than detailed and complete, since at the higher level it is not necessary for the designer to understand the detailed complexities (Gregor and Jones, 2007).

The *principles of forms and functions* provide a type of blueprint. It will describe the properties, functions, features, or attributes of the artefact.

Artefact mutability covers both changes in system state and in the basic form and shape of the artefact in allowing a form of adaption, enabled by feedback loops.

Testable propositions make the abstract testable. The degree to which theory can be translated in a proposition can require generality. Either that propositions work all the time or on the other hand, that the proposition is an approximation of what will work (Gregor and Jones, 2007). In this study we will work with what Aken (2004) defined as Heuristic Propositions. *"If you want to achieve Y in situation Z then something like action X will help"* (Aken, 2004, p.227). Denyer (2008) proposes a way to formulate propositions within an organizational setting, formulated as the CIMO-logic which we found suitable for our proposition.

Justificatory knowledge provides the justificatory, explanatory knowledge that links goals, shape, processes, and materials. Gregor and Jones (2007) link this to kernel knowledge as defined by Aken (2004).

From the additional components, *Principles of implementation* is concerned with the means by which a proposition is brought into being. This consists of descriptions, methods or a set of principles that guide the implementation of the artefact (Gregor and Jones, 2007).

We will focus on *Expository instantiations*. A realistic implementation of an artefact contributes to the identification of potential problems and demonstrates that the design is worth considering. Furthermore, the instantiation has as benefits, which it illustrates how the artefact functions with better communicative power than a textual description.

Table 2.1 – Eight components of an Information System Design Theory (Gregor and Jones, 2007, p.322)

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.

2.1.5 Data Collection

The different phases of our study included multiple sources of data such meetings, related literature papers, qualitative interviews and Skype calls. The data collection mostly centred on

different stages of decision-making in HIS. The Interview could be seen as a means to leverage an appropriate collection of data.

In order to facilitate an understanding of the possibly fraught health challenges as well as to gain domain knowledge, the interviews are open-ended as it is important that the interviewees are able to guide the discussions during the Skype call. This is feasible because the questions posed during the interviews will be open-ended, i.e. conversational, hence allowed a two-way communication to be established (Runeson and Höst, 2009, Miscione, 2007). This enabled us to amass rich data, which will be further facilitated through the extraction of requirements for various level of decision-making structures in the Malawi HIS. Similarly, Letherbridge et al. (2005) and Leech (2002) argue that open-ended questions should be included in interviews in order to gain information that is not possible to obtain when posing more specific questions. The interviews were semi-structured, and followed a defined theme so that the discussions are germane.

In addition to having a definite and relevant theme during interviewing, we also ruminated on the preferred method for data collection. On this premise, we thought of travelling to Malawi or even have a one-on-one meeting with our experts who know their onions when it comes to the health information system related matters. From this perspective, one would argue that we would have chosen face-to-face interviews as our choice and preferred method for data collection as this would furnish us with greater scope to stage manage and control the interview process (Myers and Newman, 2007). However, given the dispersed nature of our Health Information System experts as well as the Malawi rural Health officials assessing the individual with the right domain knowledge of HIS to interview indeed presented us with some challenges.

Furthermore, interviews are employed throughout the design iterations, and are deliberated upon in the section that has to do with the discussion of our research propositions. At this point, we will not fail to recognize some additional obstacles, as we were largely unable to control the environment in which the interviews occurred or benefit from face-to-face interaction, which posed as a potential methodological critique in our data collection. Kvale and Brinkmann (2009) acknowledge the obvious disadvantage of an interviewer and interviewee being distanced and unwilling to see or pick up bodily cues. To counteract this as much as possible we conducted the interviews using Skype to enhance face-to-face interaction. Using Skype enabled us to record the interview which we latter transcribed, as a tape recording system might not be suitable. In spite of all the limitations that we encountered from interviews being conducted , our interviewees responded to our questions in an overt and candid manner and were magnanimous enough in checking their interview transcriptions as well as respond to any further clarifications we had.

2.2. Application domain

Our research environment, which Hevner (2007) referred to as application domain, which consists of the people, organizational systems and technical systems that interact to work toward a goal. We can relate the three components in our environment: the people being the actors or decision-makers, the Malawi Health System as the organizational systems and the Health Information Systems in Malawi being the technical system. The Supporting Life application is such a system and is part of our application domain.

2.2.1 Malawi Health System

In our research the structure refers to the HS of Malawi. In the strategic plan from 2011 to 2016, the Malawi MoH (2011) has defined three layers of health care within both public and private ownership. The public system offers free health care and it is mainly owned by the MOH. The Ministry of Local Government and Rural Development (MoLGRD) and other ministries as Police, Education and Army also offer health services in the public sector. The Private Sector consists of both profit and non-profit organizations. The biggest non-profit organization in Malawi is a Christian Health association of Malawi (CHAM), owning over 150 health centres. CHAM has around 7000 employees (Act Alliance, 2011). The following levels are defined by Malawi Ministry of Health (2011):

1. The primary level consists of community initiatives, health posts, dispensaries, maternity facilities, health centres, and community and rural hospitals. The 12,000 HSA´s (UNICEF, 2012) and Health Centre facilities are part of this level. Community/Rural hospitals are operating both at the primary and secondary level.
2. The secondary level of health care is built on district hospitals and each district should have a district hospital. They are referral facilities for both health centres and rural hospitals. The district or CHAM hospitals provide general services, PHC services and technical supervision to lower units.
3. The tertiary level consists of central hospitals (CH) that provide referral health services in their respective regions. The Central hospitals provide specialized services within the field of obstetrics and gynaecology. There are currently four central hospitals.

The above-mentioned facilities are shown in Table 2.2.

Table 2.2 - Health Facilities in Malawi Health System (Malawi Ministry of Health, 2011, p.116)

Ownership	Number of facilities in 2010[72]									
	Central Hospital	District Hospital	Mental hospital	Community / Rural Hospital	Hospital (other)	Health Centre	Dispensary	Maternity	Rehabilitation Unit	TOTAL
CHAM	0	0	1	18	20	109	12	4	1	**162**
Local Government	0	0	0	0	0	10	7	13	1	**31**
MoH	4	23	1	18	1	258	54	2	0	**361**
MoH/ CHAM	0	0	0	0	0	1	0	0	0	**1**
MoH/Local	0	0	0	1	0	45	4	0	0	**51**
Total	**4**	**23**	**2**	**37**	**21**	**423**	**77**	**17**	**2**	**606**

2.3.2 Experts

This study is a so called 'desk research' which means that the researchers of the study will not visit the context area, Malawi, but instead collects information in a distant location. This can lead to unguided judgment of the context and wrong assumptions. We mitigate this risk by working closely with experts from our study area as well as liaising with our field workers and Lund University professors. They are able to give us a full insight in the context of Malawi, answer specific questions and review work in progress.

Joseph Wu

Joseph Wu is the Malawi country representative of Luke International Norway and therefore has extensive knowledge of the health system in Malawi (Luke International Norway, 2014). Joseph Wu has a BSc in Public Health and MSc in Epidemiology with a Major in Health Informatics and disease surveillance. The combination of Joseph Wu's research background and his field knowledge makes him a highly valued resource for our project. With his knowledge, he is able to act as an expert to evaluate our propositions and answer our questions.

John O'Donoghue

Dr John O'Donoghue is the Director of the Health Information Systems Research Centre (HISRC) at University College Cork. Dr O'Donoghue is a lecturer in the Department of Business Information Systems, University College Cork. Dr O'Donoghue is a project coordinator of the Supporting Life project. His research background and role in the Supporting Life project makes him an expert on our study area.

2.3.3 Health Information Systems in Malawi

The technical system that is part of our application domain is ,in this research, the collection of health information systems in place in Malawi. The Malawi HIS that is part of our context is described. The theoretical aspect of HIS is further discussed in the chapter 3.3.

As stated above, HIS is a part of the HS. In 1999 the HIS in Malawi was identified as being inadequate (Malawi Ministry of Health, 2003). Different projects and policies were introduced to improve the HIS. One of these being the Health Management Information System project, in collaboration with Dutch Aid (Malawi Ministry of Health, 2003). This project focused on setting up a structured HIS with defined variables to collect information and act upon it. During this project, the Malawi MoH worked on Policies and Strategies in HISs (Malawi Ministry of Health, 2003). In the process of defining policies, the information flow has been identified. Information is available in different forms, it can be, for example, wall charts, quarterly bulletins, quarterly and annual review meetings, annual review reports and thematic maps (Chaulagai et al., 2005). Surprisingly, all of the reviewed projects that discuss decision-making in the Malawi Health System are discussing the decision-making on higher levels in the system, from district and above, none of these projects discuss the decision-making on lower levels (Chaulagai et al., 2005, Malawi Ministry of Health, 2003, World Health Organization, 1994).

There are many types of players that collect data: Village Health Committees (VHC), Traditional Birth Attendant (TBA) and Community Based Distribution Agent (CBDA) (Malawi Ministry of Health, 2003). This information is communicated to Health Surveillance Assistants (HSA), who report to the Health Centres (HC), HC is one of the facilities that generate quarterly reports (UNICEF, 2012). These facilities compile the data and review the data with stakeholders. The District Health Office (DHO) compiles the data from all facilities and performs comparative analyses, and then sends the feedback back to the health facility. The information is communicated from the DHOs up to the Ministry Headquarters, which compiles the data from districts and central hospitals, performs analysis and provides feedback to the reporters. This information flow uses both paper based and digitalised reports. One of the system design principles of the HIS in the 2011-2016 strategic plan of Malawi MoH indicates that “Paper and pen based at facility level, computerized at district level and above” (Malawi Ministry Of Health, 2009, p.10). This Information flow is visualised in Figure 2.2

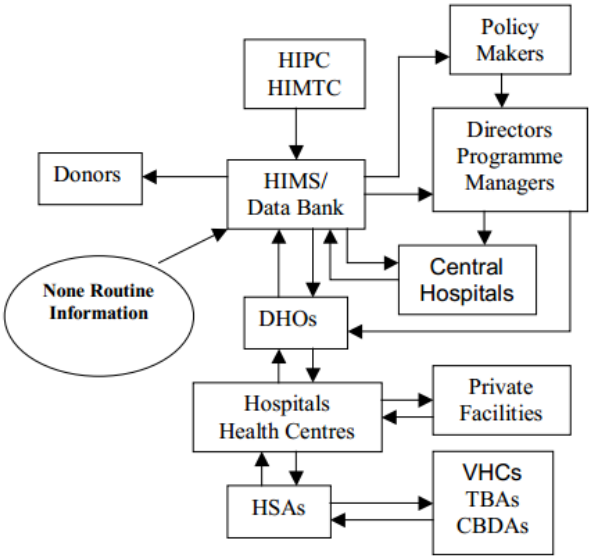

Figure 2.2 - Malawi Information Flow (Malawi Ministry of Health, 2003, p.20)

2.3.4 Supporting Life application

The Supporting Life application, which can be seen as an HIS, is part of our context. A technical description of O'Sullivan (2014), which shows that the Supporting Life application consists of three key objects: The mobile device, the web portal and the Server. These three objects are related and dependent on each other. Figure 2.3 shows this infrastructure and relationships. The HSA input data from the user (Number 5) will be transferred to the Server Box using the Malawi telecom network (Number 6 and 7). The Server Box commits this data to a remote database (Number 9). This data can be accessed by admin users using the Supporting Life web portal (Number 11).

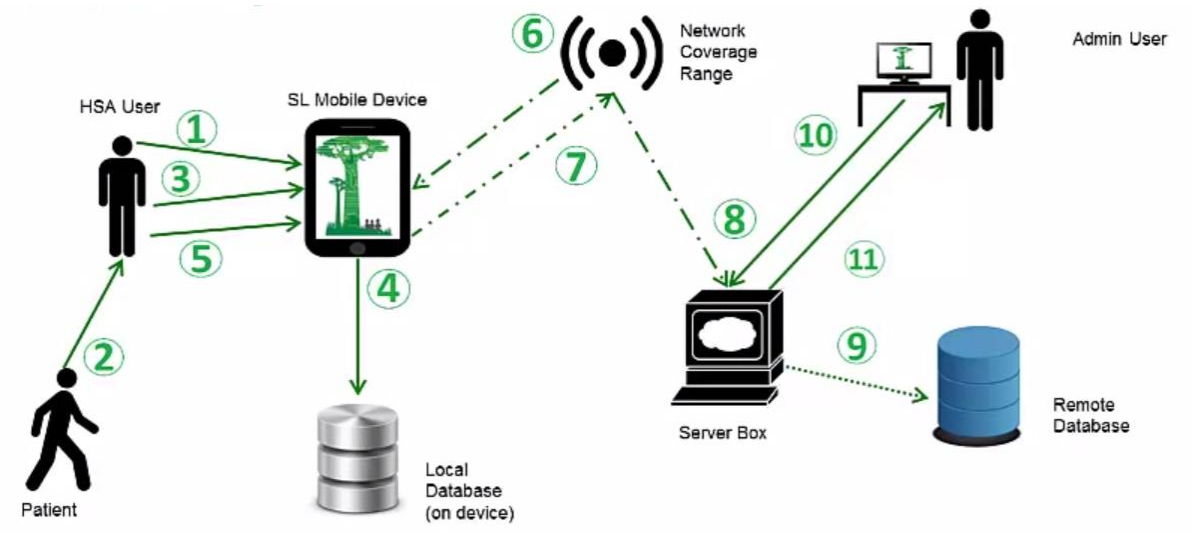

Figure 2.3 - Health Record Data Management (O'Sullivan, 2014)

The patient data originates from the mobile device application. In this application, an input of the patient data is made by healthcare workers at the patient point of care in Malawi, which is mostly allocated in rural areas in Malawi. After logging in in the application, the user (health care worker) is presented with a dashboard including assessments, profile and training. Both the Community Case Management (CCM) as the IMCI assessment are available for the logged in user. When the user wants to add an assessment, either the CCM or IMCI is selected, and the assessment in the form of a list of questions is shown. The data is, when selecting to sync, synchronized to the cloud.

The complete dataset is stored on a cloud server, the available fields are available in the SupportingLIFE Functional Specification (Flynn, 2013). The data can be retrieved by the administrators on the SupportingLIFE technology website in the form of custom reports (Flynn, 2013).

3 Justificatory knowledge

This chapter will present the important concepts and provide the theoretical baseline for the following design process, which is explained in the chapter 4. As the key concept, we will introduce the process of decision-making, significance of information in this process and its linkage to organizations. Additionally, Decision Support System is introduced with a focus on Organizational Decision Support Systems. Furthermore, we are highlighting the importance of HIS and we describe it from the perspective of different theories. To cap it all, this chapter will provide us with the justifiable knowledge needed for designing our artefact.

3.1 Decision-making

3.1.1 The decision-making process

In the past decades the world has entered into the decision-making age, resulting in exponential, and unprecedented increase in information flow and complexity (Castells, 2011, Bujkiewicz et al., 2011, Patel and Riley, 2007, Heeks, 2002, Heeks, 2006). In turn, this has resulted in the large amount of data that decision makers have to grapple with as well as the increasingly time it takes to perform accurate decisions (Lofaro et al., 2001).

In order to grasp the meaning of decision-making, the process has to be understood. Simon (1977) argues that decision-making is more than the decision itself; it is a process with four stages. *Intelligence*: scanning the environment for conditions calling for decision; *Design*: inventing, developing and designing possible courses of action; *Choice*: selecting course of action and finally *Review*: assessing past choices (Simon, 1977). The last step, review, is a repetition of the first three steps. It is therefore excluded from the trichotomy of Simon. Simon (1977) links these first three steps with problem solving, described by John Dewey (1910), who identified the stages 'What is the problem?', 'What are the alternatives?' and 'Which alternative is the best?'. Mintzberg et al. (1976) use the three phases of Simon, although renamed, in his framework to structure unstructured decisions. Unstructured refers to *"Decision processes that have not been encountered in quite the same form and for which no predetermined and explicit set of ordered responses exists in the organization"* (Mintzberg et al., 1976, p.246). In order to structure these unstructured decisions, Mintzberg et al. (1976) used the three phases of Simon's trichotomy in their study in which they analysed 25 decision-making situations and as a result extended the decision-making phases with underlying routines. In this study, we perceive decision-making as the process of intelligence, design and choice of decisions as presented by Simon (1977) and supported by Mintzberg et al. (1976).

3.1.2 Structured decision-making

There are many different types of decisions; authors use different types of classifications to structure this variety of decisions, including classification on structure, management level, degree of uncertainty and information source (Pieptea and Anderson, 1987, Vierck, 1981, Kirs et al., 1989).

The most common way to classify different decisions is a classification on the structure in which the decision is taken. Simon (1977) introduces two types of decisions: programmed and non-programmed. Simon (1977) refers to unstructured decisions as non-programmed decision-making, being a decision that is novel, unstructured and unusually consequential; there is no method for handling the problem because it has not risen before because it is complex or because it is important for the organization. These non-programmed decisions are justified by Mintzberg et al. (1976). Mintzberg et al. (1976) use the name 'unstructured' instead on non-programmed for decisions that have not been encountered before by the organization and for which no defined response exists.

Programmed decisions on the other hand are repetitive and routine, since a definite procedure has been set up to handle these decisions (Simon, 1977). Programmed decisions are also called structured decisions, these decisions can often be automated (Gorry and Morton, 1971). A decision is fully structured when all three phases (Intelligence, Design and Choice) are structured and can therefore be automated in all three phases (Gorry and Morton, 1971). On the contrary, a fully unstructured decision is one where none of the phases are structured and can be automated (Gorry and Morton, 1971). When one or two of the three phases are unstructured, the decision can be classified as semi-structured. This division is a scale and not distinct options, decisions are often partly structured and partly unstructured (Simon, 1977).

3.1.3 Decision-making information

Carlsson and El Sawy (2008) argue that the information, which is used for decision-making in high-velocity organizations, are mostly incomplete, obsolete and inaccurate. On the other hand, Kim et al. (2008) pointed out that the prerequisite for high-quality decision-making is good information. Consequently, for achieving high quality decision-making, the information system has to be optimized in such a way to provide accurate, up-to- date and complete information.

According to Vierck (1981), data is the most important asset for the organization's operating as this asset is used for managing all the other assets. Managing big amount of data is being facilitated by the support of different tools for data analysis, interpretation, visualization and digitalisation. However, big data sets does not assure making the correct decisions (Kennerley and Mason, 2008). In order to optimize its use, data must be organized into a meaningful structure. The data is transferred into information which further becomes knowledge to be applied and acted upon by executives or decision makers (Vierck, 1981).

Nevertheless the disposability of the good information does not guarantee its optimized use in the decision-making process in HS in accordance with Lippeveld et al. (2000). This is the corollary of insufficient information processing, analysing or not acting upon the relevant information (Chambers, 1994, Yajiong et al., 2008). For instance, the most frequent inappropriate uses of information experienced by health practitioners around the world are under use and non-use of information (Yajiong et al., 2008, Lippeveld et al., 2000). Marchand (2002) presents an Information Orientation framework, which integrates three Information capabilities, which are associated with effective information use - *Information technology* - capability to use information technology applications and infrastructure (software, hardware, telecommunications networks and technical expertise) in support of decision-making and communication processes. The second association is *Information management* - organization's capability to manage information during its life cycle including identifying and gathering, organizing, linking and analysing information and making sure that users are provided with the best available information. The final association is the *Information behaviours*- the capability to introduce and promote behaviours and values in its users for effective use of information (integrity, formality, control, transparency, sharing and proactiveness of the information).

Eventually, a lot of time is spent in building the environment which will enable informed decision-making and as Vierck (1981) pointed out, DSS has a great potential for 'closing the gap' between the problems faced by the decision makers within the organization and the information delivery system.

According to Lippeveld et al. (2000), information in a Health System is not a final purpose itself rather a means for better decisions in policy design, health planning, management, monitoring and evaluation of programs and services including patient care, thus improving overall health service performances. The well-established relationship between data, decisions, resources and programs is inevitable in order to achieve high quality decision (McCaughey and Bruning, 2010, McKeen et al., 1994). Figure 3.1 presents an idealized relationship between data, decisions, and resources (Lippeveld et al., 2000). At this juncture, Lippeveld et al. (2000) identifies the resource as the starting point which is, though, considered as scarce thus needs to be used in the most effective way. This will be achieved through better procedures, programs and policies (Bostrom and Heinen, 1977). As such, a new set of data appears as the output, which further supports well-grounded decision-making. Once more, the significance of data in decision-making is confirmed. This verifies what Vierck (1981) pointed out about the data as an important asset in the organization. According to Lippeveld et al. (2000), this generic view of the relation can be applied in patient care, health unit and system levels.

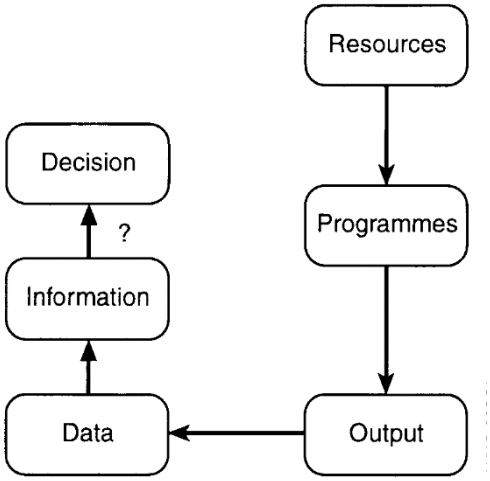

Figure 3.1 - Idealized relationship between data, decisions, resources, and programs (Lippeveld et al., 2000, p.34)

The second model of decision-making process that we will use is a data transformation model which is a modified version of the Cognitive model from Van Lohuizen and Kochen (1986), and is shown in Figure 3 (Lippeveld et al., 2000, p.35). This model indicates that the process of decision-making starts with data collection. The next step is sorting and selecting the data which again supports what Vierck (1981) states which is about the importance of organizing data into meaningful structures in order to optimize its use. After sorting and selecting the relevant data, those structures are used as information. By further analysis, the information provides us knowledge to be applied and acted upon by decision makers.

Even though the data transformation model identifies different steps of decision evolution starting from raw data, it is incomplete, as it does not consider external factors (such as the political and social dimensions of decision-making) (Patel and Riley, 2007, Todd and Benbasat, 1992, Lippeveld et al., 2000).

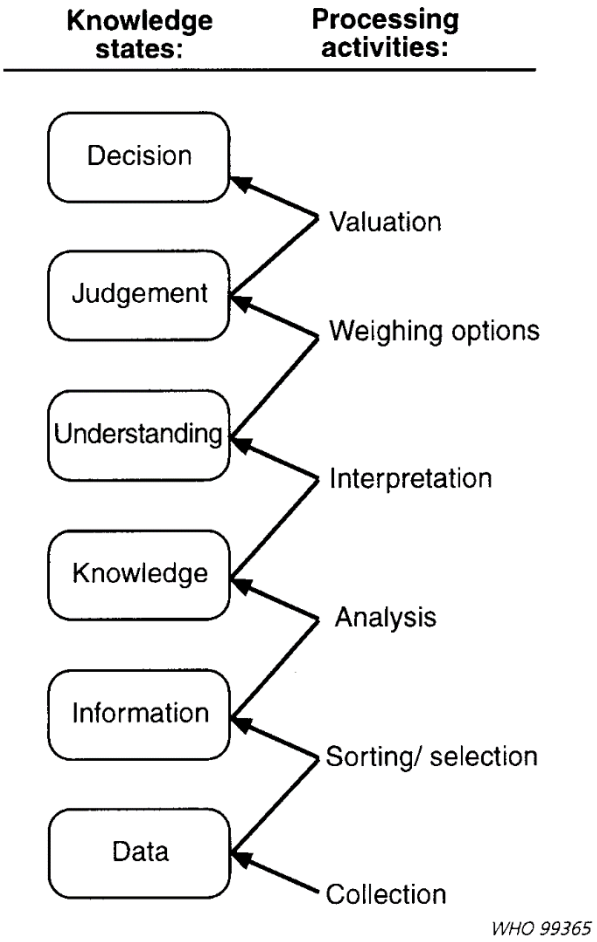

Figure 3.2 - Data transformation model (Lippeveld et al., 2000, p.35)

Information types for different stages of decision-making

As we could see, decision-making is a process of various stages. Ahituv et al. (1994) highlighted that information required for each stage has different characteristics and those authors categorize it according to previously mentioned Simon's trichotomy (Simon, 1977) of the Intelligence, Design and Choice stage, as shown in Figure 3.3:

1. Intelligence stage

According to Ahituv et al. (1994) in this decisive stage the main goal is the acquisition of knowledge about internal and external environment. It provides decision makers with aggregated and well-formatted data in the form of reports, which present the current organization's status, and ad hoc queries. According to previously mentioned Data transformation model (Lippeveld et al., 2000, p.35), the activities performed in this stage would be collecting, sorting, data selection and analysing in order to obtain knowledge about the problem area. In Intelligence stage, *proactiveness*, from Information Orientation framework by Marchand (2002), plays an important role. *Proactiveness* in this context refers to sharing and transferring the information among different nodes for the benefits of other

users or decision makers. The goal is to use the information from external and internal sources in the most effective way.

2. Design stage

This stage assumes that all the relevant data is collected and disposable thus, by planning and forecasting models supported with analytics tools, different scenarios of possible outcomes can be defined and assessed (Ahituv et al., 1994). Following data transformation model (Lippeveld et al., 2000, p.35), in this stage would be performed via interpretation and weighing of options, which would prepare the ground for the final decision-making.

3. Choice stage

By mapping it in the data transformation model (Lippeveld et al., 2000, p.35), the following activities should be performed in this stage - the valuation of the alternatives and final decision-making. Decision makers should already have access to three different types of information: the solution's alternatives, possible scenarios and outcomes of each action taken and feedback data for observing the implementation of the chosen decision (Ahituv et al., 1994).

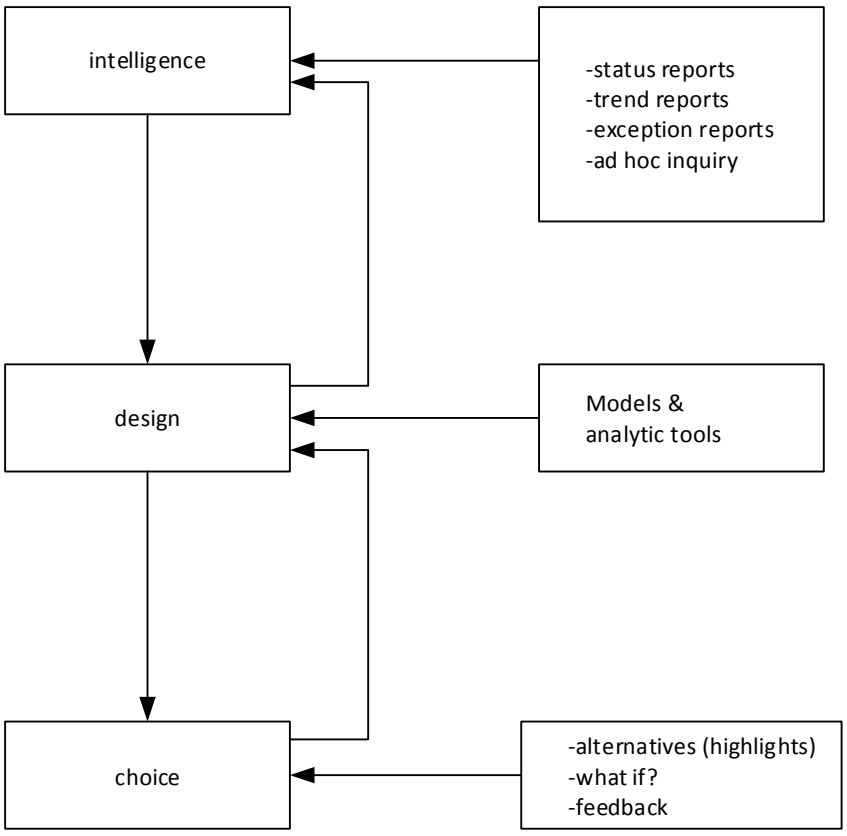

Figure 3.3 - Information required in decision-making (Ahituv et al., 1994, p.47)

From the perspective of support systems within the organization, the number of the actors from the different hierarchy levels involved in authorizing proposed organizational actions can be reduced by implementing Decision Support System (DSS). This is due to the less

extreme differentiation of information and knowledge across the levels enabled by its use (Huber, 1990). This means that if the DSS provides required accurate information to the decision makers, they will obtain knowledge about the problem area and the decision-making can be performed without approval from the higher units in the hierarchy. Within the organization each unit receives the information through the information sources which is called 'sensor units' (Huber, 1990). Those 'Sensor units' identify the relevant information from different sources and most often they do not use this information, but transfer it to the next unit which is closer to the decision-making unit.

Based on the previous, we can conclude that the decision-making is a sophisticated process, which directly depends on the IS. The IS has to be optimized in such a way that provides accurate, up-to- date and complete information. The disposability of big data sets and good information does not assure making the correct decisions. There should be well-established relationship between data thus the data need to be organized into meaningful structures. By accessing and analysing information provided by Information flow, knowledge transfer within the levels is being increased, which improves the decision-making hence the overall efficiency of the organization.

3.1.4 Decision-making in organizations

Apart from discussing how decision-making is executed, Simon (1977) presents the organizational as a hierarchic structure and relates decision-making to this. Large organization contain this hierarchic structure, which Simon relates to Complex Systems. Complex Systems are hierarchical in nature for three reasons: structure appears through evolution since subsystems are themselves stable systems, structure reduces information need and structure reduces the complexity of any particular organization (Simon, 1977). We can see HS as such complex system which includes parts and subsystems. Decision-making is unlikely to change this hierarchy, therefore the decision-making will call for departmentalization of responsibilities: in order to improve decision-making one should find the proper level in the organization for each important class of decisions (Simon, 1977). Huber (1990), discusses this in his study on the impact of advanced information technologies on organisational design and decision-making and observes that in some occasions the automatisation would alow decisions to be taken in a lower level in the organisation.

Furthermore, Foster and Flynn (1984) confirm this downward shift in decision-making in their study in General Motors. According to Huber (1990), decision support systems allow decision-making to occur at a greater range of hierarchical levels without loss of quality and timelines, thanks to available technologies. He therefore proposes the following proposition: *"For a given organization, use of computer-assisted communication and decision-support technologies lead to a more uniform distribution, across organizational levels, of the probability that a particular organizational level will make a particular decision"* (Huber, 1990, p.57). We should be careful using this hypothesis since Huber did not offer any kind of empirical evidence for this proposition, but rather offers it as a proposition to be tested. The decentralization of decision-making in the HSs is advised by the World Health Organization

(WHO) in 1994, where they discussed the District Health Information Systems (DHIS) and their role in improving the management decision-making at the district level (World Health Organization, 1994).

Using Simon's theories, we have identified different reasons why the hierarchy is important in the decision-making. Not only does a hierarchy with multiple levels improve the stability and reduces the complexity, more important it will reduce the information flow.

Simon (1977) presents his decision-making in organizations using three hierarchical levels: *Basic work process*, the lowest level, refers to the production and shipping of goods; the middle layer *programmed decision-making*, consists of processes that govern the day-to-day operation of the work process. Finally, the top layer, *Non-programmed decision-making*, refers to the process that is required to design and redesign the entire system. With this set up, Simon suggests that the hierarchy influences the structure of the decision-making, the higher up in the organization, the more unstructured the decision becomes (Simon, 1977).

Another, more often used, model for organizational structure related to decision-making is the three layer framework for planning and control in organizations (Anthony, 1965). This model corresponds to the programmed and non-programmed level introduced by Simon (1977). As it offers a more detailed distinction of layers, this model is often used when discussing decision-making in organizations (Gorry and Morton, 1971, Pieptea and Anderson, 1987, Vierck, 1981) and when discussing the relation between DSS and organizational levels (Power, 2002). Consequently, it forms a base for the Decision Support Systems (Arnott and Pervan, 2005).

The framework is built up of the categories, with which organizational activities regarding decision-making can be identified. The top layer is the *Strategic Planning* "Strategic planning is the process of deciding on the objectives of the organization, on changes in these objectives, on the resources used to attain these objectives, and on the policies that are to govern the acquisition, use and disposition of these resources" (Anthony, 1965, p.24). It is a process having to do with long range strategic plans and policies that determine the direction of the organization, the strategic decisions (Anthony, 1965).

The second layer in the layer of the framework is the management control. "Management control is the process by which managers assure that resources are obtained and used effectively and efficiently in the accomplishment of the organization's objectives" (Anthony, 1965, p.27). Management control decisions are made within the guidelines set by the strategic decisions. In this way the objectives, facilities, organizations and financial factors can be seen as given resources (Anthony, 1965). It can be hard to distinguish these two processes of management control and strategic planning, generally due to the interactions between these processes (Anthony, 1965).

The third level in the framework for planning and control systems is the *operational control*. "Operational control is the process of assuring that specific tasks are carried out effectively and efficiently" (Anthony, 1965, p.69). The focus of this category is on individual tasks or transactions. Operational control is related to the stock of a specific item, in contrast to the stock as a whole or to specific personnel, in contrast to Human Resource Management. These

three levels are used by different authors to characterize the decision-making within organizations including Pieptea and Anderson (1987) who rename the three levels into Top management, Middle management and Supervisory level.

Anthony (1965) introduces a fourth layer in his framework called *programmed control*. Decisions in this process are programmed, where rules are devised and the action that is most efficient under a given set of circumstances is prescribed. Programmed control can be applied to activities where the optimum relationship between input and output can be determined, if this is not the case then we can call these activities as non-programmed (Anthony, 1965).

Gorry and Morton (1971) use this presented organizational framework as a base for their organizational decision-making framework. It is widely used, "The Gorry and Scott Morton framework is perhaps the best known, most durable, and most frequently cited in the IS field" (Kirs et al., 1989, p.184). Out of their belief that understanding of managerial activity is a prerequisite for systems design and implementation, they present a model that describes decisions made in an organization. As they say "Information systems should exist only to support decisions, and hence we are looking for a characterization of organizational activity in terms of the type of decisions involved" (Gorry and Morton, 1971, p.22). The model is built up by combining the view on decision-making of Simon (1977) and the organizational structure of Anthony (1965). They conclude that observing the decisions in the organization will improve the quality of the system. According to these authors, it is important to be aware of the differences in the implementation process and models due to structured and unstructured decisions and differences in database concepts, types of decision makers and organizational structures along the organizational planning and control axis (Gorry and Morton, 1971).

This framework proposed by Gorry and Morton (1971) is validated by Kirs et al. (1989). Using an experimental lab study with 42 MBA students as subjects to investigate, they concluded that "the framework proposed nearly 20 years by Gorry and Scott Morton appears to describe differences among information systems in a valid manner" (Kirs et al., 1989, p.192). Besides validating the framework, Kirs et al. (1989) also created a visual representation of the framework of Gorry and Morton (1971) which can be found in Figure 3.4.

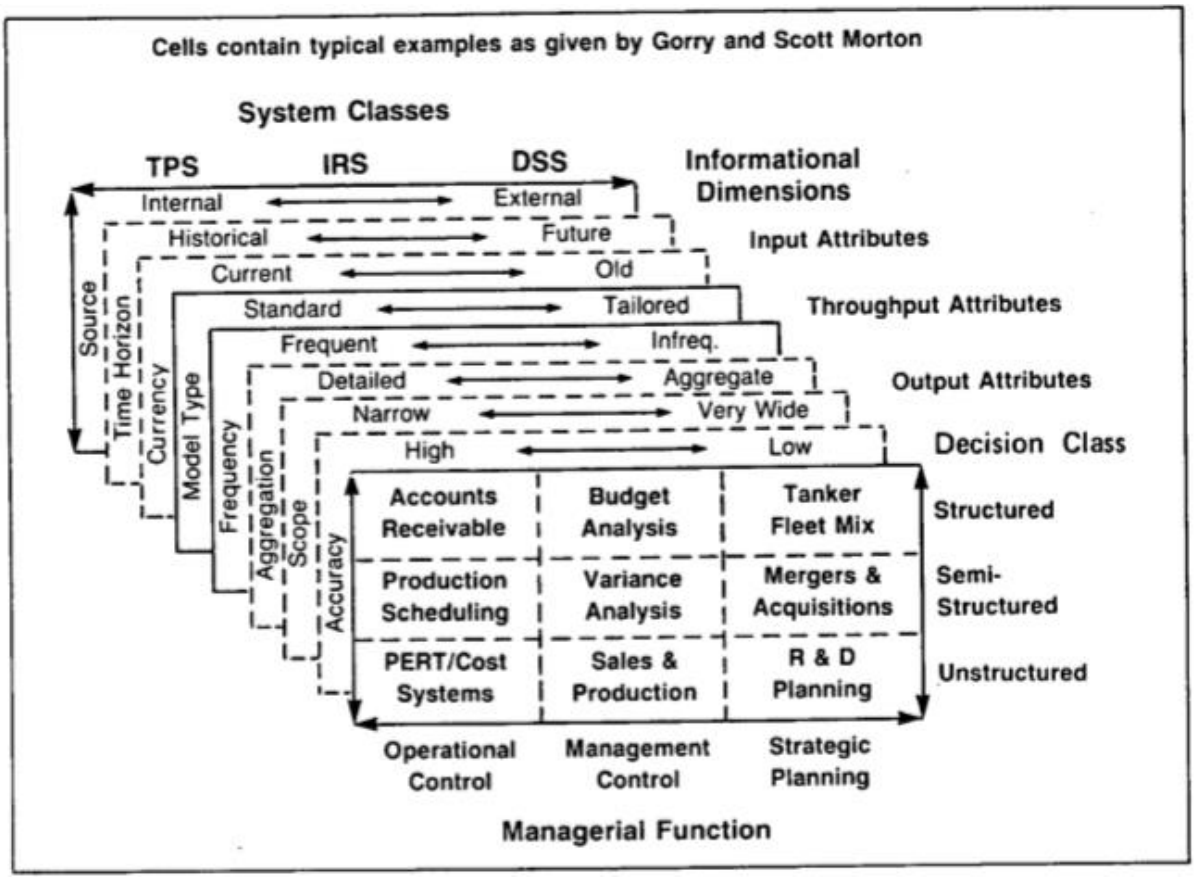

Figure 3.4 - Information requirements by Functional Activity (Kirs et al., 1989, p.186)

The above literature on decision-making in connection with the organizational activities can form a base for a classification of decisions. Pieptea and Anderson (1987) observed that the above-defined characteristics of decision-making are interrelated. As such, the organizational hierarchy, presented by Anthony (1965), is related to the structure of decisions as presented by Simon (1977). Gorry and Morton (1971) present that the use of information is related to the hierarchy, as can be seen in Figure 3.5. Relevant in this case are the information source, the currency and the aggregation. Pieptea and Anderson (1987) use these relationships to propose decision classes; they propose a table with three classes to relate structure, management level, degree of uncertainty and information source in order to determine the costs and benefits of the DSS.

Vierck (1981) also relates the different characteristics of decision-making. In his study, two DSS characteristics are related: the amount of problem's structure and the degree of internal and external information source. At the lowest level in the hierarchy, the supervisory level, there is a high level of structure and use of information; while on the top level the decisions are more unstructured and information originates more often from external sources (Vierck, 1981). This is illustrated clearly in Figure 3.5.

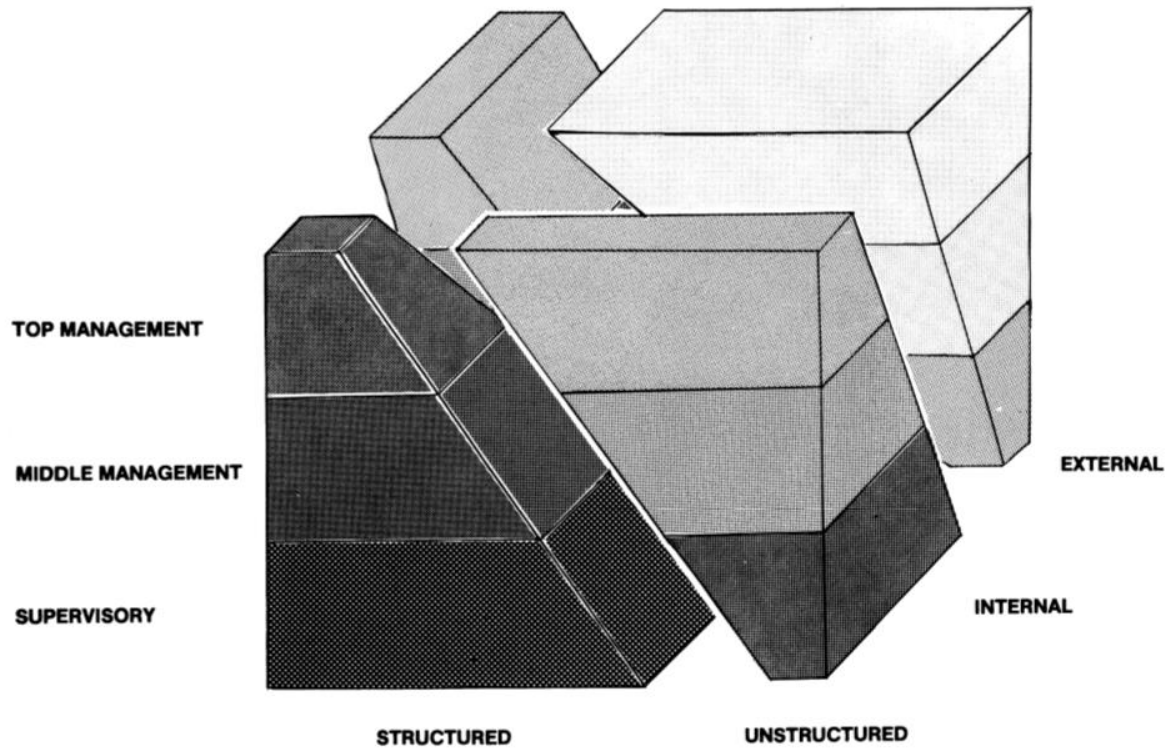

Figure 3.5 - Three-dimensional aspect of Decision-making in organizations (Vierck, 1981, p.42)

Based on the characteristics of decision-making, and the relations between them as observed by Pieptea and Anderson (1987) we can formulate a table of decision classes (see

Table 3.1). These decision classes can be used to understand the managerial activity and decision-making and as Gorry and Morton (1971) argue, this is a prerequisite for system design and implementation. The combination of these models can be used to predict the organizational information needs, and can lead to a higher quality of implementation.

Table 3.1 - Decision Characteristics related to organizational level

Decision level	**Structure**	**Information source**	**Information currency**	**Information aggregation**
Top management	Semi structured and Highly unstructured	Mostly external	Old	Aggregate
Middle management	Semi structured	Internal and external	Timely	Slightly aggregated
Supervisory	Highly structured and semi structured	Internal	Current	Detailed

3.2 Decision Support Systems

The Decision Support System (DSS) has been researched for the last decades. As Sprague (1980) argues, it has been defined as an interactive computer based system which helps decision makers to utilize data and models to solve unstructured problems and moreover could be dedicated to improving the performance of knowledge workers in organizations through the application of information technology.

Before developing the DSS for a specific decision class, the prerequisite is to identify how those decisions are made (Remus and Kottemann, 1987). This includes collecting the data and understanding the environment, where decisions are taken and who makes them. This will provide a good baseline for decision support system.

Sprague (1980) assigns different levels of DSS to five different roles such are managers, Intermediary, DSS builder, technical supporter and the tool smith depending on how the problem is broad or narrow, how the worker comfortable with the computer equipment and the strength of the technology.

The highest level of DSS is assigned to the managers or users who are directly using the application and they are responsible for the decisions' consequences. In our research, the focus will be this level of the users.

It is important to emphasize that in the beginning, DSS primarily referred to a computer based system for supporting the individual decision making (George, 1991). Later on, George (1991) explains how this concept was being developed at the broader level of decision making which includes divisions, departments or even entire organizations. Depending on the level where the decision-making is supported, three different types of DSS are identified by Hackathorn and Keen (1981): individual, group and organizational decision support system. As our research focuses on decision-making within the Malawi HS, we need to consider the entire organization's tasks sequence. Hence, the DSS type that corresponds to our system is organizational decision support system (ODSS).

Hackathorn and Keen (1981) characterized ODSS as a system which supports the execution of the task or activity within the entire organization. Those tasks and activities depend on the sequence of operations executed by various actors (managers). Each individual actor has its own assignments or tasks and very important to be emphasized is that each individual actor's task has a tight interconnection with other actors' within the system. The authors further explained that computer-based support system is used equally as a means for both communication and coordination, and on the other hand, for problem solving or support for decision-making.

Influenced by Hackathorn and Keen (1981), we can define the main features of ODSS in Malawi HS:

- The focus of this ODSS is activity or a decision that affects different system's units. The term unit refers to different levels and facilities within Malawi HS which are explained in further text

- ODSS cuts across all identified levels in Malawi HS;
- ODSS implementation will involve computer based and communication technologies, which will truly enable ODSS to perform according to its goals.

Summarizing, in order to establish the base for ODSS, our reasearch aims to identify the accurate Information flow among the units (levels and facilities) in Malawi HS which is delineated further in the Design proposition.

3.3 Health Information Systems

HIS is defined as "the production, analysis, dissemination and use of reliable and timely health information by decision-makers at different levels of the Health System" (World Health Organization, 2007, p.18). The aim of HIS towards quantitative data makes it clearly distinguishable from health care information for professionals or more general health related knowledge (AbouZahr and Boerma, 2005). HIS helps in improving the Health System "all the organizations, institutions, resources and people whose primary purpose is to improve health" (World Health Organization, 2014). The importance of research in the HIS field is therefore without doubt very high. HIS directly leads to improved management decisions (Lippeveld et al., 2000) which lead to a decrease in mortality and morbidity. In more detail, improving the HS will improve health and efficiency, increase responsiveness and protect against social and financial risk. Pfeffer (1992) pointed out that the decision itself changes nothing while its implementation often makes the difference. The execution of the decisions in our case affects human beings' lives in a community or the entire population. Thus, the importance of the understanding of decision-making within HIS can be seen as crucial.

The need for information in the HS has a long history, in 1987 the WHO announced that: "Information should be used for feedback to workers, managers and policy workers to achieve the needed changes in the implementation of primary Health Care" (World Health Organization, 1987, p.9). Kale (1994) reported the inadequate Health Informatics and the potential of improving this. Sixty seven health representatives concluded that some of the information needed by developing countries needs to be generated by the country itself (Kale, 1994). Although there is a focus on information in these articles, the focus should be on the usage of data rather than on the data, a so called action-led approach (Sandiford et al., 1992).

Managing the implementation of HIS is still of high interest to researchers, due to the high number of failed implementations for example in Mozambique, Uganda, Ghana, Rwanda, Tanzania (Braa et al., 2007, Gladwin et al., 2003, Braa et al., 2004). According to Heeks (2006) most of those HIS's fail in some ways.

One way to simplify the System of Health Information is to break it down in Demand, Supply and Level (AbouZahr and Boerma, 2005). *The demand* denotes to know who needs data and for what; *the supply* refers to the tools and methods available to collect this information and *the level* refers to the layer in the system where data is generated and used.

The supply and demand differ along the levels of the HS (AbouZahr and Boerma, 2005). More authors press the dependency of the HIS on the HS. For example, "a health information system (HIS) cannot exist by itself, but is a functional entity within the framework of a comprehensive health system to improve the health of individuals and the population" (Lippeveld, 2001, p.3). Although the HIS and the HS are clearly linked, "Little is known about how decisions are made at the various levels of the health system" (Lippeveld et al., 2000, p.34). A solution to overcome this lack of knowledge is to extrapolate organizational literature to HS (Lippeveld et al., 2000). Recalling the earlier described theory of (Simon, 1977) about Large Organizations, we can spot the similarities between a HS and the Complex

System that Simon described in these hierarchical systems. This resemblance in organizational decision-making theory and HSs is critical in our research. AbouZahr and Boerma (2005) confirm the theory of Gorry and Morton (1971) pointing out that "The quantity and detail of data needed is generally greater at the lower levels of the system, compared to the higher levels where policy making takes place" (AbouZahr and Boerma, 2005, p.579). This is visualized in Figure 3.6 in which the levels of the health care system relate to the decision style and tools of decisions.

Based on previous we can conclude that HIS is an important field for research, and lacks understanding in decision-making. Both the HIS and the related decision-making is highly dependent on the organizational structure, some authors have presented these differences and argued the importance of these levels, as can be seen in Figure 3.6.

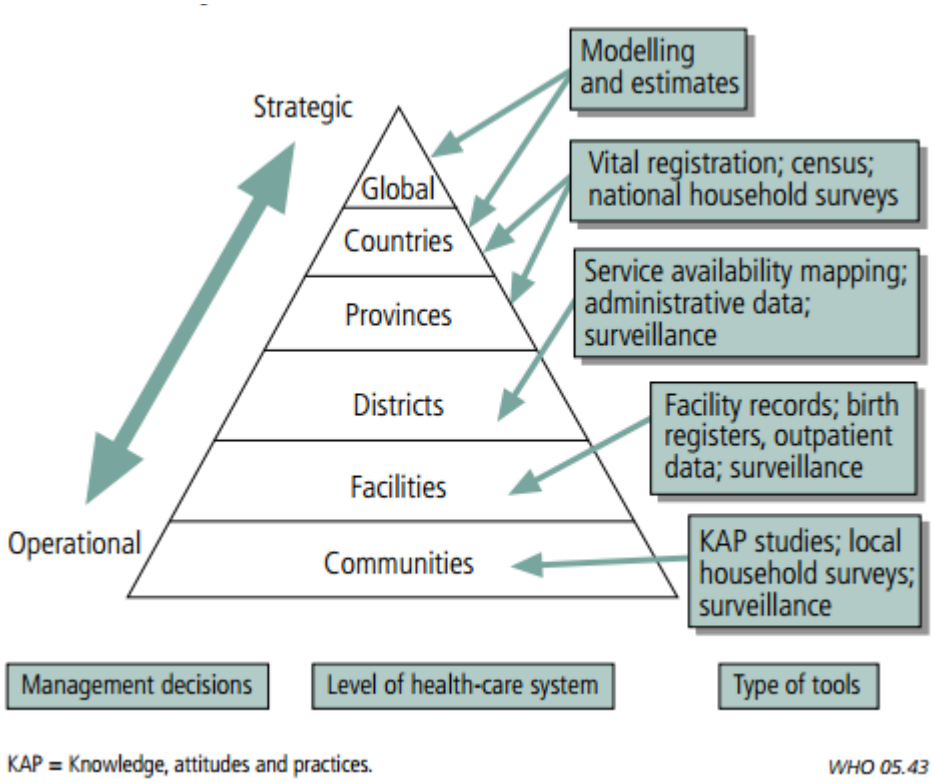

Figure 3.6 - Data needs and sources at different levels of the Health Care System

4 Design proposition

In this chapter, we will show the iterative process of designing the artefact, which is the design proposition in this research. The iterations are based on the justificatory knowledge, the application domain and the knowledge and evaluations provided by our experts. The result of the iterations and our design proposition is the final model. In order to test its usability, we will map the Supporting Life HIS in the model. Hence, we are proposing two scenarios for this implementation.

4.1 Iterative design process

The objective of this iterative process is to increase the level of reliability and validity of our model. Each iteration starts with a model proposal that is afterward evaluated by our experts, John O'Donoghue and Joseph Wu. The feedback from them is of crucial importance as regards the iterative processes of our model.

The applied evaluation can be categorized as artificial since the artefact is not placed in the natural context, but rather is evaluated by the experts from the field. This view was accurately captured and motivated in the design science section of this research. The disadvantage of this evaluation is that the context is not as real as it would be in a naturalistic setting. However, due to the experience and engagement of our interviewees in this field, Joseph Wu and John O'Donoghue, which both have profound knowledge of the model context, we argue that the following evaluations will provide us with the guidelines and relevant feedbacks which lead to validity and reliability of our final model. All the evaluations are qualitative in nature and are performed in a form of the semi-structured interview.

Starting from the first iteration, the focus is on exploring the context where we define the environment of Malawi HS. In the second iteration, our main goal is to get better insight on the information flow within the levels. Finally, the last iteration focuses on organizational decision-making. Finally, we present the complete blueprint, which includes all three aspects: context, information and decision-making of Malawi HS.

4.1.1 First iteration – Context

The goal of this first iteration is to represent a model that visualizes the context of the information flow and gives a first overview of how the information is communicated between the different levels. This model is based on the literature review , description of the HS (Malawi Ministry of Health, 2011) and the information flow from the national policy (Malawi Ministry of Health, 2003).

Development

Braa et al. (2007) introduced a model to visualise the uneven development of HIS infrastructure across regions in Ethiopia. This model identifies levels and the facilities within the HS and in which form they store data. The purpose of the model is to visualise the difference between regions and their use of gateways, where gateways can be classified as *"a piece of software that links together different sub-infrastructures into an integrated one"* (Braa et al., 2007, p.397). We will use the model from Braa et al. (2007) as a guideline for developing our model. The regions that are visualised are of no interest for the Malawi HS. Instead, a country wide approach is required, in Malawi and is defined as a Sector Wide Approach (SWAP) (Meer et al., 2008).

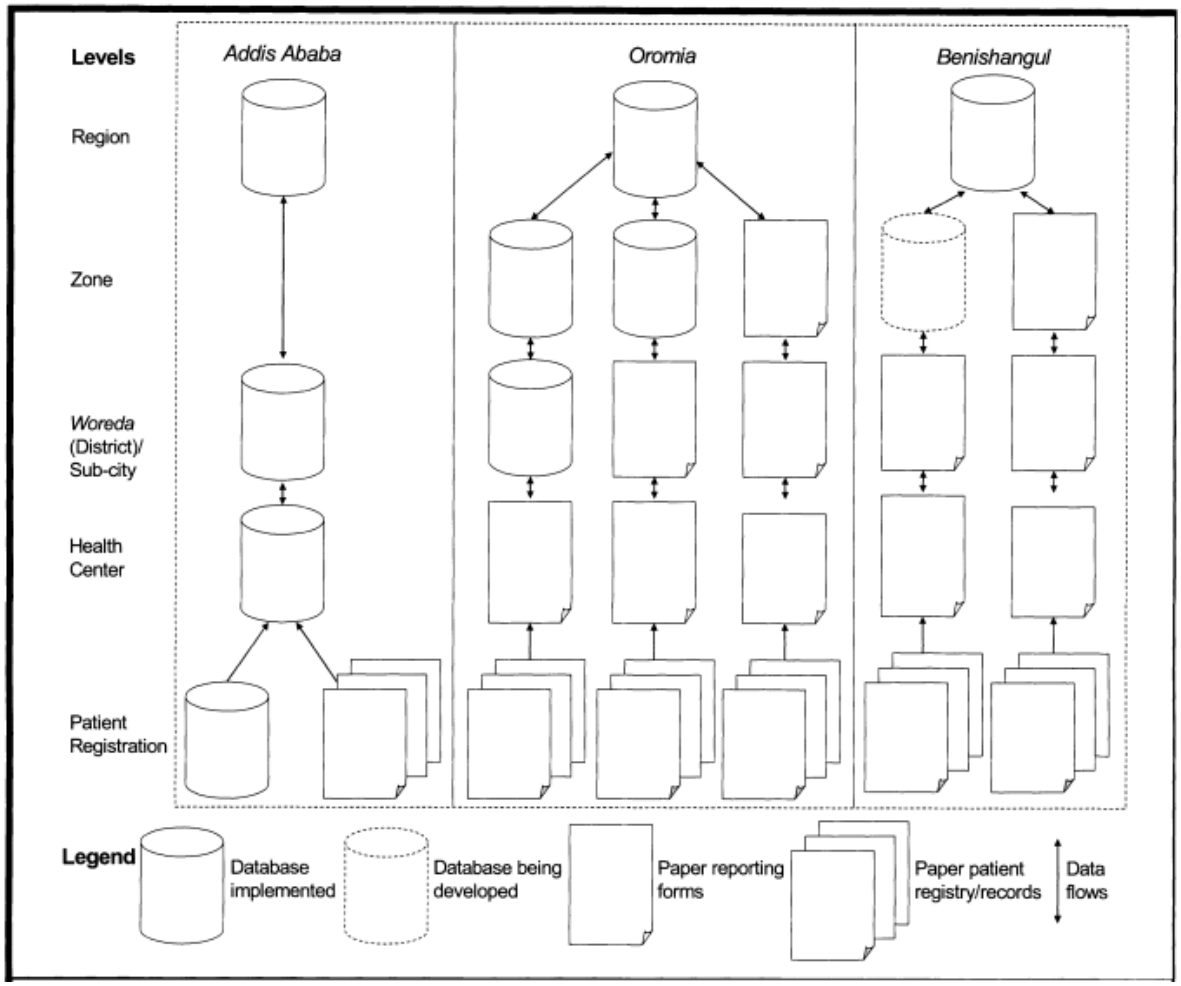

Figure 4.1 - Uneven development of HIS Infrastructure Across Regions in Ethiopia (Simplified) (Braa et al., 2007, p.394)

The knowledge we derived from the application domain can be used as a base for defining a model of facilities. With this information it is possible to identify the entity 'facility', which represents a group of facilities within the Malawi HS. These facilities operate directly within the health system, which means that they offer health care. A different entity is the MoH. This entity is a governing entity, and it does not provide healthcare but rather provides services to the different health facilities.

As described in the application domain, Malawi HS consists of three levels and within each level there are different facilities. The facilities are identified over the ownership dimension. The ownership is a property of a facility and identifies which instance owns and manages the facility. This ownership can be categorized into public or private. Ownership is important in this model since it influences data ownership and communication flow.

The levels, facilities and ownership are the crucial properties for identifying information communication flow and points of decision-making. It can be created as a matrix of these properties which depict the existing facilities as well as their corresponding ownerships.

Another property that highly influences information communication is the type of data collection, which is identified in two types: paper or computerized. A computerized data storage at two facilities does not mean that the information that is communicated is digital, due to use of standardization. As the Malawi MoH has argued, the HIS is computerized on district level and above, and paper based on lower levels. This is confirmed by Dr O'Donoghue who argues that although both HSA and health centre can have a digitalized system, the report is still generated and printed at the health centre before processing.

This communication between facilities, by Braa et al. (2007) identified as gateways, is marked in the model with the arrows. Two way arrow indicates the existance of top-down communication. The Malawi Ministry of Health (2003) highlighed in their national policy that the top-down communication is as important as bottom up communication. This communication between departments has to be structured by rules and policies. An example of the information communication between facilities is sending different forms from HSA to the Health Center. For e.g. 1a, 1b and 1c forms, which are filled by using spreadsheet software and then communicated upwards. Form 1a (Appendix 1), is used to communicate information from HSA up to Health Centers. Form 1b is used to communicate information from Health Centers up to the DHO (Appendix 2). Form 1c is used within the District Level. These forms are used to communicate the information from the lower to the higher levels. In the following model the communication will be described in more details.

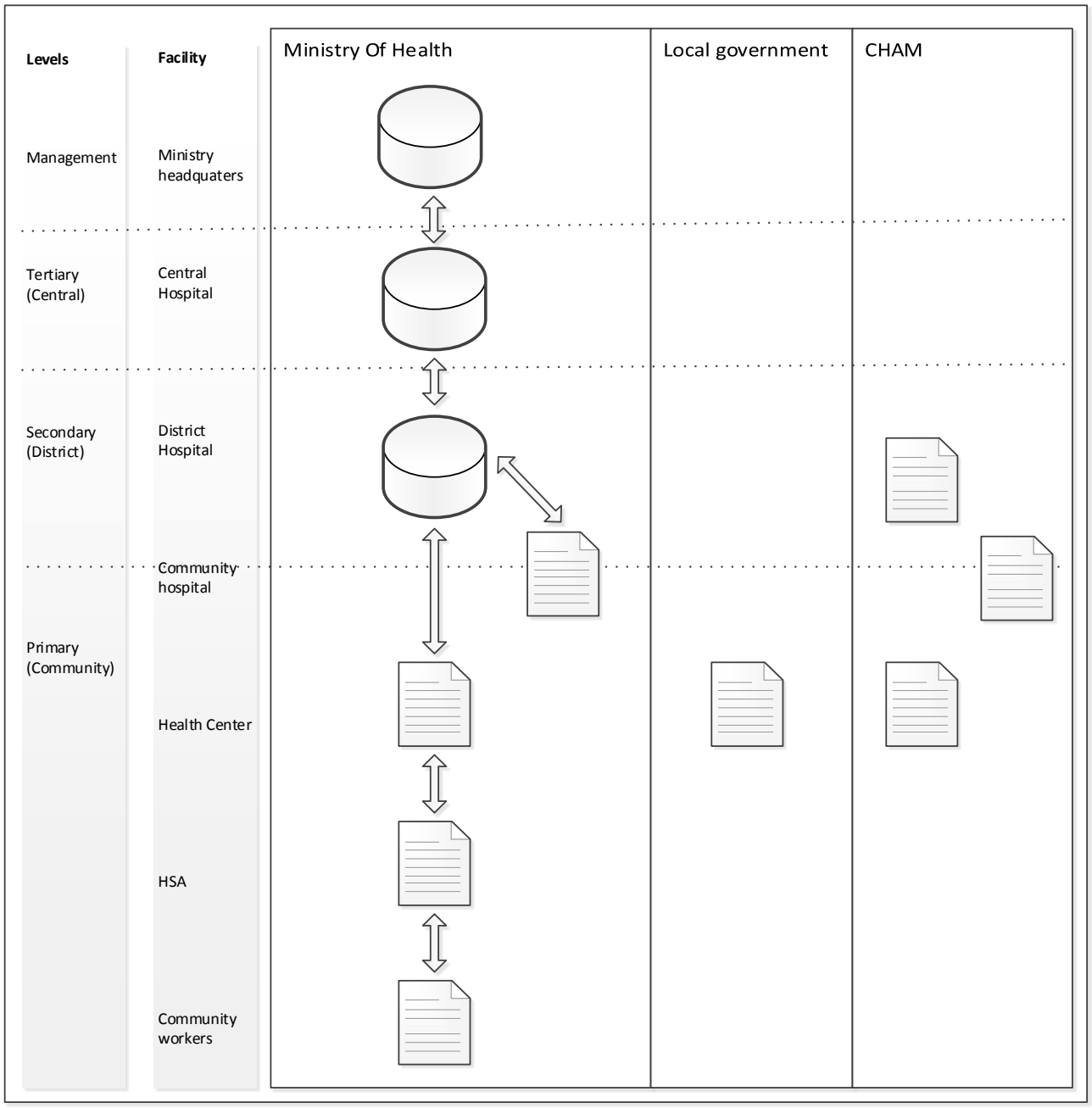

Figure 4.2 - Malawi Health Information Communication, version 1

The developed model has two disadvantages in the current state. Firstly the model lacks depth, it visualizes the information flow for decision-making but lacks to give detail about which decisions are made, by who and under which governance. Secondly, the model requires validation. The sources of this model are mainly from Malawi MoH and are confirmed by independent references, e.g. Chaulagai et al. (2005). However, these references are not up to date, and do not give a detailed overview from within the context. A way to increase the validity of this model is to validate this model with experts within the context.

First model evaluation

In the first model evaluation, we presented the model proposal from the first iteration to our expert, Joseph Wu. The interviewee was requested to reply to what extent this model represents the truth. A list of 10 questions was sent to the interviewee with the aim of clarifying the doubts we faced during the model designing (see Appendix 4). The objectives of this evaluation are testing the realibility and obtaining additional information and knowledge about the context.

Our interviewee primarily gave us a general feedback and impression of the model. Therefore, starting from the lowest level of the system in the model, we discussed both correct and incorrect segments of the proposed model as described in the following text. The full transcript is available in Appendix 5.

Our interviewee confirmed the level categorization on primary, secondary and tertiary. However, on the primary level, there is a fault regarding the Community health centre and the Village Centre. In this respect, our expert did clarify that those two facilities are working on the same level thus there is no such reporting flow from Community health centre to the Village clinic.

With regard to the Governance consideration, Joseph Wu highlighted that HS in Malawi is a public organization. He affirmed that MoH governs the entire system and there is no local government in this system. CHAM, follows the structure of MoH as well. Therefore, the only relevant owners we should consider is MoH as all the levels run on the structure which is aligned with this entity.

Joseph Wu gave us the explanation of the data flow and its aggregation on the example of the form 1a,1b and 1c which was provided earlier by John O'Donoghue. We were provided with a better insight about the information aggregation at certain points in the HS.

The patient level data collected from HSA will be aggregated into the numbers within more understandable outlines. Further, higher-level facilities transform this information into the appropriate forms, by breaking it down, grouping, categorizing and finally using it for decision-making. This is supported by the beforehand mentioned theory about different characteristics of the information for each stage of decision-making as explained by Ahituv et al. (1994), and influenced by Simon's trichotomy (Simon, 1977).

As an outcome from the first model evaluation, we identified the crucial points, which require changes. Here is a list of the concrete actions that are going to be performed in development of the second model version:

- Community health care worker is to be placed on the same level as HSA;
- The primary level consists only of Health centre and HSA;
- Community hospital is to be renamed into Rural hospital as a part of the Secondary level;
- Local government and CHAM should be eliminated as the category of the facilities' governance;

- Centralized database is to be added, on the level of Ministry of Health;
- VHC or CBDA report vertically, there is no bridge between them and HSA. The information goes directly to DHO.

Conclusion of the first iteration

The first evaluation led to the conclusion that the previous model lacked detail and was not valid and relaible. The sources used for this iteration did not provide accurate and up-to-date information thus did not delineate the current state of the Malawi HS. Nevertheless, the qualitative data acquired from the expert provided us with the significant information which will support our second iteration model proposition described in the following chapter.

4.1.2 Second Iteration - Information flow

The second iteration has an objective to correct the deficiency of the first model by proposing a new layout. Based on the justificatory knowledge and expert feedback from first iteration, we are proposing more detailed version of the model. In this iteration the focus is on the information communication flow along with the referral hierarchy and the central database.

Development

Joseph Wu confirmed the distinction between the hierarchy of healthcare and the hierarchy of the information communication. In Table 2.2, the health facilities are visualized based on a 2011 report about the structure for health care (Malawi Ministry of Health, 2011). Also, it is visualized in the first model, Figure 4.2, and finally confirmed by our expert. Joseph Wu explained the referral hierarchy which concerned a patient from the village clinic up to central hospital. If the highest level, central hospital, is unable to treat the patient then the patient will be treated abroad. We can see that the information flow does not adhere to this hierarchy, and that certain levels in the healthcare are not included in the information hierarchy. This can be concluded based on Figure 2.3, from the Malawi Ministry of Health (2003) report. The two hierarchies , the point of care hierarchy and the information communication hierarchy, are significantly different and should therefore be observed separately.

Joseph Wu clearly marked that a district hospital has a DHO department that is responsible for the information received from facilities, but do not use this information for decision-making since they have no understanding about the data itself. DHO plays a central role in the information structure. The DHO is run by a District Health Officer, the district hospital director, who governs the data from all facilities in the district. Joseph Wu explains in the first evaluation: “The hospital will not govern the data, but District Health Office will”. In each DHO, there is an assigned HMIS (Health Management Information System) officer, who organizes and collects the data from the various facilities within the district. The HMIS officer is the ‘contact window’, which is according to beforehand mentioned, Huber (1990), ‘Sensor Unit’, who shares and exchanges the information. The HMIS officer collects data from various sources, for example about vaccination, mortality and disease surveillance. They collect data according to different programs or projects needs.The highest authority to

organize and manage data is the Centre for monitoring and evaluation division (CMED). The CMED manages the whole Health management information system and assigns the HMIS.

The central, governing, role of the DHO is emphasized in the information communication. Where in our first model, the information went through all layers before ending up at the DHO, we found out that the information can flow from a village clinic directly to the DHO, or through a Health Centre to DHO. Data from the VHS or CBDA is reported vertically without any need for reporting to HSA. Moreover, there is no hierarchical information communication above the DHO level, since all levels from DHO and above have access to the central database.

Another clarification we obtained during the first evaluation is about the governance of the healthcare. The governance of the facility has no influence on the flow of information or on the healthcare structure. The only exception in this structure is the private facilities. Private sector is not described in the literature since the MoH has not been familiar with private facilities until recently. The number of those facilities is low and they do not report, thus they are excluded from the information flow.

Forms 1a, 1b and 1c (Appendix 1-3) are the examples out of 130-140 HMIS reports which are circulating in the HS in Malawi. In Malawi those forms are used to collect data at the community level, and at the moment most of them are filled on the paper. These paper based forms are sent to the higher levels as part of the information flow, and are supposed to be digitalized at the district level. The reporting from the district level upward disappears as MoH governs the central database and there is no need for any report-based forms to be communicated.

The forms 1a, 1b and 1c are used to communicate Community Case Management (CCM) information and we will use them to exemplify the information flow. The 1a form is filled by HSA worker and sent to Health Centre; the Health Centre aggregates multiple 1a forms into 1b form and sent it to DHO. Additionally, DHO enters the information from the 1b form in the central database and generates 1c form based on this information. The information communication follows a flow in which data is transferred into information which further becomes knowledge to be applied and acted upon by executives or decision makers (Vierck, 1981).

All the information is stored in the central database, which is governed by the Ministry of Health. It is a web based system and as long as there is connectivity, the data will be sent and submitted to the central database. Joseph Wu pointed out that the district level facility does not send the aggregated data to the central hospital: only the patient level data is delivered to the Central Hospital, for e.g. demographic data or the condition of the patient. District Hospitals and Central Hospitals generate their own reports and submit them to the MoH.

Based on this feedback we developed the second version of the model, which can be found in Figure 4.3.

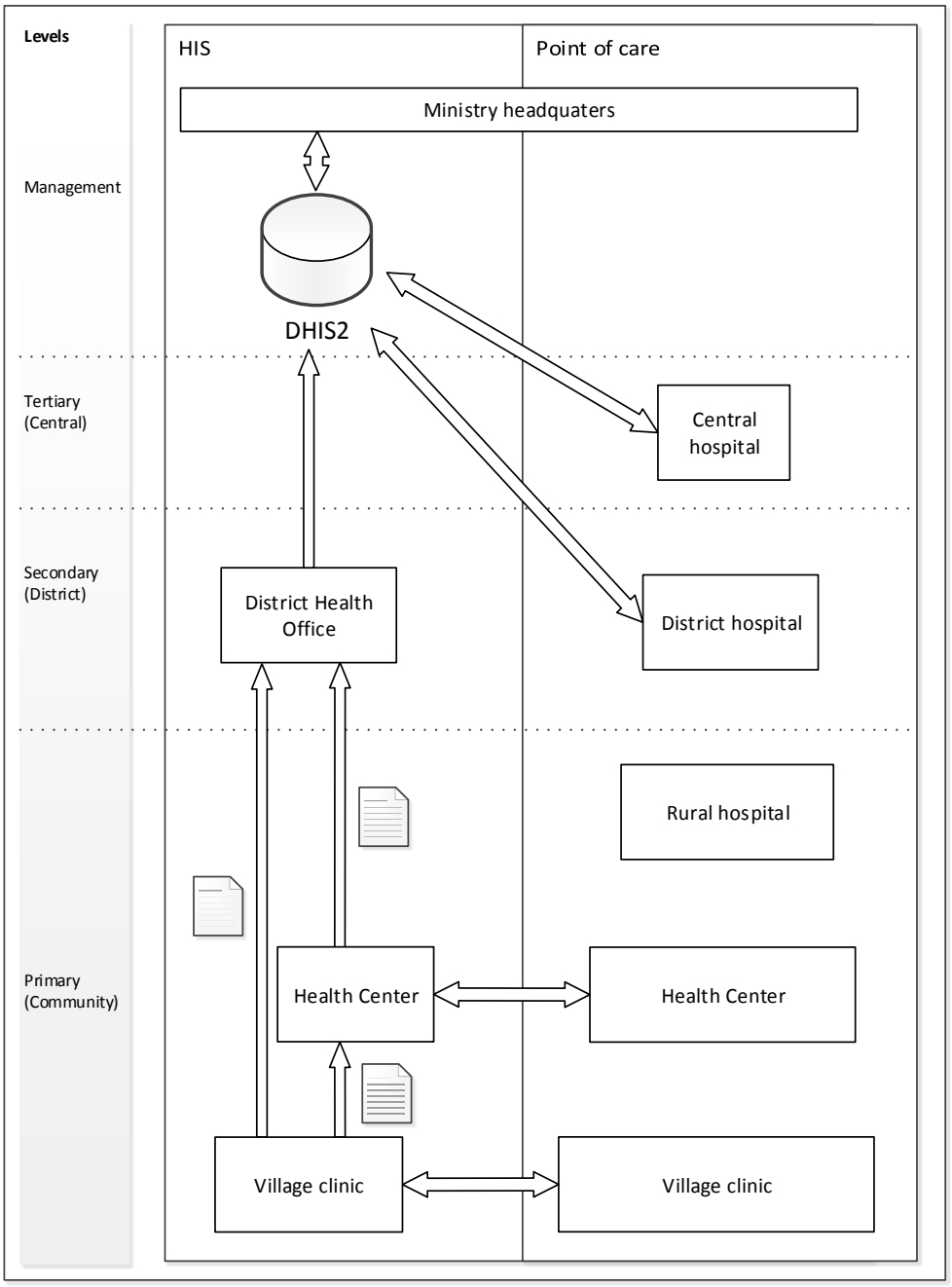

Figure 4.3 - Malawi Health Information Communication, version 2

Second model evaluation

The objective of this evaluation is testing the validity of the model proposed in the second iteration. Moreover, it provides better insight about how the model can be improved in order to increase its contribution to Supporting Life. Our interviewee for this evaluation, John O'Donoghue, a project coordinator of Supporting Life and expert in HIS, gave us a valuable feedback on our model from the perspective of the project and HIS.

John O'Donoghue stated that, on the lower level of abstraction, from the perspective of Supporting Life, it would be useful that the model displays how the data acquired by HSAs by using Supporting Life application, circulate up across the identified levels. Mapping the

Supporting Life application into this flow will delineate how the collected data is used and how the application is integrated with DHOs, DHIS2 and the existing IT systems.

From the point of visualization, we were suggested to place the labels on the arrows, which present the information exchange among the levels. This would ease referencing to the particular arrow within the text.

Our interviewee pointed out that, after having been confirmed by Joseph Wu, who is recognized by John O'Donoghue as the most relevant expert in our research evaluation regarding the reliability, our model has an opportunity to be the first blueprint, which presents high level of abstraction of different levels within Malawi HS. This makes our model unique and a big contribution for the future development of HISs (such as Supporting Life application) which relates to the purpose of this research.

Conclusion of the second iteration

This iteration resulted in providing some more insights required to increase its contribution to Supporting Life. The response from John O'Donoghue indicates that our iterated model conforms to his expectations and thus is valid. Moreover, he confirmed that this model operates on the high level of abstraction, which is our initial idea. The next iteration model will be enhanced by the suggestions and feedback from this evaluation.

4.1.3 Third iteration – Organizational decision-making

The third model includes detailed insight of the context and information communication as the result of the previous two iterations. Additionally, in this iteration we are focusing on Organizational decision-making. The decision-making perspective is based on the proposed theory which is about the three organizational levels influencing decision-making structure and information characteristics.

Development

Top management refers to the Strategic Planning (Anthony, 1965). This process is pronounced with long-range strategic plans and policies, which thus determine the direction of the organization. This shows resemblance with the management level in the MoH, as they make decisions on strategy, direction, hierarchy, architecture, overall budgeting and human resources (Malawi Ministry of Health, 2011, Malawi Ministry of Health, 2003). Moreover, they build the Health Sector Strategic Plan, HSSP, which defines how and where the resources are going to be engaged with regard to the specific projects (NGOs, aids projects). These decisions show a clear resemblance with what Anthony (1965) defines as choosing objectives and planning how to achieve these.

The middle management resembles the management control (Anthony, 1965). This process ensures that resources are obtained and used effectively and efficiently in the accomplishment of the organization's objectives by managers. It is related to strategic planning in that the decisions are made within the guidelines set by the strategic decisions. This decision layer shows resemblance within the Secondary and tertiary healthcare level. This mainly concerns

the tertiary level, which consists of only 4 central hospitals, with each operating in the guidelines of the MoH and making decisions for the HS in order to achieve these objectives. In the Malawi HS we can see the District Hospital as a key facility in middle management, as a result of their increased responsibilities since the decentralization act in 1997. As Joseph Wu explains, the secondary and tertiary levels make the decisions concerning the resources allocation.

The supervisory level, *operational control* (Anthony, 1965), is the process of assuring that specific tasks are carried out effectively and efficiently. The focus of this category is on individual tasks or transactions. Operational control can be seen in the community level, at the level of the health centre where resources are allocated based on demand and supply. This process relies on rules which is one of the characteristics of operational control (Anthony, 1965). As Joseph Wu explains, and what is visible in form 1a, the village clinic is requesting a stock of medicines when it runs out. This is day-to-day work which follows a set of directions, a characteristic of operational control (Anthony, 1965).

The *programmed control* (Anthony, 1965), a separate level of decisions, can be seen as the process where rules are devised that prescribes the action that is most efficient under a given set of circumstances. In the HS like in Malawi we can see this in certain protocols, for example when the supply of drugs reaches a low level, or when certain diagnosis leads to specific care. This programmed control can mainly be found in the community level.

By identifying these levels of health care, we can formulate certain assumptions about the decision structure and information characterizations, based on theory we have presented and discussed earlier. The result of this relationship between characterizations and organizational level can be found in

Table 3.1. Resemblances with the theory become clear when the table is filled with information from the Malawi Health System, resulting in Table 4.1.

Decision level	**Structure**	**Information source**	**Information currency**	**Information aggregation**
Top management	Strategic plans and programs	Various sources (WHO, surveys)	Yearly overviews and district summaries	Summarized overviews (1C)
Middle management	Infrequent resource allocation	Surveys and internal information	Monthly summaries	Aggregated data (1B)
Supervisory	Programmed decisions and stock ordering	Internal information from forms	Direct feedback from requests and forms	Raw data, summarized forms (1A)

Table 4.1 - Application of decision characteristics

The identification of the levels, decision-making points and the impact on the information characteristics and decision structure, allows us to develop the updated model including these

findings (Figure 4.4). The model is visualizing the decision-making as part of the structure, indicating the organization's needs on the different levels.

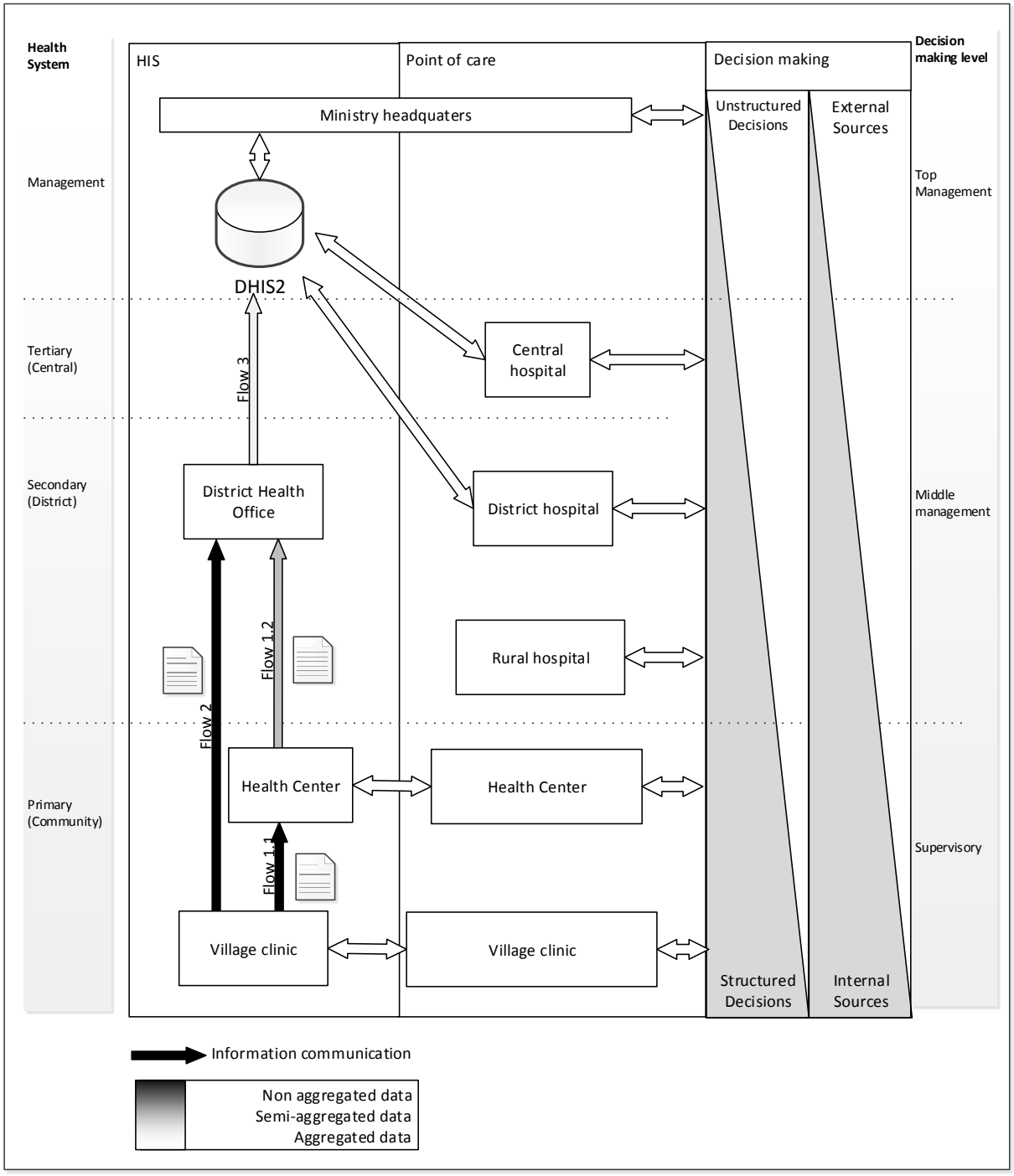

Figure 4.4 - Malawi Health Information Communication, version 3

Third model evaluation

The goal of this evaluation is testing the reliability and correctness of the third model proposal and it is based on the Joseph Wu's feedback on the model 3. He provided some additional comments, which gave us better insight about the data centre, Health centre and rural hospital relation.

The most interesting insight pointed out during this session is the differences and similarities between the Rural Hospital and the Health Centres. Joseph Wu explained that a Rural Hospital is a larger scale of Health Centre in terms of the size and it may offer some more specific services, such as maternal health. However, it still provides fewer services than the District Hospital. Both Rural Hospital and Health Centres communicate with the village clinics.

Regarding the decision-making, he explained that Central Hospital makes only the decisions that concern the hospital itself. Those decisions are about the resource mobilization, budgeting, about some human resource requirements, though they cannot recruit stuff on their own. MoH is the only one who can make such decisions. Rural and Health Centres are providing similar information to DHOs and they do not require any information from CMEDs. The decisions that are made by Rural hospital and Health centre are similar; thus from the perspective of decision-making, those two facilities can be merged. Nevertheless, it is important to make a differentiation between them concerning their roles as the point of care facilities and patient referrals.

From the point of data managing, the central Database or as marked in our model, DHIS2, is considered as a physical means for the data centre. Joseph Wu highlighted the importance of CMED once more explaining that this authority plays the crucial role regarding the data management. Even though, CMED does not enter the data but collects and analyses it while DHO inserts the data. CMED department consists of mostly statisticians. They are in charge of feeding the information to the management team and responding on MoH's requests for different reports and dashboards. Moreover, the ones who also request information from CMED are HMIS officers.

While HMIS collects the data from the fields, from the community and hospitals, and feeds the data to the DHIS2, the person from CMED analyses the data, generates the information and then distributes and feedback the information to District Hospital and MoH. The lowest level that CMED communicates with is District Hospital.

As far as the data integrity is considered, Health centres and DHO level should manage data quality insurance. Nevertheless, in reality data quality is low which tells us that the data maintaining activities are not performed at the satisfactory level.

Conclusion of third iteration

The output of the third iteration has been classified by our expert as much clearer with good reflection on our understanding of the system. Joseph Wu stated that, from his perspective, the model has the satisfactory level of reliability and correctness. Likewise, the feedback from this iteration enhanced our model with the features that are realistic. This increased the validity, and reliability of our design proposition. Therefore, these modifications will lead to our design proposition.

4.2 The health information communication model

4.2.1 Modification on evaluation

The iterative research approach as described led to the development of the model shown in Figure 4.5. This model originated from the third iteration version. It was also at the same time visualized in Figure 4.4. Furthermore, this includes the corrections proposed in the evaluation of this model. These changes include a shift in the decision-making level, based on Joseph Wu´s explanation of decisions taken at the Rural Hospital level. It also includes the CMED department, which acts as an analysing instance to extract data from the database and communicate information to both the MoH and the District Hospital. Besides changes on the model, there is also an alteration in description of the model. Flow 3 is an interface, which Joseph Wu Referred to as the DHIS2 website (HISP Malawi, 2011). Furthermore, it is found that the Central Hospital only make decisions that influence their own hospital and rural hospitals share similarities with the health centre when it comes to decision style. This is visualized in both Table 4.2 and

Table 4.3.

4.2.2 Design Proposition

As stated in the introduction the purpose of our research is "to provide a model of Health information communication in Malawi, which will be used as a guideline for implementation and support of the particular HIS" .This model explains how the information flow in Malawi supports decision-making. In the proposed model in Figure 4.5, we have effected this visualisation.

The model consists of three lanes; all of them are visualizing a factor that is influenced by hierarchy, in this paper referred, which is referred to as level. These lanes are HIS, Point of Care and Decision-making.

The central lane, which is placed in the centre because of its key role, visualizes the point of care within the Malawi HS. It is a visualisation of facilities at which the health service is delivered and where decisions are made. At this lane, the data is collected and information is used for decision-making.

The left lane, the HIS, resembles the HIS. In this model this is referring to the collection of different systems that result in the support of the information flow as presented. The flow is visualized in arrows, displaying the direction and aggregation of the data. The identified flows, which are named in the model, are further explained in Table 4.2 which explains the model in more detail.

The third lane, Decision-Making, is related to the type of decisions that are made at the different levels of the point of care facilities. This lane indicates if decisions are structured or unstructured and if information from external sources is used in the decision-making. The purpose of these factors is to clarify which information is relevant for the decision-making.

The Point of Care and HIS lane, are strongly related to their level in the HS. This level shows the responsibilities that the facilities have when it comes to health care and information services. These levels are defined in policies of the MoH (Malawi Ministry of Health, 2011).

The identified decision-making levels are related to our theory and can be used to understand the way decisions are made and the responsibilities that the facilities carry with these decisions. This lane is related to both, the central lane and the decision-making lane. The decision-making responsibilities are explained in,

Table *4.3* in which examples of decisions are visualized.

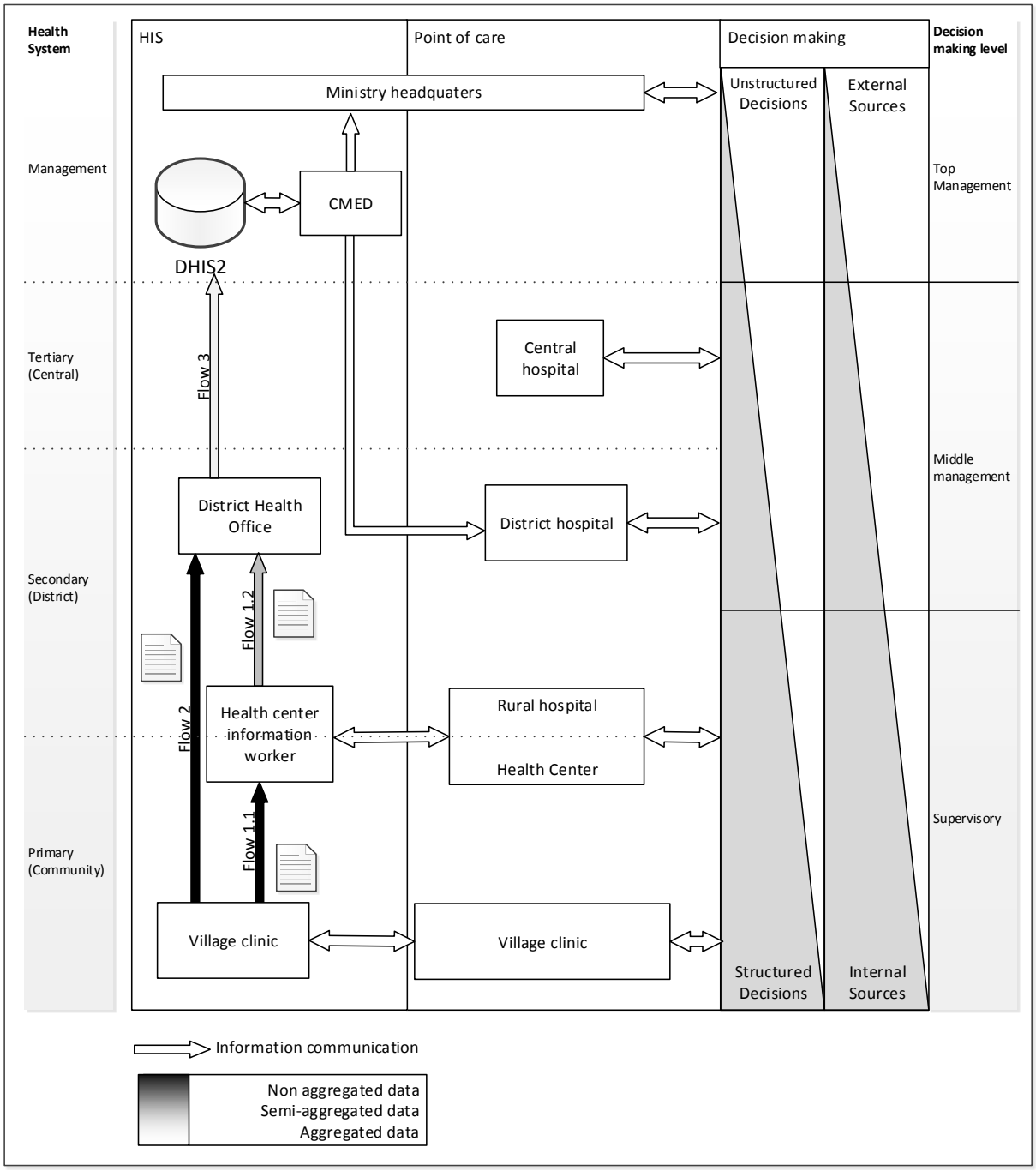

Figure 4.5 - Health Information Communication Model – Design Proposition

Table 4.2 - Information flows within Malawi HIS

Information flow	Example	Level of aggregation	Timeliness
Flow 1.1	Form 1A (Appendix 1)	Aggregated on Village clinic level	Monthly
Flow 1.2	Form 1B (Appendix 2)	Aggregated on Health centre level	Monthly
Flow 2	Surveys	Aggregated on village clinic level	Irregular
Flow 3	Interface		

Table 4.3 - Decisions at health system levels

Health system level	Example of decision
Ministry of Health	Strategy, direction, hierarchy, overall budgeting and human resources
Central hospital	Managing internal hospital resources
District hospital	District budgeting, resources mobilization
Rural hospital	Similar decisions to Health Centre
Health centre	Relocation of supplies, drugs or patients
Village clinic	Drug orders and referral of patients

As argued before, in order to communicate the knowledge, the presented artefact will be explained using the structural components of theories in IS, defined by Gregor and Jones (2007).

Table 4.4 – Mapping to anatomy

Component	Mapping to artefact
Purpose and scope	The artefact supports HIS implementation to fit the Health System and helps identify possible improvements in the Health Information System.
Constructs	Health System, Health Information System, Information flow, decision making, decision structure, decision making level.
Principle of form and function	A division of the health system is connected to information communication and decision making to provide insight when designing or evaluating a HIS.
Artefact mutability	The HIS HS descriptions in this model can be modified for the purpose of either adding detail according to the Health System or adapting to a new Health System.
Testable propositions	A Health System that copes with complexity can adapt this model to visualize their information flow and, by doing this, support implementations of HIS and allow for optimizing the Health System.
Justificatory knowledge	The model is based on insight gained from HIS and DSS literature; Decision Making characteristics support the design of the model.
Principles of implementation	A description of the components is given in order to provide the user with the knowledge necessary to apply the model to

	problems.
Expository instances	The use of the model for the implementation of the HIS Supporting Life, as described in chapter 4.3, led to implementation scenarios.

4.3 Exposition of proposition

In the previous chapter, Joseph Wu and John O'Donoghue evaluated the model on reliability and validity respectively. The purpose of the following evaluation is to test the Usability of the model. A realistic implementation of an artefact contributes to the identification of potential problems and demonstrates that the design is worth considering. Furthermore, the benefit innate in instantiation is that it illustrates how the artefact functions with better communicative power than a textual description (Gregor and Jones, 2007).

This evaluation proposes two implementation scenarios of HIS: one scenario that fits the existing model and another scenario that proposes improvements to the proposed model. The HIS that will be implemented is the Supporting Life application as described in Chapter 2.4.4. This chapter presents the working of the system and the technical set up that is supporting this system.

Firstly, the components of the Supporting Life application are mapped to the defined facilities. The user of the application is the HSA worker who provides the health care. The application is used at the lowest level of the Health System, the village clinic. The smartphone running this application is used both at the point of care as the Health Information System lane. The Supporting Life application exists as a single central remote database, which is also a part of the HIS.

4.3.1 Scenario 1 – confirming the current information communication

This scenario describes an implementation that follows the structure that is defined in the model. The Supporting Life information flow is mapped to the defined Malawi HIS. This approach reduces friction and thereby improves implementation quality.

In the Malawi Health System, there are three information-governing roles involved in managing the CCM data, currently in paper forms. The lowest governing level is the Health Centre Information Worker. The role of this Information Worker is to gather data from the Village Clinic and summarize it in order to feed to the higher levels. In the paper-based CCM, these are the 1a and 1b forms, as mentioned in Table 4.2. The Health Centre or Rural Hospital is the first point to check data quality of the inserted data and it will convey this data to the DHO in the form of 1b report. Supporting Life can assist in this process by generating the 1a forms at Health Centre level, instead of the Village clinic. Moreover, 1b forms can be pre-filled with the information that is available in Supporting Life. The model shows that Health centre information workers inform the Health Centre/Rural Hospital; these facilities make

decisions about the Village Clinics. Supporting Life can support these structured decisions by offering real time overviews at this level.

The information handling process above the level of Health Centre will not change in this implementation. The second governance level is the DHO where the information will be received either from Village Clinic or from Health Centre (Flow 1.2 or Flow 2) and further will be inserted it in the DHIS2. From DHIS2 the CMED can extract data and report back to the District Hospital and MoH based on the information flows indicated in the model below.

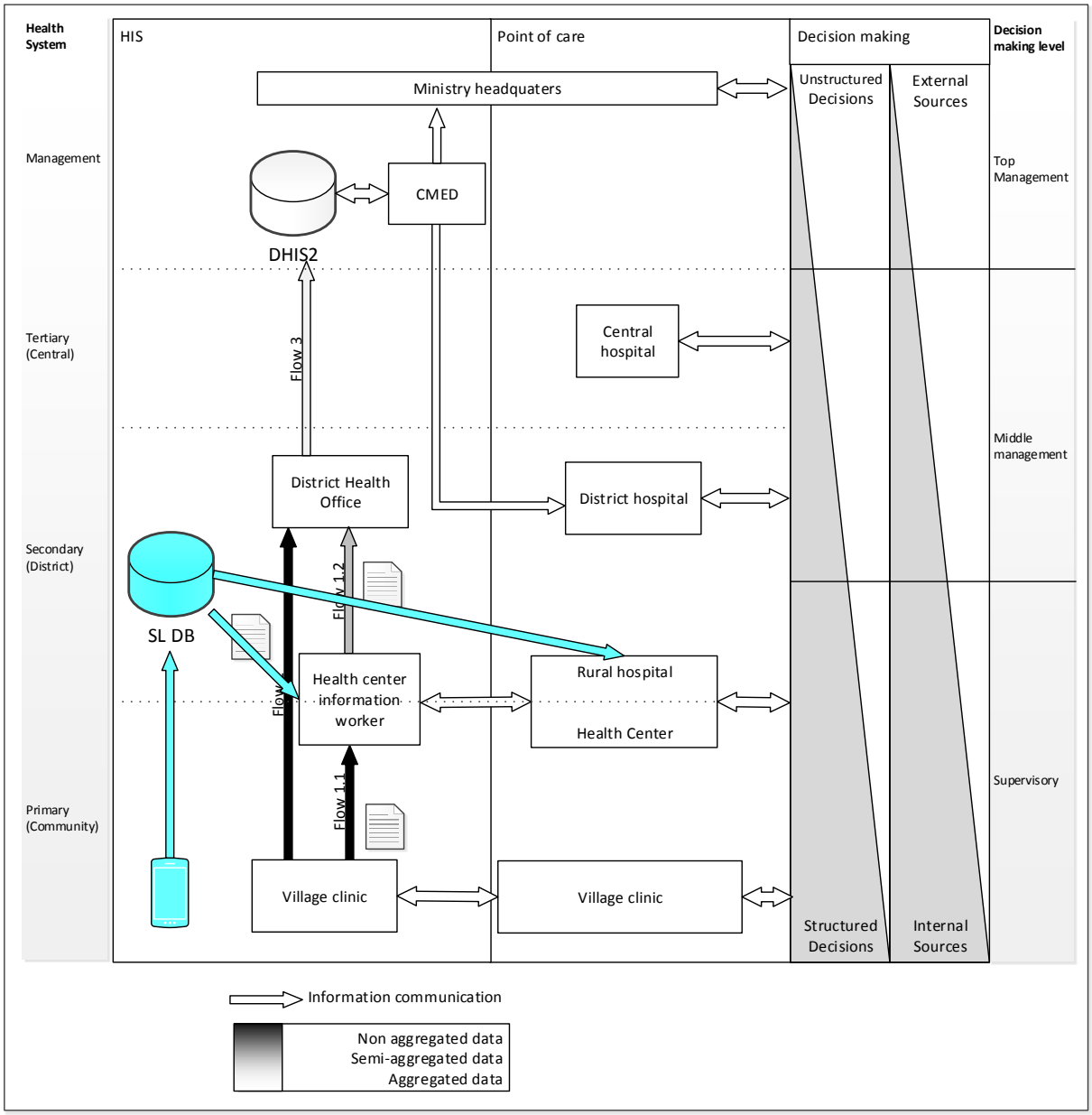

Figure 4.6 - Scenario 1 applied on model

This scenario proposes an implementation that fits the current model and therefore does not require expensive training. It also supports a phased implementation where Supporting Life can be implemented district by district. The implementation leads to an increase of data

quality, due to multiple levels of data control and decreases the workload of Information Workers since the generation of reports will be automated.

4.3.2 Scenario 2 – Improving the information flow

The second scenario is an improvement of the information flow that is described in the proposed model. It leads to an improvement in information accuracy and quality since it automates certain labour intensive activities.

Information flows from the village clinic, through health centre, to DHO. During this process, it is being transformed into more aggregated form twice. As the forms in the appendix show, this decreases accuracy. The report is sent only once, in the beginning of the month, which leads to a delay of up to a month. Additionally, the process of information handling contributes to this delay. To overcome this, the abilities of Supporting Life can be utilized by aggregating and transforming the data automatically. Thus, the input of Data into Supporting Life, in this solution, would be available instantly to the different levels within the HS.

This requires an interface for the DHIS2, in which relevant data from the Supporting Life database will be transferred real time to this database. It is then possible to extract reports from the DHIS2 system and feed them to the District Hospital and the MoH. These reports show data that is, depending on the DHIS2 interface, nearly real time and without any human interaction.

The benefits of this scenario are thus a reduction in the required human resources. Concerning the information, the accuracy and quality of data will increase and thus the quality and accuracy of the reports. Furthermore, the level of detail of the data can increase since the data handling is automated and the performance is being improved.

This implementation has some disadvantages. It requires re-education, since this way of information handling will differ from the protocols that are now in place. Another disadvantage is the process of merging paper based and digitalized information. It is unrealistic to assume that the whole country will use the same way of collecting data, and in that case the data from the different sources should be integrated somewhere in the flow. In this implementation, the merging will be done on the DHIS2 level, which will lead to incomplete data in DHIS2 as long as the paper-form data is not integrated with the digitalized data.

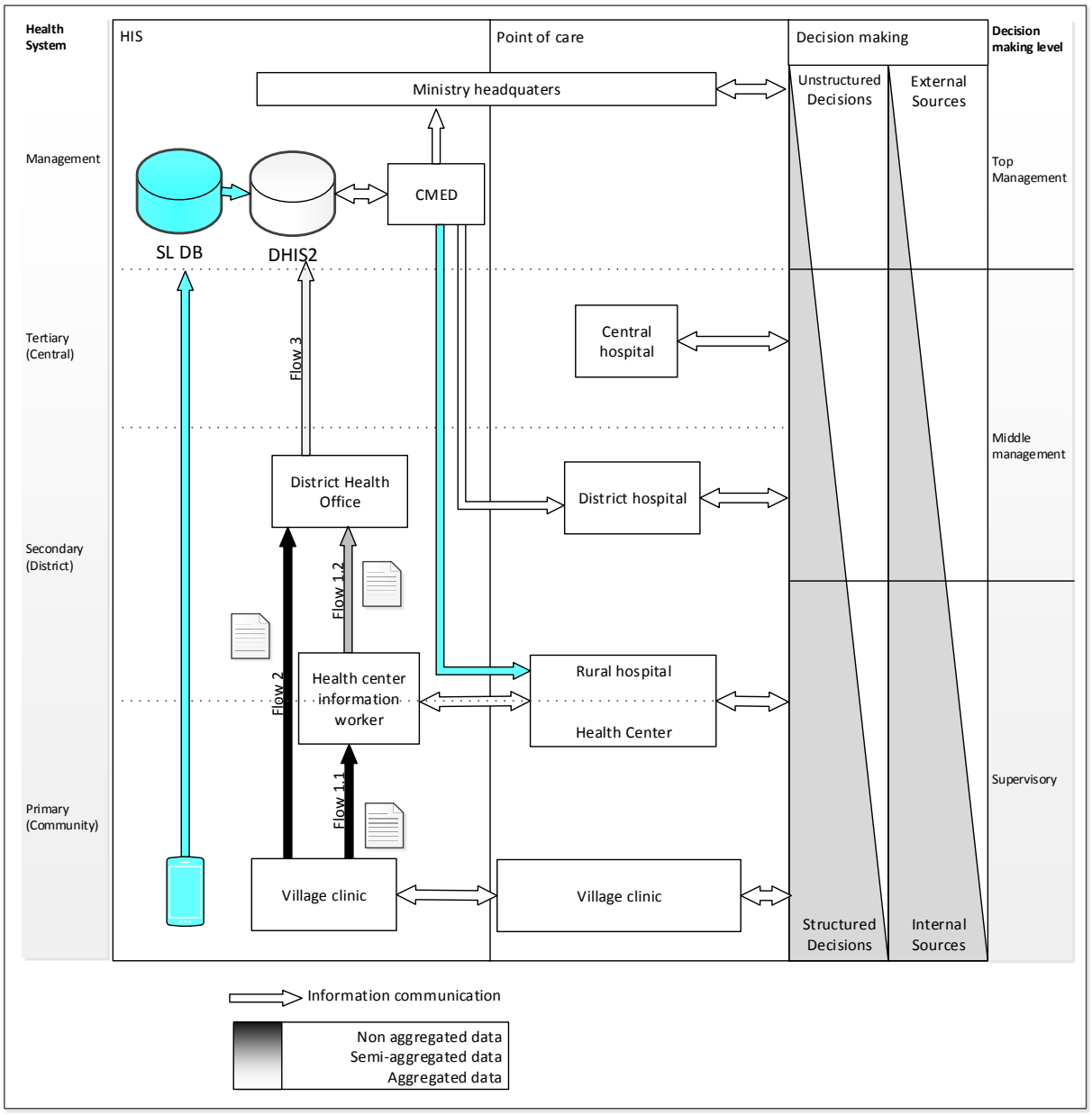

Figure 4.7 - Scenario 2 applied on model

The description and visualization of the two scenarios using our design proposition, indicates the usefulness of the artefact of our research. By using this model it is possible to fit applications in a complex HIS and HS context. This exposition displays that this model can be used as a guideline for the implementation of a particular HIS such as Supporting Life.

5 Discussion and conclusion

We are closing our thesis with discussion and implications of the design proposition. Moreover, in this chapter we are arguing about the research quality and finally we are concluding the thesis by answering the research question along with the ideas for future research development

5.1 Discussion of Contributions

This research contributes in different ways, including a contribution of a model, which contributes in the support of HIS implementations and contributes in the identification of possible improvements. Apart from the proposed model, contributions are made in the decision-making theory. These different contributions and their relations are visualized in Figure 5.1.

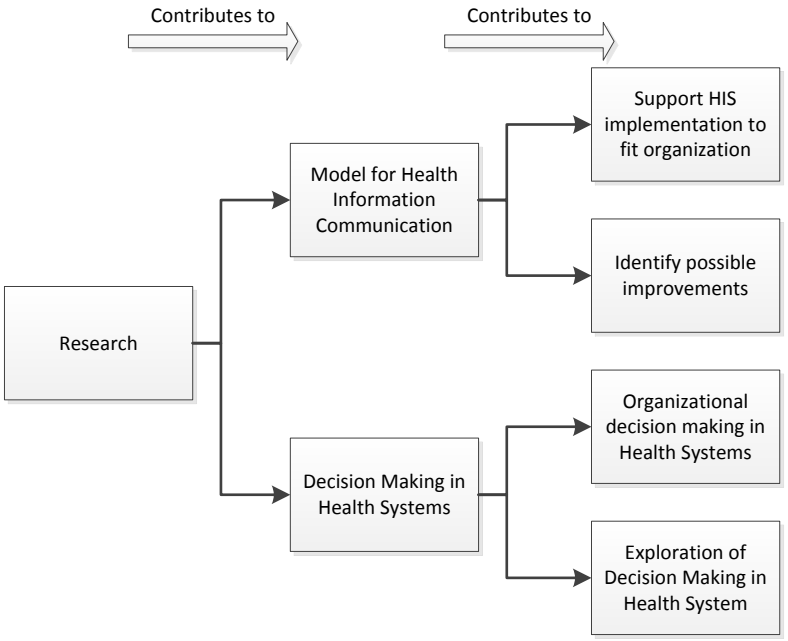

Figure 5.1 - Schematic overview of contributions

The most significant contribution of this research is the model for Health Information Communication in Malawi. This artefact is described in detail in the design proposition, mapped to the anatomy of design science. In this sense, this research fulfils its purpose, which is to deliver this artefact. This research proposition has multiple purposes, it gives an insight in the information communication in Malawi, it visualizes the information flow and it indicates the point of care origin as well as their decision-making information. This model is a

contribution to the Malawi Health System and can be used by the Ministry of Health. Furthermore, as described in the artefact mutability, this model can be adjusted to fit specific Health Systems.

This delineation contributes to HIS implementation in that it improves the fit of the implemented application. Understanding of managerial activity is a prerequisite for systems design and implementation (Gorry and Morton, 1971), this model provides this understanding. This is visualized in the exposition, in which a scenario is proposed for the implementation of a HIS to fit the system in place.

The insight in the Information Communication that supports decision-making leads to the identification of possible improvements to this system. The governing authority can use the proposed model to pinpoint flaws in the information communication and plan solutions to improve this, thereby adapting the model to an improved solution. This is illustrated in scenario 2 in the exposition.

This model leads to some key insights in Decision-making. Applying decision-making theories to the Health System leads to knowledge in the intersection of these two concepts. More specifically, this model successfully applies organizational decision-making theories to the Health System. The proposition applies the Gorry and Morton (1971) framework and confirms assumptions derived from this framework (Table 4.1). In this way the model fulfils a knowledge problem addressed by (Lippeveld et al., 2000, p.34): *"Little is known about how decisions are made at the various levels of the health system"*. We can see this contribution as twofold: firstly the research confirms the organizational decision-making as applicable on Health Systems, secondly, the research explores decision-making in Health Systems, creating insight in the way demand and supply of decision-making differ along the levels of a Health system (AbouZahr and Boerma, 2005).

5.2 Ensuring Research Quality

5.2.1 Reliability and Validity

All research is ultimately susceptible to a discussion of reliability and validity. In reliability, a couple of authors would argue that quantitative research is the only sure way to ensure reliability (Yin, 2003). Whenever a researcher desires to employ the design science research as a means of achieving a specific goal, a qualitative strategy also forms part and parcel of what it takes to ensure that a good iterative data inquiry is achieved (Gregor and Jones, 2007). In qualitative strategy, reliability indicates to what degree the research process has been systematic and transparent (Straub et al., 2004, Morse et al., 2002, Frankfort-Nachmias and Nachmias, 2007); it also entails how reliable is the data and to what extent the collected data can be seen. To elaborate slightly, by making the research process as such more accessible to outside viewers it is deemed more reliable which is in accordance with (Silverman, 2006).

Generally, the stated criteria to ensure rigour in research are validity, reliability, and generalizability. However, there seems to be variation with regard to the interpretation of those concepts, especially in the context of more qualitatively oriented work. It has been argued that concepts of validity, and reliability have their background in natural science research and are developed for qualitative methods, and that they are less appropriate and do not have the same point of origin in behavioural and design-oriented research, see for example Lincoln and Guba (1985), Seale (1999), Silverman (2006). Others such as (Lincoln and Guba, 1986, Krefting, 1991) argue that reliability is about trustworthiness of the data, which is achievable via structural and historical review of patterns of decisions, events and actions taken. Lincoln and Guba proposed the concept of trustworthiness as the beacon of quality in qualitative research. In other words, "How can an inquirer persuade his or her audience (including self) that the findings of an inquiry are worth paying attention to, worth taking account of?" (Lincoln and Guba, 1985, p.290). Trustworthiness is consolidated by a complete account of the criteria's *credibility, transferability, dependability, and conformability*. However, these criteria do not conflict with validity, dependability, reliability, transferability, and generalizability; instead, they are to a certain extent comparable with each other. Credibility is akin to internal validity, transferability is similar to external validity, dependability has similarities with reliability, and conformability has similarities with objectivity. Hence, there are quality measures that should be acceptable to both quantitative and qualitative proponents and the concept of trustworthiness.

Our data emerged from some activities: literature review, interviews and feedbacks from our experts. These activities are mapped to the criteria of trustworthiness.

Credibility is interpreted as social settings with multiple realities. The existence of multiple descriptions of one social reality is what assures trustworthiness (Lincoln and Guba, 1985). In our research, triangulation (cross-checking of data) has been applied to ensure credibility. From this context, prolonged engagement – lengthy and intensive contact with the phenomena enabled us to assess possible sources of distortion and especially to identify saliences in the situation during the literature review section, as well as the interactive sessions with our

experts. However, in the interview with our experts, triangulation was not feasible. Instead, a version of member check was applied, i.e., new or modified models were introduced iteratively thereby facilitating the development of the model to support decision-making in Malawi.

Regarding transferability, qualitative studies are mostly covered with a small set of informants and are known by depth and contextual dependencies rather than breadth and universal laws. This situation causes innate problems when transferring findings from one social setting to another (Lincoln and Guba, 1985). To mitigate this, researchers are admonished to furnish a means to judge the extent to which the findings are transferable into another context. As applicable to our research, we ensured that rich and appropriate description of our design propositions of the model is provided in chapter 4. Furthermore, the transferability of our artefact is described in the artefact mutability in Table 4.4.

Dependability concerns the possibilities to investigate trustworthiness through an auditing standpoint (Lincoln and Guba, 1985). This is achieved by presenting an exhaustive scenario of our iterations as well as the research approach. For example, this comprises: the rich response from our experts, important decision made at all stages of our model evaluation and modes for model analysis.

Concerning conformability, it is argued that there cannot be any defective objectivity when qualitative methods are applied. Instead, the inquirer has to convince the audience that he or she has acted in good way, which does not impede the investigative process of the research. It ought to be made evident that the researcher's bias has not thwarted the theoretical stance or the analysis (Lincoln and Guba, 1985). In order to increase conformability in our research, our experts are selected based on their connection with the Support Life project. We did not influence them to change the opinion that they had concerning the previous state of the existing model at the inception of our research work. In addition, there was no interference in the follow-up interview as well as feedback from our experts. These actions would go a long way in the reduction of any intending bias.

5.2.2 Ethics

One key consideration in our research is to ensure that those we relied on as regards having access to the Malawi Health Information systems data were in no way disadvantaged and pressured upon by agreeing to speak to us. Kvale and Brinkmann (2009) emphasize on the consideration of ethical implications at every stage of research. In this context, strict adherence to ethical standard in the course of the design science research will go a long way in enhancing the entire research work. From this perspective, Hevner and Chatterjee (2010), argue that a good ethical standard will be set in design science research if scientist could enrich people's understanding with regard to their actions with a focus on unintended consequences. Also, the design science research cannot be value-free but to express the basic values of research as explicitly as possible (Hevner and Chatterjee, 2010).

These norms and values are inherent in the observation of the four general requirements for research, which is the information requirement, the consent requirement, the confidentiality requirement, and the utilization requirement (Bryman, 2001). Taken altogether, these requirements are principally directed outwards at informants, while there are also ethical requirements aimed inwards to the researcher. To elaborate slightly, Bryman (2001) recommends researchers to ensure that research ethics are manageable and feasible in the sense that will not make the information to be sensitive and provocative. In our research, by informing those involved at an early stage about the purpose of our study, and the need to harness information presentation, we were poised to satisfy the information requirement as depicted in Bryman (2001). If the informants disagree, they can decline any participation in the study. In this context, we did not experience any scenario whereby our experts declined to speak with us in the context of the health information domain.

The consent requirement overlaps with the information requirement because participation is voluntary and no informants of low age were interviewed. In other words, we ensured that the informants who are seasoned and experienced were engaged in the course of the execution of our research. The confidentiality requirement is satisfied by only presenting information about informants with their consent. In those cases where the organization demands anonymity, the identities of the informants and organization are obfuscated. The utilization requirement implies that the information collected is used only in the specific investigation, and this is agreed upon with every informant. From our perspective, the research carried out in this research has not conflicted with the guidelines of research ethics, and our belief is that the requirements are fulfilled.

5.2.3 Bias

Bias is a difficult and inconspicuous element for any researcher to remove from their research as it can be particularly difficult to recognize bias in oneself (Ehrlinger et al., 2005, Pronin and Kugler, 2007). However, we have attempted to recognize this by acknowledging our potential fallibility (Norris, 1997) and taking some counter measures such as member validation during the evaluation stages of our model. Having this in place enabled us in limiting the potential biases (Seale, 1999). This is much evidenced by the identified facilities that we discovered in the diverse sections of decision structures in the Malawi HS that underpin the establishment of the significance of the assumptions we had made. Moreover, the sundry supervision and review process we had with our experts as well as our thesis supervisor indeed broadened our scope with regard to knowing some areas of our research where biases are very much pronounced and coming up with some concrete steps on how to avoid being biased. This lends credence to the critical examination and auditing of our work (Creswell, 2007, Seale, 1999) questioning our ideas and assumptions.

5.3 Limitations and future research

One can argue that this model could be optimized, however we share the opinion of Simon (1996), who argues that the design process is generally concerned with finding a satisfactory design, rather than an optimum design. Since both John O´Donoghue and Joseph Wu see this model as being complete, we see this model as being satisfactory.

As far as the data about HS in Malawi is being considered, some details were excluded due to the lack of complete information. This refers to the information about the private sector facilities and the remote rural areas in Malawi, which use their own communication channels different from the official one. According to our experts, those factors can be considered as minor. Therefore, we consciously excluded them from our model on this level of abstraction.

As could be seen, the proposed model displays a detailed description of the Information flow in Malawi, thus lacks generalizability over other countries. However, MoH outside Malawi can use this model as an example of a functioning HIS and they can customize it according to their own HS environment.

Finally, some gaps and ideas for the future research we identified with help of our experts are:

- Developing the model on the lower level of abstraction;
- Populating and projecting dashboards from the perspective of decision-making for the particular level in Malawi HS;
- As Supporting Life is a mobile application, testing the benefits of Mobile device artefacts from the perspective of 'timely' characteristic of information. Apart from increasing the quality and the speed innate in the information provisioning, does this directly improve the decision-making?

5.4 Conclusion

This study describes the development of a model that visualizes how information is used to support the decision-making at different levels in the Health System.

This research identified both knowledge and technology problem. Lack of the established model, which delineates the information flow in Malawi, is considered as a knowledge problem. On the other hand, we identified insufficient data quality and currency within the HS caused by inefficient paper based communication of data as the technology problem.

We meet the purpose of this research by providing the model which does not exist. The model describes the information communication within the system, starting from data collection, aggregating and delivering information to the facilities. Consequently, the decision-making at these facilities is supported by delivered information. Therefore, this model identifies how information flow is supporting decision-making and thereby answers our research question.

The development of this model is influenced by design science research and is supported by empirical evidence. The described design proposition is the most significant contribution of this research. This model for Health information Communication can be used to support HIS implementations. Our research confirms assumptions about relation between decisions characteristics and different organizational levels within the Health System. The proposed artefact is mutable, allowing this model to be adapted to different contexts. In this sense, the model provides an abstract overview which thus allows for more detail to be added.

Appendix 1 – Form 1 A

FORM 1A

VILLAGE CLINICS MONTHLY REPORT FORM FOR UNDER FIVES

Village clinic_____ **Month**_____ **Year**_____
GVH_____ **HSA name**_____ **Date of reporting**_____
TA_____ **Do you stay in the catchment area**_____
District_____ **Nearest Health facility**_____
Village clinic catchment population_____

CM Cases report summary																
Condition	**New cases**				**Referrals with danger signs**				**Referrals made bacause of Drug stockout**				**Deaths (within 7 days of receiving treatment at a village clinic)**			
	2-4 months	5 - 35 months	36-59 months	**TOTAL**	2-4 months	5 - 35 months	36-59 months	**TOTAL**	2-4 months	5 - 35 months	36-59 months	**TOTAL**	2-4 months	5 - 35 months	36-59 months	**TOTAL**
Malaria/Fever																
	2- 11 months		12- 59 months	**TOTAL**	2- 11 months		12- 59 months	**TOTAL**	2- 11 months		12- 59 months	**TOTAL**	2- 11 months		12- 59 months	**TOTAL**
Diarrhoea																
Fast Breathing																
Red eye																
Malnutrition (Red MUAC and Swelling of both feet)																
Palmar pallor																
Other conditions																
TOTAL																

New cases by gender	**males**		**females**	

Supplies management Table

Name of Drug/ Supply	Unit of Issue	(A)	(B)	(C)	(D)		(E)	(F)	(G)	(H)
		Quantity on Hand at the beginning of the month	Quantity Dispensed	Losses	Adjustment		Quantity received	New stock on Hand	number of days out of stock in the month	Did the Stock out last 7 continuous days or more (Y or N)
					(+)	(-)				
LA 6X1	Tablet									
LA 6X2	Tablet									
paracetamol	Tablets									
ORS	Sachet									
Zinc	Tablet									
Cotrimoxazole	Tablet									
Eye ointment	Tube									

How many times were you supervised in the month ☐ How many times were you mentored in the month ☐

Name of Approving officer_____ Signature_____

* Report should be sent to the DHO by 2nd of each month * To be completed in duplicate, copy for the village clinic and another to the health facility

Appendix 2 - Form 1 B

FORM 1B

VILLAGE CLINICS MONTHLY CONSOLIDATED REPORT - Health facility Level

Health Facility_____ **Month**_____ **Year**_____

District_____ **Total number of CCM HSAs staying in their catchment area**_____

Number of village clinics that have reported this months_____ **Total population in Hard to reach areas** _____

Total number of functional village clinics within the catchment area_____

CCM Cases report summary

Condition	New cases				Referrals with danger signs				Referrals made bacause of Drug stockout				Deaths (within 7 days of receiving treatment at a village clinic)			
	2-4 months	5 - 35 months	36-59 months	TOTAL	2-4 months	5 - 35 months	36-59 months	TOTAL	2-4 months	5 - 35 months	36-59 months	TOTAL	2-4 months	5 - 35 months	36-59 months	TOTAL
Malaria/Fever																
	2- 11 months		12- 59 months	TOTAL	2- 11 months		12- 59 months	TOTAL	2- 11 months		12- 59 months	TOTAL	2- 11 months		12- 59 months	TOTAL
Diarrhoea																
Fast Breathing																
Red eye																
Malnutrition (Red MUAC and Swelling of both feet)																
Palmar pallor																
Other conditions																
TOTAL																

New cases by gender	males		females	

Supervision schedule for the month

n HSAs with Village clinics		n village clinics planned visits		n village clinic visits done		n Hsas supervised in CCM		n HSAs who had their skills reinforced by case observation, case scenarios during supervision	

Supervision summary

Theme	Case management	Decision-Treatment Consistency	Reporting completion & quality	Logistics	Availability of drugs	Availability of supplies	Community involvement	Water and sanitation
HSAs who got correct scores on the following per checklist								

Supplies management Table

Name of Drug/ Supply	Unit of Issue	(A)	(B)	(C)	(D)		(E)	(F)	(G)	(H)	(I)
		Quantity on Hand at the beginning of the month	Quantity Dispensed	Losses	Adjustment		Quantity received	New stock on Hand	number of HSAs reporting any stockout	number of HSAs reporting a stockout lasting for 7 continuous days or more	number of HSA days stockout
					(+)	(-)					
LA 6X1	Tablet										
LA 6X2	Tablet										
Paracetamol	Tablets										
ORS	Sachet										
Zinc	Tablet										
Cotrimoxazole	Tablet										
Eye ointment	Tube										

Number of HSAs reported to have been supervised in the month ☐ Number of HSAs reported to have been mentored in the month ☐

Name of village clinics not reported

Name of Approving officer_____ Signature_____

* Report should be sent to the DHO by 5th of each month

* To be completed in duplicate, copy for the health facility and another copy should be sent to DHO

Appendix 3 - Form 1 C

FORM 1C

VILLAGE CLINICS MONTHLY CONSOLIDATED REPORT - District Level

District_____ Mzimba North **Month_____** **Year_____**

Number of village clinics that have reported this month_____ **Total number of CCM HSAs staying in their catchment area_____**

Total number of functional village clinics in the district_____ **Total population in Hard to reach areas _____**

CCM Cases report summary																
Condition	**New cases**				**Referrals with danger signs**				**Referrals made bacause of Drug stockout**				**Deaths (within 7 days of receiving treatment**			
	2-4 months	5 - 35 months	36-59 months	**TOTAL**	2-4 months	5 - 35 months	36-59 months	**TOTAL**	2-4 months	5 - 35 months	36-59 months	**TOTAL**	2-4 months	5 - 35 months	36-59 months	**TOTAL**
Malaria/Fever																
	2- 11 months		12- 59 months	**TOTAL**	2- 11 months		12- 59 months	**TOTAL**	2- 11 months		12- 59 months	**TOTAL**	2- 11 months		12- 59 months	**TOTAL**
Diarrhoea																
Fast Breathing																
Red eye																
Malnutrition (MUAC and Swelling of both feet)																
Palmar pallor																
Other conditions																
TOTAL																

New cases by gender	**males**		**females**	

Supervision schedule for the month									
n HSAs with Village clinics		**n planned visits**		**n visits done**		**n Hsas supervised in CCM**		**n HSAs who had their skills reinforced by case observation, case scenarios during supervision**	

Supervision summary

Theme	Case management	Decision-Treatment Consistency	Reporting completion & quality	Logistics	Availability of drugs	Availability of supplies	Community involvement	Water and sanitation
HSAs who got correct scores on the following per checklist								

Supplies management Table

Name of Drug/ Supply	Unit of Issue	(A)	(B)	(C)	(D)		(E)	(F)	(G)	(H)	(I)
		Quantity on Hand at the beginning of the month	Quantity Dispensed	Losses	Adjustment		Quantity received	New stock on Hand	number of HSAs reporting any stockout	number of HSAs reporting a stockout lasting for 7 continuous days or more	number of HSA days stockout
					(+)	(-)					
LA 6X1	Tablet										
LA 6X2	Tablet										
paracetamol	Tablets										
ORS	Sachet										
Zinc	Tablet										
Cotrimoxazole	Tablet										
Eye ointment	Tube										

Number of HSAs reported to have been supervised in the month ____ Number of HSAs reported to have been mentored in the month ____

Number of village clinics not reported

Signature_____

Name of Approving officer_____

* Report should be sent to the DHO by 10th of each month

* To be completed in duplicate, copy for the health facility and another copy should be sent to DHO

Appendix 4 – Proposed questions to Joseph

General Question: Does above model accurately represent the Malawi Health Care System?

Structure

Q1: Are the identified levels representing the current health system in Malawi?

Q2: We identified key facilities in the information flow. Are there any key facilities which we did not mention? (For example, should we consider Mental Hospitals and General Hospitals?)

Q3: Who governs HSA´s (e.g. MoH only)?

Q4: The HSA communicates their IMCI data to the Health Centre by using 1a, 1b & 1c forms. The information flow diagram shows us that HSA communicated information from Community workers like Village Health Committees, Traditional Birth Attendant, and Community Based Distribution Agent?

Q5: The institutions that own the facilities are shown vertically, are these representing the key owners?

Information flow

Q6: The Health Information Systems Assessment Report, 2009 shows that the community level data communication is paper based and district level is computerized, is this correct?

Q7: How is the communication between different instances established, e.g. between local government and Ministry of Health or CHAM and Ministry of Health?

Decisions

We want to go more in detail in the decisions made and supported by the HSA's, Health Centres and Community hospitals.

Q8: Within these facilities, who has ownership of clinical and managerial data? With ownership we mean: the person/department responsible for data-collection, analysis and quality.

Q9: For which class of decisions is each of these three facilities responsible? (E.g. the Health Centre can make decisions to manage underlying communities)

Q10: What is done with the data collected at HSA, Health Centre, Community Hospital and District Hospital?

Appendix 5 – Transcription of first model evaluation

Date: 8th of May 2014

Time: 11:30-12:30 CET

Interviewers: Jerrold Stolk [S], Sonja Erdevicki [E]

Interviewee: Joseph Wu [W]

[Introduction of interviewers]

[S] Can you tell us about yourself, because we know just a little bit about you?

[W] OK, I am Joseph Wu, the country representative for Luke International and we are an organization based in Malawi. And I am also lecturer at Mzuzu University. My specialism is Epidemiology and Health Management.

[S] Luke International, what kind of organization is that, is it an Aid organization

[W] Not really an aid organization but we are doing implementations, projects in the field, so basically three main working area's in Malawi. One is for Health Information System Strengthening. Following the WHO guideline we are assisting the Malawi Government and the health facility to strengthen their Health System. So that is from community level up to the national decision-making level. And second area is about capacity building, so that is why we support the research project and also conduct some research project with the Mzuzu University and some Academic institute from Taiwan. The third working area is community based organization. Mainly to support the CBO's in relation to the HIV, either the victims or the people that are vulnerable; those are affected due to the HIV epidemic.

[E] Are you part of supporting life directly, or acting as a connection from Malawi, what is your position in the Supporting Life Project?

[W] In supporting Life project our organization is basically assisting in different working packages, which includes assisting for the RCT (randomized controlled trial) and also feasibility study, and field observer to collect the data. We mainly work close to community health care workers (HSAs) and we also assist project partners to come with the initial help and other stake holders in Malawi.

[Introduction of model]

[S] Regarding the model we proposed can you give us a feedback. Visualizations of Malawi health systems and how the information is flowing through the system and which decisions are made on each level. This model is based on the literature and information about Malawi health system.

[S] Can you tell us if this model gives a good picture of Malawi Health System?

[W] Regarding the model I have a few questions. First of all, the Community health care worker and HSA are at the same level. It is like the primary service provider for Supporting Life project for community childhood management. HSAs work in the community and they are community workers. HSAs are the one on the ground, they provide service and they generate the information and send it to Health centre, which is correct here.

[S] The reason we came up with that is that we saw communication that went through HSA towards the Health Centre.

[W] Eventually, the HAS works in the community as community workers. They send the information. Regarding the Community hospital, what are you referring it to? In Malawi we don't have a term Community hospital. Are you referring to the rural hospital?

[E] It is rural hospital; it is from a study, from Figure 2. We can call it rural hospital if that is the most common name. Is that a common name, rural hospital?

[W] Yes, the rural hospital term exists in Malawi. So, the hierarchy is from HSA. Also when HSA works in a community there is a term Village clinic. It is indicated as Village Health Centre. It is visualized in your figure, we don't have TBA now. The figure is from 2005, that category has been moved. The HSA they work in village clinic, next the patient will be refer to Health centre and then from there to the Rural hospital. After that the patient will be refer to District hospital which is correct here. From District to central Hospital which then if there is a problem they can be refer to other country hospital. Usually this other country is in South Africa or other country with they have medical agreement, for example India, they have agreement for the patient to be refer there for some treatments.

[W] Regarding your references, are you aware with the WHO guidelines which were generated from the Health Metric Network (HMN)?

[S] No

You need to Google that, The Malawi Ministry of health, when they were designing the Health System, basically they are following the WHO guideline which is similar to the HMN. The Guideline which was first drafted in the year 2007, in that guideline you will be able to find architecture. Which will address the data and information flow, I think it will be useful for you to review this guideline.

[W] Regarding Figure 1, The Ministry of Health, Local government, totally follow Ministry of Health, and CHAM, they follow the same system. There is no local government in Malawi system. I am not quite sure why you have this?

[S] That has to do with the governance of the facility, there are different governances and we assumed they influenced the information flow.

[W] As in Malawi the Health system is public, the highest guideline, as long as they got support from the government, they follow the initial health structure. There is no difference between the structures. The CHAM facility provide health centre, some of them are rural hospital some of them are district hospital level but they don't have central hospital. They follow the similar structure so there is no need to separate them in the model. The information, in term of patience data, the flow, follows the same track.

[W] I need one clarification- Are you following the patient level data for clinical care or the aggregated level data for management?

[S] We are looking at the information used for decision-making, for example in the 1a, 1b and 1c form, they receive aggregated data.

[W]When we are looking at the whole data flow, at certain stage, the patient level data will be aggregated into the numbers. Basically, if we use the Supporting Life as the example, the data is collected at HSA (village clinic) level, they will aggregate the data and start quote the data as a report as an information.

They will aggregate all the data and come up with the more comprehensive numbers. Then on the higher level, we try to break it down, do grouping, categorize the data and use it for make the decision.

[S] This is what we want to know, the information that they aggregate for decision-making.

[W] Do you want to know how the current system how is it working and how is it running?

[S] Yes, that would be the best, we got the 1a, 1b, 1c forms and we would like to understand how they are working.

[W] 1 a, 1b and 1c these are HMIS (Health Management Information System) reports. In the ministry of Health the highest authority to organize and manage this kind of data is Centre for monitoring and evaluation division (CMED), which is under the Department for planning which is under the Ministry of health. CMED is managing the whole Health management information system. Those three forms are just some out of the, I forgot the number, 130-140 forms. In Malawi those forms at the community level, at the moment, most of them, they will be filled on the paper. This paper form will be sent to the data model, the information flow model, and it will go up to the district level which is supposed to be become digitalized (DHIS2). And for that gap,

between the districts and the Ministry of health will disappear, as the Ministry of Health has Central data base managing all this data.

[W] The central data base in on level on Ministry of Health. It is only one data base, it is web base system. As long as there is connectivity the data will be sent and submit to the central data base. Eventually, the district level data won't be sent to the central hospital won't send the aggregated data. Only the patient level data, maybe like demographic data or the condition of the patient will be sent to the central hospital.

[W] For Aggregated level data, there will be no bridge in between the district and ministry of health headquarters. District hospitals submit the data and the data will go just straight to Ministry of health. The central hospitals also will generate their own report and submit it to ministry of health.

[S] Thank you, we can go through the questions. The first question, are the identified levels representing the health system in Malawi?

[W] I think this question has been covered.

[S] Can you please validate the identified: primary, secondary and tertiary levels?

[W] Primary, secondary and tertiary level is a good categorization. Additionally, you should consider adding to the model facility Private facilities. You won't be able to find in your references as the government do not have idea about Private sector until recently. The number of those facilities is low. They do not report and they are not the part of the information flow, and the ministry of health wants to fix this.

[S] A question for the primary and secondary level, is the rural hospital a bridge between these levels?

The Community in the model should be changed into rural hospital. The rural hospital is part of the secondary Level. The primary level is only the health centre and below.

[S] Who governs the HSA?

[W] Ministry of health governs everything.

[S] There are different community workers like Village Health Clinics, TBA. They communicate information through HAS's, is that correct?

[W] It is not quite correct. VHC or CBDA report vertically, they don't need to report to HSA. The information goes directly to DHO, District Health office. The hospital will not govern the health data, but District Health office will. All the data goes from the facility directly to the DHO. DHO is the district hospital director. One person is assigned two functions at a time.

[S] Are the 1a, 1b and 1c directly reported to DHO?

[W] 1a form data goes to health centre, Health centre will compose to generate 1 b form 1 a. The DHOs are collected various 1b from various village clinics and generate 1c. Finally, they submit 1c to Ministry of health. 1b and 1c directly are input to DHIS2, not 1 a will stay at the health facility. 1b is transformed to 1c and 1a to 1 b. 1c form is more or less automatically generated.

[S] So 1a forms input from 1b, 1c is built up from 1b?

[W] Yes

[S] Why is there a 1c form, since the data is already in the system?

[W] The 1c is automatically generated.

[S Q: 5] The institutions that own the facilities are shown vertically, are these representing the key owners?

[W] You should not consider other owner that Ministry of Health as they all follow the same structure.

[S Q: 6] The Health Information Systems Assessment Report, 2009 shows that the community level data communication is paper based and district level is computerized, is this correct?

[W] Correct

[S] How is the communication between different instances established, e.g. between local government and Ministry of Health or CHAM and Ministry of Health?

[W] In each DHO the CMED will assign the personnel, HMIS the officer, who is the one who organize and collect the data from the various facilities within the districts; he is the 'contact window' who shares and exchanges the information. They do not have anything with decision-making as some of them they don't have the capacity of understanding about the data.
HMIS officer collect more data than IMCI, they collect the information from the different sources, for example about vaccination, mortality, disease surveillance, from different forms.
At the community level they don't serve only the patients but they serving for the health people. That is why it will be more information than within the hospital. That information is on the different forms, they are not included on 1a or 1b.
There is no time defined for sending them. It depends on the different programs, projects. Thus they send them according to different programs and time frames.

[S Q: 9] WE can skip question 7 and 8 since we discuss them. For which class of decisions is each of these three facilities responsible? (E.g. the Health Centre can make decisions to manage underlying communities)

[W] I cannot help with this question. You need to define more clearly the decisions. Decisions have to be categorized, Are you talking about the human resource decisions, drugs, pharmacy. The decisions are various and you need to be more specified. Once you categorize them I can try to find out about them.

[E] What kind of decisions can be made based on data from Supporting Life?

[W] Regarding the community, from IMCI, they will follow the guideline, when they should order the drugs, when the kid would be referred to the hospital. But regarding the human resource, for example, they obviously, they cannot make any decision.

[S] Can you say something about the decisions on the Health Centre level?

[W] About patient care whether or not the patient is referral or about relocation supplies, some village clinic have more drugs or more kids hospitalized so they can decide about the transfer of the resource to other clinic. They can relocate the resource according to the needs and capacity.

[S] The district hospital, what decisions are they making?

[W] They can decide the mobilizations of different resource but not human resources, decisions about budgeting but only for the district.

[S] Ministry of Health, what decisions are they making

[W] They are managing entire country; they make decision on strategy, on direction, hierarchy, architecture, overall budgeting, and human resource. They come up with the Health Sector strategic plan, HSSP, they make decisions how and where they are going to put the resource into the specific projects (NGOs, aids projects and so forth).

[S] So the DHO Operates in the boundaries set by the WHO?

[W] Yes

[S] Does the MOH make use of external information; do they run programs to collect data at community level?

[W] Yes

[Closing of interview]

Appendix 6 – Transcription of second model evaluation

Date: 12th of May 2014

Time: 2:00-2:30 CET

Interviewers: Jerrold Stolk [S], Sonja Erdevicki [E]

Interviewee: John O'Donoghue [D]

[D] I am not sure about this figure of 130-140 of forms that you mentioned in you text, where did you get this information?

[E] Joseph Wu told us about it during the call. He was not sure about the exact number but it is around 130 and 140 forms across all the five levels.

[D] This is very interested information, I was not aware of it before. So forms 1a, 1 b and 1 c are just 3 forms out of those 130-140 existing forms?

[S] Yes. This number of forms makes it hard to structure everything as they go through different flows

[D] That is true, a really good point. This is really good to know that. In your figure, the diagram, with the information flow. Is there no Health information system at the Rural hospital, is it all paper based?

[S] Yes it is paper based until the District health office. Interesting point here, as you can see, is that DHIS2 has the central point in the system. The DHO inserts all the aggregated data in forms they get directly to the DHIS system. In the first model proposition we put communication between district hospital, central hospital and ministry headquarters, which was wrong. Now we see that all the information goes through DHIS.

[D] Are you going to use 1a, 1b and 1 c as you main examples in you Master Thesis or are you going to use other forms?

[E] We are going to use these three.

[D] Going through the text and diagram, I suppose it is not clear, who are the data from those forms feeding through, are those forms start from the village clinic are they more on the way up? What is the difference between 1a, 1b and 1c in relation to the overall diagram?

[S] Those forms are just the examples of different forms are used. As we see in the structure, 1a finish in the health centre, 1b from Health Centre to Health Office. There are forms that go from Village clinic directly to DHO. So, this model shows information flow in general and not a specific for 1 a, 1 b, 1 c flow.

[D] Maybe to give you a suggestion, of course you do not have to act up it- take all the arrow between the facilities and maybe you can label all of them and in the text then you talk about the forms 1a, 1b and 1c, you can refer to labels, for example label 1, or label 2 within Figure 1

[S] Good suggestion. Do you think this model is correct? You think you can the information that you need form this model?

[D] From those meetings I had with Ministry of Health in their headquarters, with district health officer, with Joseph, everything you presented in this diagram is quite what they said. I see that your model is good and you probably have a good reflection about what is happening on the ground. It is operating on the high level. I think the diagram is abstract enough.

In the reality if you go to south Malawi in some district they might use some other communication channel, which is always to be the case anyway. I think you have a really good model. It looks really realistic for me, although I won't be in a position to correct it or not but from the thing I see it looks quite good to me.

[S] This is still not the final version. We are working on the 3rd version which includes the decision-making where it takes place. In the left side of the diagram you see HIS which communicate the information. They communicate back to the Health point of care and the Health point of care they make decision. We identified some decision-making with help of Joseph. Form theoretical point of view we want to combine that decision-making information to the organizational decision-making. On the lowest level are structured decisions, higher levels have unstructured decisions and so forth. And we will present to Joseph to confirm it.

[D] Yes I think Joseph can help you. As we were discussing previously, as part of your Thesis, you might be able to populate Dashboards and project the Dashboard from the perspective of decision-making for the specific level. Are you still considering Dashboard or you focusing on organizational Decision-making?

[E] We are now focusing on the organizational decision-making and in that case we should focus on one level and present the Dashboard. For our thesis due to the time limit, we will not be able to do that part. Being realistic with our time we will focus only on Organizational Decision-making for this time- identifying the information flow and decisions for each level. Moreover, we want to propose how the model will be used for the case of Supporting Life. To describe the project and to use the information we got from specification and that also work in progress.

[D] From the perspective of Supporting Life it will be interesting the data which is being collected from the village clinic.

I don't know if it is realistic or not, but can you identify the data sets within the Supporting Life that would be of interests for each of those levels?

[E] This is exactly what we were talking about. But also the forms 1a, 1b and 1c they are the forms based on Supporting Life data?

[D] Yes, exactly. The data is pretty much the same.

[S] That can be a part of evaluation to the model. If we now the decision to be made, we can also link it to the data set.

[D] Actually you use the forms and in relation to the Supporting life project makes a lots sense.

Also it will be interesting the benefits of Mobile device artefacts, also time can improve the quality of data as well. Does that really improve the decision-making apart of giving the information more quickly?

[S] We identified that the information flow of 1a, 1b and 1c is all paper based, and indeed it takes a lot of time to circulate them (once a month)

[D] I think there are load of opportunities with this research.

[S] We are all very interested on this project but it was very tough to focus on one thing.

[D] Yes I can imagine. Just wondering, did Joseph suggest any contact point in Ministry of Health or he will provide the information himself?

[S] Not yet. As of now, he is the only contact point in this moment form Malawi. Also, we arrange the second call with him and it would be nice if you can join the call.

[D] Sure. Please let me know about the time. Once you have this model confirmed, if Joseph says the model is realistic what are you further plans for research revise?

[S] If the model is correct, we will test it with the Supporting Life application, we will finish out master thesis document and we will send a version to you before the pre-seminar.

[D] How many pages do you have so far?

[S] Around sixty, we plan to have around 80

[E] What is your opinion, you overall impression about our model? Is this what you were expecting from us?

[D] This is fantastic. I think it is great. The document I sent you show the different across 3 different African countries, and what you are doing now, is one for Malawi. And If Joseph confirms that this is correct, this will be the first time we have kind of high level, an abstract what the different levels are within Malawi. And this will make your work going forward if we want to develop more application in the future.

I am very interested to see how are you going to map the Supporting Life application , it is not going to touch only the village clinic it is going to touch but everything, all the ways up. It will be very interesting how Supporting Life it can integrate with DHIS2, how it can physically integrate DHO, with their existing IT system and so on. When you have the names of the systems and what kind of interfaces they have, then that will be very interesting. And if we talk together with Joseph on Wednesday it will be great.

[S] Yes, great. The call with Joseph is already scheduled

[Closing of interview]

Appendix 7 – Questions for third evaluation

1. Are the Information handling and Point of care workers separate in the village clinics and health centres? Are they the same persons or are those roles separated?
2. What is the Rural hospital role in the Information flow? To whom do they send the aggregated data and what kind of reports do they send?
3. Does the HMIS governs the data and send it to the central data base or to CMED?
4. Does CMED only govern the data from database, or do they generate the particular reports when the Ministry of health needs it? Can you please explain their role in more details?
5. Can you give an example of decisions made at central hospital, are these strategic plans or are these decisions to follow up the plans made by WHO?
6. Can you give an example of decisions made at rural hospital, how do these decisions differ from the health centre and district hospital?
7. Can you give an example of an interface of DHIS, visualizing the way data is entered in this

Appendix 8 – Transcript of third model evaluation

Date: 15th of May 2014

Time: 11:00-11:30 CET

Interviewers: Jerrold Stolk [S], Sonja Erdevicki [E]

Interviewee: Joseph Wu [W]

[Opening of interview]

[S] For today we would like to discuss the new model that we developed, based on your comments and based on some comments from John as well. You received the document right?

[W] Yes, the one you sent yesterday

[S] This is right, some questions together with that one as well, which we would like to discuss. First let us go through the document, and then through the questions. Let's go through the model, what we did, we saw a separation between the levels of Health System what you said. How the patient is going up the flow, which is the point of care. We combined this with the Health Information System, which operates sometimes at the same level, but follows a complete different flow then the patient would go. That is why we separated the two. And we also added from theory off, decision-making, which we saw some similarities between what you see in an organization, the difference between structured decisions and unstructured decisions based on internal sources and external sources.

[S] That is what we added, in the tables below we give an example of the flow and also describes the health system levels and what decisions they make. Is that clear to you?

[W] Yes, it is very clear, compared to the previous one.

[E] Can you give your general impression about this?

[W] The only question I want to understand more is about the flow 2, information flow 2. There is some information directly going to the DHO. So for my understanding, I am not really sure if they transfer the information straight to the DHO. How did you get to this understanding of information flow 2?

[S] We interpreted, what you said about surveys, that they go from village clinic directly to DHO. Is that correct?

[W] Yes, yes, I think in this one, we can probably do some verification with the village clinic and the DHO. For this information flow 2, we might be able to get clarification from the village clinic as well as from the DHO.

[S] That would be great

[W] Would you mind that I share this document with the ministry of health? For them to give some input about the model.

[E] Definitely, that would be helpful to get some feedback from them.

[W] If it that is possible, I will share the document with the head of information department, he might give some input.

[S] That would be very great. Do you want us to forward it to you in a certain format?

[W] Just the figure

[S] So is there information flowing from the Village Clinic up to the Ministry of Health as well, a fourth flow?

[W] No, all the data from the village clinic, will stop at the DHO. The DHO, there is where the information will stop.

[S] That's clear

[W] That's clear

[S] WE had the general impression, maybe now we can continue with the questions. Starting at question 1, as you can see in the lower section of the model, we separated village clinic and health care information workers from the point of care workers. Are they really different persons or is it the same person just sending through forms?

[W] They are different persons

[S] OK, that was to make sure that we separate them correctly. OK we did not find much information about the rural hospital and their part in the information flow can you maybe explain a bit about that?

[W] Well, for rural hospital it's like a larger scale of health centre, in terms of the size. In the health centre they will only provide a patient clinic. But in rural hospital they may have some limited service provided like for in patient like Wad, usually that is for the maternal health.

[S] But they are a contact point for the clinic as well?

[W] Yeah, they will also get in contact with the village clinic.

[S] So they are at the same level as the health centre?

[W] Yes, more or less like that, but they provide more services, but fewer then District Hospital.

[E] Are they supposed to be also on the left side of our model, are they communicating to District?

[W] They are more or less similar to the Health Centre; they provide similar information to the DHO.

[E] That makes sense, thank you

[S] that is clear for us, then we have a question about the HMIS worker that is working at the District Health Office, is he sending the data to the central database or the CMED?

[W] CMED is like the department, the authority handling the central database. So if we look at the central databases, that physical thing will be located in CMED, they will handle the central data.

[S] If we look at entering data, is that done by DHO or by CMED?

[W] The District Health Office, CMED they govern he data, they only collect data and analyze that.

[E] CMED is the one that will be in charge for making dashboards? For MOH

[W] Exactly, they are the one feeding the information to the Management team.

[S] So the MoH is not using the DHIS directly but is requesting the reports from CMED, they are using the DHIS?

[W] Yes and most of them they are statisticians, so they have to analyze the data as well.

[S] OK, and is that also for the District Hospital and central hospital, if they want to make a decision they want to have a report they ask to CMED and CMED will create it?

[W] Usually they have to ask data from CMED, eventually they should just go to the HMIS officer who is located in the DHO, but usually those people they will ask data from CMED, rather than those people who sit in the DHO and analyze the data. It is about the capacity, only the people who are able to provide a service are in the central level.

[S] So what you say is that the HMIS officer is requesting data from CMED, or is this done in the District Hospital itself?

[W] They request not data, they request information. They will collect data from the field, from the community and from the hospitals. Then they feed the data to DHIS2 and the person in the CMED, they will analyze the data and generate information, and then they separate it. They feed back the information to the DHO level and also to the management team.

[S] So the CMED only communicates to district level, which is the lowest level. They do not feed reports to the health centre level?

[W] No they don't

[S] So the only way a Health Centre gets informed is by the information they receive themselves, the information they receive from the village clinic?

[W] Yes

[E] Who is in charge for maintaining the data, like to organize the data in the database in when there is a problem, like overlapping data? That is about the data integrity, about which level are you talking? Supposedly that is to be done at each level, not for the village clinic, but the health centre and DHO, they should do some data quality assurance. That is what they are supposed to do, but in the real world, so far, not performs very well. So what we can observe from the whole system is that the data quality is not so good.

[E] OK, So the integrity is not very high.

[S] We will note that. So we have some question, first question 7, do you have an example of DHIS? The way the DHO is entering data in DHIS2, maybe screenshots or a description or a document?

[W] Maybe you can try to Google the HISP Malawi. I think within the website there is some demonstration page. The better way would be that when you send me the data model, you also send me the needs. We don't have the authority to just give out the government system screenshots or data.

[S] It is clear; we will ask that as well. WE have some questions, also about decision-making. Because our theory for the model also focuses on decision-making and as you can see in table 2 we made some example of decisions just for the reader to get some impressions of what kind of decisions are made at each level. The central hospital and rural hospital are empty. Could you maybe give an example of the kind of authority they have and the kind of decisions they make?

[W] For central hospital, the decision they have to make is only within the hospital itself.

[S] Ok, so they don't have a managing role.

[W] No, no, what they have to do is managing that central hospital.

[S] So they are not really requesting information from CMED then as well?

[W] No, no

[E] Do they make decisions about resource mobilization or transferring the resources, do they make decisions about that as well?

[W] Within the central hospital, that is including the mobilization.

[S] OK

[W] For a certain department, how much budget should a hospital director allocate?

[S] The same question for rural hospital. As it is the same level as health centre, do they make the same decisions then?

[W] Yes, exactly.

[S] Maybe we can combine them, in our case they don't differ that much in decision-making.

[W] Yes, but probably in the section of definition of health facilities you can differentiate them. You can combine them, but you need to clarify them when you describe their role.

[E] Sure, because they have obviously different roles.

[S] So what we actually can see is that the district hospital, they had a governance act, they have a lot of responsibilities, they use the management information to manage the whole district. So they use the CMED information for that?

[W] Yes correct.

[S] And then the central hospital has a less role, they manage only their own hospital, and the ministry of health manages the whole system.

[W] Yes, correct.

[S] So the key decision makers are the ministry of Health and the District Hospitals?

[W] Yes, very clear, you have a very clear concept.

[S] Yes it is getting clearer for us yes. Maybe we can update the model a bit and then send it to you, so you can forward it to the Ministry of Health.

[W] Yes, no problem

[Closing of interview]

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