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ON ADOPTION AND USE OF HOSPITAL INFORMATION SYSTEMS IN DEVELOPING COUNTRIES
Experiences of Health Care Personnel and Hospital Management in Tanzania

ABSTRACT

The use of health IT has become prevalent in hospitals across the world. Hospital information
system (HIS) is the backbone of a modern hospital. It generally consists of several integrated
modules covering distinct parts of administrative and clinical functions of a hospital, including
inpatient and outpatient operations, human resources, electronic medical records (EMR),
information on imaging, laboratory, and pharmacy. HIS can improve the operational
performance of a hospital, and ultimately lead to better patient experience, improved health
outcomes, and increased revenue for the hospital.

Developing countries have special challenges in adopting and using these systems, including
low computer skills of personnel, substandard ICT infrastructure, and widely prevalent paper-
based systems across hospitals. The government of Tanzania has recently implemented a
national eHealth strategy to support the adoption of health IT. As a result, local health care
facilities have started adopting hospital information systems, and decision-makers at hospitals
need guidance on how to select an appropriate HIS.

As user experience is an important aspect of health IT affecting the adoption and use of these
systems, we studied the perceptions of health care personnel and hospital management in
regard to three hospital information systems, AfyaPro, Care2X, and GoTHoMIS, used in
Tanzanian hospitals. The thesis consists of the qualitative user study and literature review of
HIS adoption and use in developing countries. The thesis has been done in collaboration with
Capacity Building of Tanzanian Health Information System project*,* a multi-stakeholder initiative
consisting of partners in Finland and Tanzania. The project aims to build eHealth competencies
in Tanzania.

The study found out that hospital information systems provide a myriad of quantifiable benefits
to both hospitals and patients, but they still pose many challenges to the users. Automation,
reduction in manual work, and tracking various hospital metrics were perceived as major
benefits of HIS. However, hospital personnel's lack of ICT skills, frequent power cuts, lack of
necessary HIS integrations, and usability issues were perceived as challenges in HIS use. The
main rationale for this thesis was to explore the user perceptions of HISs and to inform
decision-makers in Tanzanian hospitals for selecting an appropriate hospital information system
and guide HIS developers in creating better systems.

Keywords and terms: eHealth, health informatics, user experience, hospital information system,
developing countries, Tanzania

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ACRONYMS

APHFTA	Association of Private Health Facilities in Tanzania
CBTHI	Capacity Building for Tanzanian Health Information System
CSSC	Christian Social Services Commission
eHealth	Electronic Health
EMR	Electronic Medical Record
FCMS	Finnish Christian Medical Society
GDP	Gross Domestic Product
HIS	Hospital Information System
ICT	Information and Communication Technologies
IS	Information System
IT	Information Technology
MOHSW	Ministry of Health and Social Welfare
MTUHA	Mfumo wa Takwimu wa Uendeshaji wa Huduma za Afya (Health Management Information System in Kiswahili language)
MoHCDGEC	Ministry of Health, Community Development, Gender, Elderly and Children
NHIS	National Health Information System
UHC	Universal Health Coverage
UN	United Nations
UX	User Experience
WHO	World Health Organization

DEFINITIONS

eHealth: "The cost-effective and secure use of information and communications technologies (ICT) in support of health and health-related fields, including health-care services, health surveillance, health literature, and health education, knowledge and research." (WHO, 2005)

Health Information Technology: "The application of information processing involving both computer hardware and software that deals with the storage, retrieval, sharing, and use of health care information, *health data*, and knowledge for communication and decision making." (Thompson & Brailer, 2004)

Health Informatics: "Interdisciplinary study of the design, development, adoption, and application of IT-based innovations in healthcare services delivery, management, and planning." (HIMMS, 2014)

User Experience: The ISO standard 9241-210:2019(en) regarding the ergonomics of human-system interaction defines user experience as "user's perceptions and responses that result from the use and/or anticipated use of a system, product or service." (ISO, 2019)

1. Introduction

1.1. The rise of health information technology

The use of electronic health (eHealth) applications is growing rapidly around the world. Individuals and organizations alike are benefiting from the rise of health information technology. Health IT has a pivotal role in modern health care allowing patients and care providers access and exchange accurate and timely health data, improving patient engagement and safety, and facilitating better overall care (Buntin, Burke, Hoaglin, & Blumenthal, 2011).

Hospitals are at the forefront of providing care in the community. System inefficiencies in hospital administration can lead to substandard patient experience, or even poorer health outcomes. Health care facilities are getting their share of health IT solutions: hospital information system (HIS) consists of integrated modules covering distinct parts of administrative and clinical functions of a hospital that include, but are not limited to, inpatient and outpatient operations, human resources, electronic medical records (EMR), information on imaging, laboratory, and pharmacy. While providing multiple benefits to patients, hospitals themselves gain by improving their operations, management, and decision-making processes, saving money and resources along the way. HIS can be said to be the backbone of a modern hospital.

An estimated 1.5 billion people in Asia and Africa are taking advantage of eHealth solutions (Kanani, 2016). Tanzania, with its population of over 56 million, is no stranger to the global phenomenon of health care transformation. Mobile health solutions are quickly becoming a part of everyday life of Tanzanians, and many of the country's hospitals have started adopting hospital information systems to manage the daily flow of clinical and administrative information while responding to the country's multiple public health challenges more efficiently.

However, the current health IT landscape of Tanzania is fragmented at most. Variety of HISs developed by a multitude of IT vendors are being adopted and used in silos by health care facilities (Tanzania National eHealth Strategy 2012-2018, 2013). The HIS components vary between different systems and standard formats for e.g. EMR are non-existent. This makes it more challenging for the hospital management to understand the differences between HIS products and select the most suitable one. Ministry of Health in Tanzania has published its vision of a national health information system that would integrate all hospital information systems in the country to relevant external systems via Health Information Mediation gateway, as seen in Figure 1, but there is still a long way ahead to reach this grand goal.
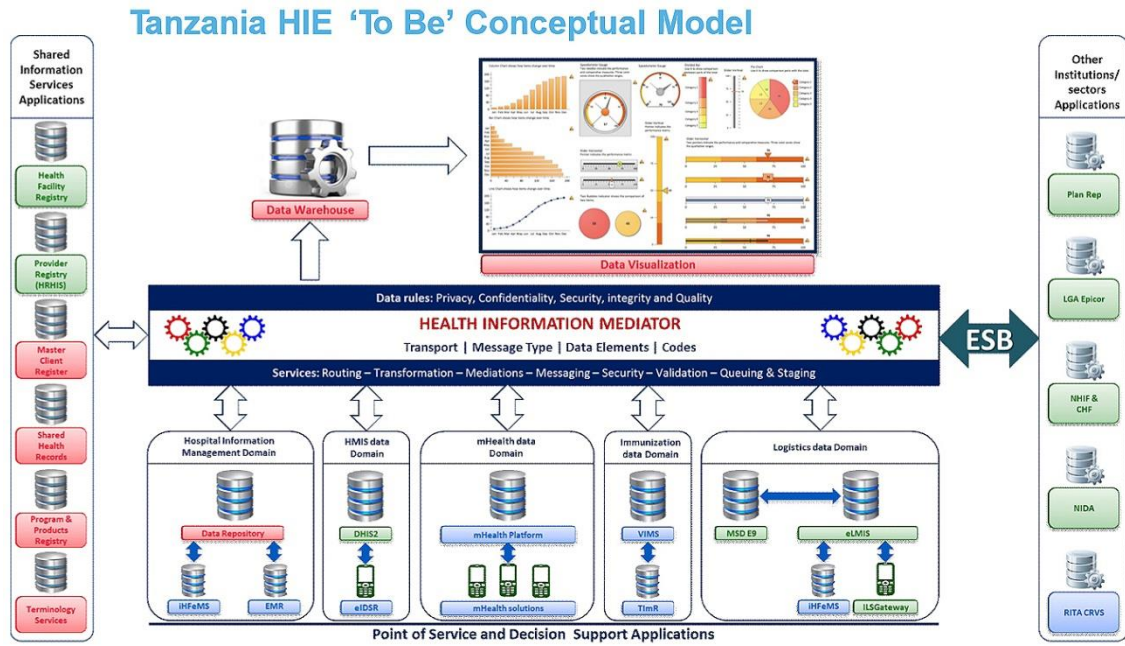
Figure 1. The vision for a national health information system by the Ministry of Health, Tanzania.

Health IT silos and lack of standards hamper interoperability, which is one of the major challenges in the Tanzanian eHealth scenario (eHealth Strategy for Quality Healthcare Delivery Service, 2013). Exchange of patient information between healthcare providers should be effortless and straightforward to ensure better health outcomes for patients. Hospitals and state-level authorities should be able to easily exchange local health data to allow mapping of country-wide health statistics for better understanding and coordination of public health issues, e.g. management of potential infectious disease outbreaks.

1.2.   The aim, scope, and structure of the thesis

The **primary purpose** of this thesis is to generate information that is useful to decision-makers in hospitals operating in Tanzania. Some of the results could be applicable in other developing countries as well. The thesis aims to provide supportive information for selecting an appropriate HIS that meets the requirements of the hospital in question, taking into account the user perceptions that influence the adoption and use of such systems. This, in turn, will contribute to more efficient use of scarce health care resources while improving the operational efficiency of the health care facility. The **secondary purpose** of this thesis is to provide HIS providers with information for designing better hospital information systems. Thus, the primary research question of this thesis is "which issues in user experience support or hinder the adoption and use of electronic hospital information systems in developing countries?" and the secondary

research question is "what design implications can be drawn to create better hospital information systems?"

The **focus** of this thesis is on the user experience (UX), i.e. the various human factors influencing the adoption and use of the HIS. The three HIS products used in the Tanzanian hospitals included in our user study are described in Chapter 2.4. The aspects of UX covered in the context of this thesis are 1. perceived quality of use, 2. benefits, challenges and suggestions for improvement, 3. learnability, training and customer support, and finally 4. the extensiveness of the system in regard to integrated modules and functionalities. This thesis **will not** cover the societal, organizational, technical, or other factors that also influence the adoption and use of a HIS.

The thesis consists of **three main parts**. The first part contains an introduction to the topic and the context of the thesis, and presents related work. The second part presents the user study with Tanzanian hospitals along with the results, methodology used in the research, and discussion. The third and final part presents the conclusion.

2. Context

2.1. National and global eHealth initiatives

Access to affordable, high-quality health care is still a major concern around the world. As much as half of the world's population is not able to receive the health care they need. Universal Health Coverage (UHC) is a global initiative by the World Health Organization (WHO) aiming toward accessible and affordable health care for all the world's citizens (WHO, 2019). Every member state of the United Nations (UN) has agreed to strive toward this objective as part of the Sustainable Development Goals set by the UN in 2015 (UHC2030, 2019). WHO Global Observatory on eHealth emphasizes the strategic role of electronic health in achieving the UHC (WHO, 2015). Strengthening health systems and *building capacities for eHealth is an integral part of the progress toward the UHC*.

The Ministry of Health and Social Welfare (MOHSW) in Tanzania is planning a National eHealth Strategy (Tanzania National eHealth Strategy 2012-2018, 2013) to better respond to the country's health challenges. The aim of the initiative is to support the adoption and use of health IT to facilitate and coordinate the transformation of the country's health sector, eventually improving the delivery and quality of health care for all citizens. *Change and Adoption* is listed as one of the key focus areas in the National eHealth Strategy of Tanzania. This focus area covers the creation of a strategy that helps to promote the adoption and use of eHealth solutions in health care facilities. It is also acknowledged in the strategy that the *user perceptions influence the sustainability and success of the eHealth solution* (Tanzania National eHealth Strategy 2012-2018, 2013).

The UHC initiative by the WHO as well as the Tanzanian government's National eHealth Strategy set the wider context for this thesis, and help to understand the significance and far-reaching implications of the study.

2.2. Health system and public health in Tanzania

Tanzania is one of the fastest growing economies in Africa, yet one third of its population lives in extreme poverty. The steadily rising Gross Domestic Product (GDP) has not translated into improved health outcomes for an average Tanzanian (White & World Bank, 2013). Total health care expenditure of GDP in Tanzania was 5.6% in 2014 (WHO, 2019). Equitable access to efficient health care is essential for economic and social development of any country. Tanzanian government strives toward this goal through its National Health Policy that aims to ensure the provision of health care services to all citizens (MoHCDGEC, 2017).

Tanzania is located in East Africa, and it consists of two major areas: Tanganyika, the Tanzanian mainland, and the semi-autonomous archipelago of Zanzibar. There are

25 administrative regions and 113 districts in the mainland of Tanzania. The districts of the country are semi-autonomous in health planning and implementation. Vast majority (90%) of the Tanzanian population lives within 5 km from a primary care facility, but most of them live in rural areas, far away from hospitals and specialist care (Tanzania National eHealth Strategy 2012-2018, 2013).

The health system is decentralized and multi-tiered. The patient's first contact point is generally a local health centre. Based on the initial health assessment, the patient is then sent to more specialized centers of care if necessary. Figure 2 displays the levels of care and responsibilities in the Tanzanian health system. There are approximately 4,679 dispensaries, 481 health centers, and 237 public and private hospitals across the Tanzanian mainland (Tanzania National eHealth Strategy 2012-2018, 2013).
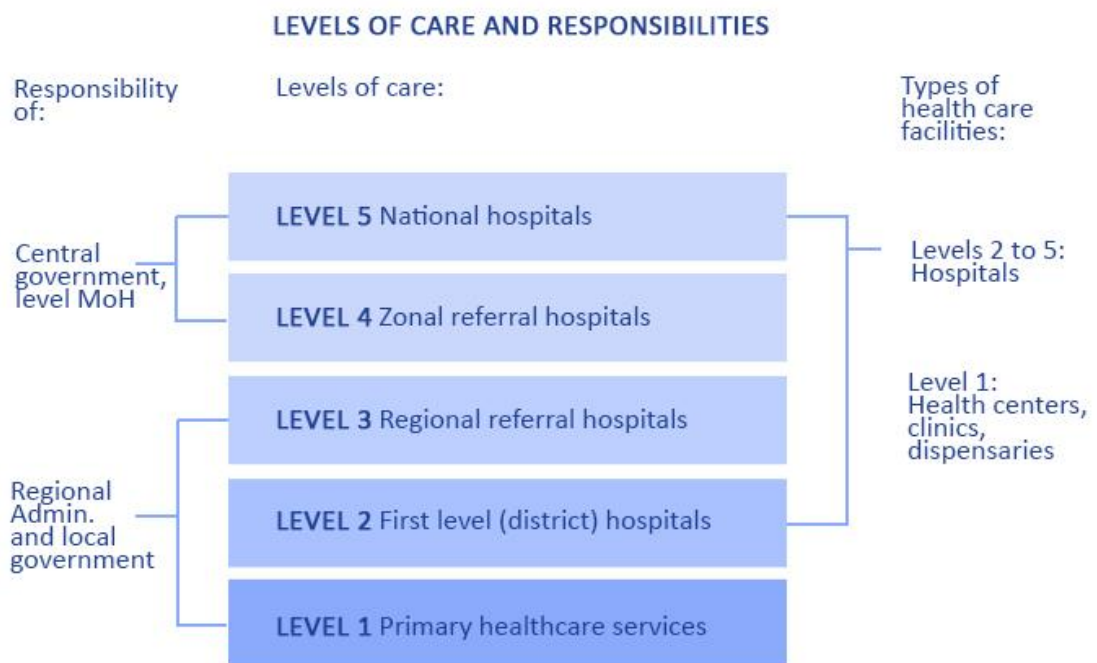
Figure 2. Levels of care and responsibilities in Tanzanian health system (Pharmaccess, 2016).

Health sector in Tanzania is facing many challenges. Shortage of qualified health care professionals is immense, as only 35% of the positions are filled (eHealth Strategy for Quality Healthcare Delivery Service, 2013). Epidemic of infectious diseases such as tuberculosis, HIV, and malaria continue burdening the country's health care system, malaria being the most pressing challenge with over 10-20 million contracting the illness every year. Tanzania continues to rank high in child and maternal mortality, one of the most vital quality indicators of a country's health system. Furthermore, Tanzania suffers from health care system inefficiencies, as well as limited health care access in

the rural areas (eHealth Strategy for Quality Healthcare Delivery Service, 2013). The situation is further exacerbated by poverty, population growth, poor infrastructure, and low level of education.

Hospitals in Tanzania often face power cuts, network connection issues, and other infrastructural problems that can come in the way of using a hospital information system effectively. It is important to understand the context in which these systems are used on a daily basis. Hospital information systems are not a panacea to the public health issues of Tanzania, but if successfully implemented, they can alleviate the challenges by making processes in hospitals more efficient and helping to save resources.

2.3.   Project description and partners

This thesis has been done in collaboration with *Capacity Building of Tanzanian Health Information System (CBTHI)* project, a multi-stakeholder initiative aiming to build eHealth competence in Tanzania. Creating, exchanging and promoting eHealth knowledge and research, building professional networks, and sharing experiences are its essence. The project was launched in 2012 and is run by the Finnish Christian Medical Society (FCMS). It is funded by the Finnish Ministry of Foreign Affairs during the years 2017-2020. Capacity building is one of the fundamental building blocks of creating an enabling environment for eHealth in Tanzania. Specialists in health information systems and ICT from Finland and Tanzania are involved in the project, as well as postgraduate students from Finnish and Tanzanian universities.

The CBTHI project involves several stakeholders in both Finland and Tanzania. Main project partners in Finland are FCMS, PITKY - Information Processing Association in Pirkanmaa Region, ETLA - Research Institute of the Finnish Economy, and Tampere University. The project partners in Tanzania include University of Dar es Salaam (The College of Information and Communication Technologies), The Nelson Mandela African Institution of Science and Technology, Ministry of Health, Association of Private Health Facilities (APHFTA), Christian Social Services Commission (CSSC), Lutheran Investment Company and the ICT department of the Evangelical Lutheran Church in Tanzania.

The need for a comparative study of hospital information systems was expressed by CSSC and the APHFTA during the inception of eHealth Tanzania project in October 2017. These organizations must be prepared to give recommendations and instructions to member hospitals regarding the purchase and introduction of a HIS: this is the main rationale for our study. FCMS is conducting a comparative study of the three HISs used in Tanzanian hospitals: AfyaPro, Care2X, and GoTHoMIS. This thesis covers the study of the hospital personnel's experiences of these systems. FCMS has also conducted a

technical comparison of the three systems in 2018. The results of the user study and the literature review presented in this thesis will also be reproduced in a report on HIS product comparison by the FCMS.

2.4. Description of the HIS products

The user perceptions of three hospital information systems (HIS) have been explored in this study. The HIS products involved in this study are briefly described in this section.

The guidelines from MoHCDGEC state minimum requirements for the HIS modules: patient management (i.e. outpatient and inpatient), laboratory, laboratory orders, operating theatre, billing, pharmacy and inventory, medical records, human resources, reports, mortuary, and financial management. Most of these modules are covered by all of the three products. All modules are lacking hospital-level financial management and human resource management.

2.4.1 AfyaPro

AfyaPro is a HIS product by Africa eHealth Solutions International (AeHS). It is cloud-based (Azure), but can also be installed locally. AfyaPro runs only on Windows. It is the only one of the three systems that offers patients access to their own medical data. AfyaPro is used in 21 hospitals in Tanzania (Africa eHealth Solutions, 2019).

2.4.2 Care2x

Care2X was initially an open-source full hospital information system, but since the sponsors have withdrawn, the system has been supported by Lutheran Investment Company in Tanzania. Most of its major components are free to use. Care2X runs on both Linux and Windows. The user interface of Care2X can be adjusted to the hospital's specific needs and in addition to a desktop computer, it can also be used with a mobile phone and a tablet. Care2x user interface can be seen in Figure 3. In 2017, seven hospitals in Tanzania were using Care2X (Wambura, Machuve, & Nykänen, 2017).
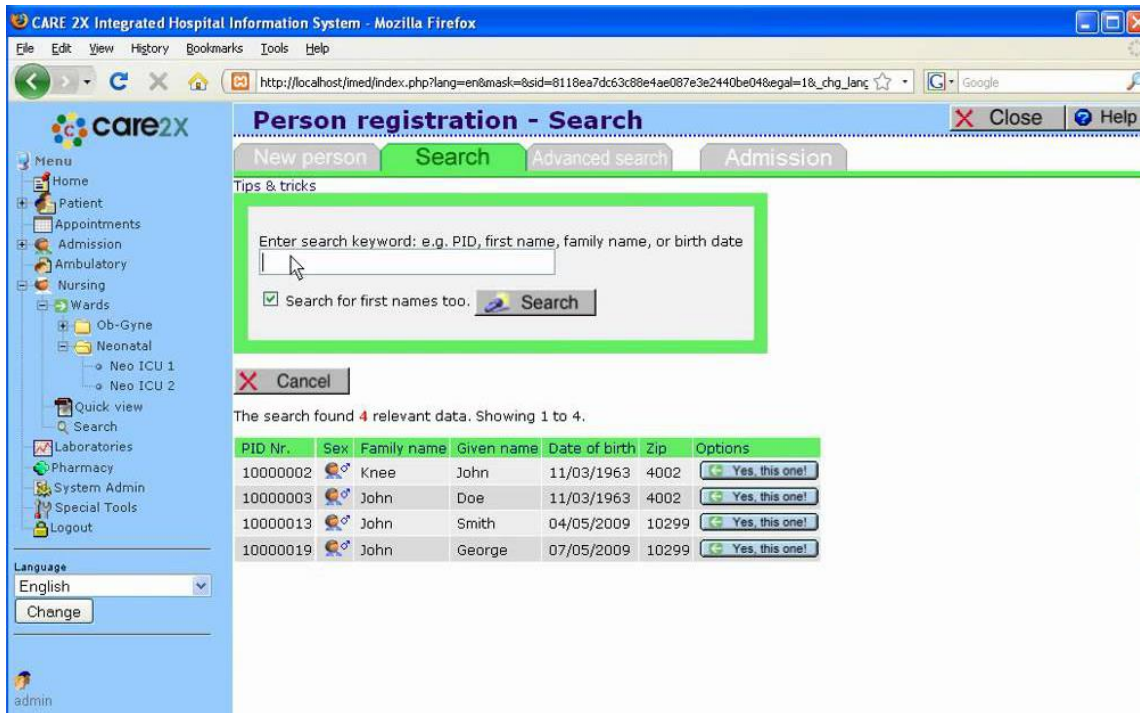
Figure 3. A screenshot of Care2x user interface with a person registration function.

2.4.3 GoTHoMIS

Developed by the Government of Tanzania (GoT), GoTHoMIS has the most solid prospect for continuity. By 2017, it was used by approximately 170 health facilities across the country (Government of Tanzania - Hospital Management Information System, 2017). GoT plans to nationally centralize the use of GoTHoMIS across the country's hospitals. Purposed for the collection and reporting of facility level clinical information as well as supporting hospitals in service delivery, the main functionalities of GoTHoMIS include EMR, laboratory information system, inventory and tracking of medical supplies, billing and revenue collection, performance tracking and reporting (government standard MTUHA forms) (Government of Tanzania - Hospital Management Information System, 2017). Figure 4 displays some of the integrations of GoTHoMIS.
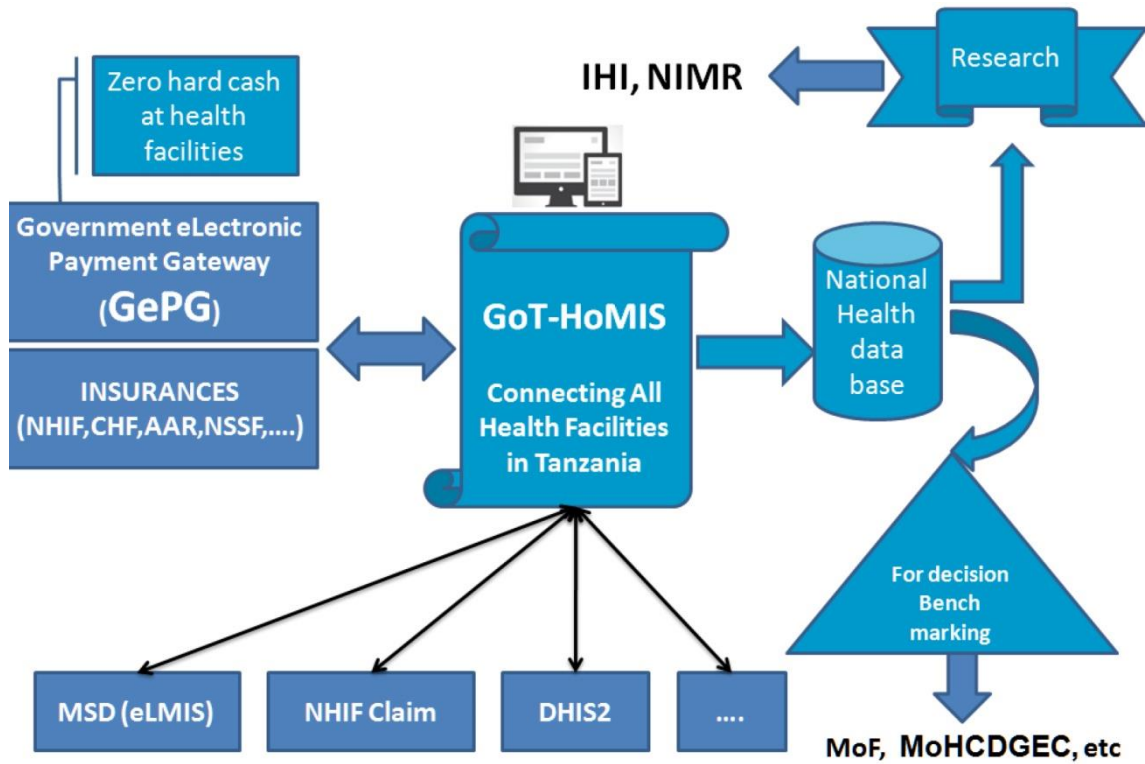
Figure 4. Government of Tanzania plans to connect GoTHoMIS to all hospitals (Government of Tanzania - Hospital Management Information System, 2017).

3. Related work

In this chapter we take a closer look at hospital information system adoption and use in developing countries through reviewing relevant literature. This literature review covers the perceived benefits and challenges influencing HIS adoption and use in developing countries, creating a theoretical basis for our study. It will also look at the challenges related to HIS design in developing countries. We will also explore the limitations of other studies and see how our study relates to them.

Scientific publications, e-books, news articles, and reports were searched for this thesis using ANDOR, a database provided by the Tampere University. Several searches of the database were conducted using various combinations of search terms that included "user experience", "hospital information system/s", "health information technology", "Tanzania", and "developing countries". Google search was used as well.

3.1. Benefits of HIS use in developing countries

Automation of data flow and accurate patient records were an important factor mentioned among the perceived benefits in a HIS user study by Nkanata, Makori, and Irura (2018). This is one of the key factors that help improve the operational efficiency of a hospital. In resource-constrained settings, this could prove to be even more critical than in the developed countries. If the HIS is appropriately implemented, it will improve the patient experience while improving the hospital efficiency (Nkanata et al., 2018)

Hospital information systems can be an effective way of bringing transparency and accountability to an organization. A study by Nkanata et al. (2018) revealed that HISs used in Kenyan hospitals are capable of preventing corruption inside the organization. This is achieved when hospital finances are effectively managed through a software and no malefactor can complete suspicious transactions without leaving a trace. This can also have a positive effect on hospital revenues.

3.2. Challenges in HIS adoption and use

Despite the promising results of using health IT in developing nations (Blaya, Fraser, & Holt, 2010), the level of adoption and use of hospital information systems and other eHealth applications is still substandard in many developing countries, including Tanzania (Zayyad & Toycan, 2018; Omary, Lupiana, Mtenzi, & Wu, 2009). The challenges that developing countries face in the adoption and use of HISs are often very different than those in the developed countries: prevalent paper-based systems, subpar ICT infrastructure, and inadequate computer skills of health care personnel slow down the progress (Kajirunga & Kalegele, 2015).

Often there is a prevailing perception among hospital management that investments in health IT would be better allocated to improving basic facilities, such as clinic infrastructure, purchasing medicines, or recruiting more health workers. They might seem more tangible and useful targets for investment in a developing country setting, but there is an increasing amount of evidence that a HIS may well improve the capacity and utilization of resources in resource-constrained environments, as the administrative processes become more efficient. (Cline & Luiz, 2013) Effective communication of such knowledge to the hospital management can make or break the successful adoption of a HIS.

A study by Littlejohns, Wyatt, and Garvican (2003) shows that the workload of clinicians often temporarily increases when a HIS is firstly introduced in an organization. While the effect is temporary, it is necessary to communicate these expected challenges to ensure the user acceptance in such a situation. Information provided well in advance about the expected changes helps preparing the hospital personnel, and ease the HIS adoption in this regard (Nkanata et al., 2018). To reduce the additional workload for the clinicians and other health care personnel as much as possible, accurate and thorough training should be provided.

Sometimes providing training in HIS use is not enough. Inadequate computer skills of the hospital personnel is among the major reasons for challenges in HIS adoption and use in developing countries (Busagala & Kawono, 2013; Kajirunga & Kalegele, 2015), as well as lack of competent ICT personnel (Nkanata et al., 2018). Training the hospital staff with basic computer skills is often a necessity before HIS can be used in a sustainable manner.

A study from Tilahun and Fritz (2015) found that medical doctors often abandon using electronic medical records (an essential part of HIS) due to lack of integration with common reporting systems. This means that to use the EMR, the doctor would need to key in the information to the system, as well as produce a physical report for external authorities. Sometimes the HIS can indeed increase the workload, instead of simplifying it. Hence, it would be important to ensure that the HIS has necessary integrations to avoid additional documentation and increase efficiency.

Partial use of a HIS inside a hospital also contributes to user dissatisfaction and HIS inefficiency (Tilahun & Fritz, 2015). If there is a HIS in the hospital, it should be used in all departments, so that they can work collaboratively while making the whole hospital more efficient.

A learning brief regarding a HIS implementation in a Tanzanian hospital conducted by the International Institute for Communication and Development (IICD) from the Netherlands stated that health care personnel sometimes only partially fill the data in HIS forms (Kimollo, Lenoir, & Niemi, 2010). This is a contributing factor to

unsustainable HIS use. HIS needs to be fully integrated to the work flow of a hospital, so that the users have all the information they need without ending up with missing data.

Cline and Luiz (2013) suggest that the sustainable success of using a HIS in an organization comes down to the technology-related aspects as well as change management inside the organization. While considering the various aspects of user experience of hospital information systems, we should not forget that the organizational factors are at play when considering the successful long-time use of a HIS.

3.3.   Challenges in HIS Design

As developing countries have only recently started adopting hospital information systems, they have been forced to use the HIS products designed mainly in the developed nations, mostly suitable for the settings in developed nations. Poor design of health IT applications was mentioned as one of the reasons affecting the adoption and use of HISs in Tanzania (Kajirunga & Kalegele, 2015). If the HIS is not appropriate for the environment where it is used in, it will not be useful and is bound to fail.

Heeks (2002) points out how a significant portion of ICT implementations fail in developing countries and suggests a theoretical model for understanding why these failures happen. The crux of his model draws from the contingency theory and it points out the design-actuality gap: if the information system (IS) design does not match the actual user context, the implementation is bound to fail, partially or totally. According to him, there are a number of factors affecting each ICT implementation specific to the particular situation in question, and failing to address these factors likely leads to failure of the implementation. These factors could include business processes and cultural factors, among others. He also points out that controlling all the variables appearing on many different levels of the user context might not even be possible as they keep changing over time.

Heeks (2002) makes a comparison between design-imposing applications and actuality-supporting applications. The former refers to designs that contain deep inscriptions, such as processes, values and systems, that are inherent to the developed country setting, whereas the latter refers to designs that contain relatively shallow inscriptions, hence allowing easier adaptation to developing country settings. According to Heeks (2002), actuality-supporting applications have much better chances of succeeding.

3.4. Limitations of previous studies

User experience is an important aspect of the study of IT systems. Health IT and hospital information systems make no exception. Ahlan and Ahmad (2014) reviewed literature on health IT acceptance in developing countries and found out that there are relatively few studies in this area. Similarly, Handayani et al. (2017) noted that hospital management and IT vendors should have a better understanding of the perceptions of the users that significantly affect the adoption and use of a HIS. In their study involving hospitals in Indonesia, they also found out that there is a lack of studies in HIS user acceptance that would involve all the user groups including doctors, nurses, hospital management, and administrative personnel. Our user study, presented in Chapter 5, involves all of these user groups.

A study conducted in Nigerian hospitals by Zayyad et al. (2018) revealed that perceived usefulness along with general willingness to use the system, beliefs about the system, and attitudes toward it were major factors influencing HIS adoption and use among health care professionals. These are important aspects to study if a deeper understanding of HIS use is desired.

A multitude of human factors are at play in the use of hospital information systems. While identifying, let alone controlling, every variable is probably not feasible, much can be done to mitigate the complications that hinder the adoption and use of a HIS in terms of user experience. However, this requires rigorous research.

The main rationale for our user study in hospital information system use, presented in Chapter 5, was to provide information on HIS selection to decision-makers in Tanzanian hospitals. The reviewed literature also provides evidence that there is a lack of information about suitable ICT solutions in developing countries (Busagala & Kawono, 2013) which further supports the need for our user study.

This literature review looked at the adoption and use of hospital information systems in developing countries, and also commented on the design of such systems. This is the end of the first part of the thesis. The following second part will present the study methodology and the results of the user study conducted in Tanzanian hospitals. The findings of this literature review will be reflected upon the study results in the discussion section in Chapter 5.6.

4. Methodology

The user study aimed to investigate the user perceptions of three selected hospital information systems, AfyaPro, Care2X and GoTHoMIS, used in Tanzanian hospitals and health care facilities. In this chapter, the methods and the participants of the study will be described. Interview data used in this thesis was provided by the project partner who has been described in detail in Chapter 2.3. Various user groups were interviewed with semi-structured interviews after which the data was analyzed using qualitative analysis.

As the sample was relatively small (n=35), it might not be possible to generalize the results to cover all hospitals in Tanzania, let alone other developing countries. However, the results aim to provide a window to the use of hospital information systems in Tanzanian hospitals, and inform the decision-makers in Tanzania on selecting a HIS that is suitable for their purposes. Depending on the individual scenario, the results could be applied in hospitals located in other developing countries after evaluating whether there are enough similarities in the setting.

4.1. Interviews

Thematic, semi-structured interviews with open-ended questions were conducted to collect data on the experiences of the users. Semi-structured interviews were chosen as they allow for a more free-form interaction without being too rigid. User perceptions that the researchers wished to gain understanding of included four main areas. The areas concerned 1) operation of the systems, and perceived quality of their use, 2) the experienced benefits and challenges of the systems, and suggestions for improvement, 3) the learnability, training, and customer support of the systems, and 4) the extensiveness of the systems in regard to integrations and functionalities. In order to gain a deep and thorough understanding of these areas, semi-structured interviews and qualitative content analysis were selected as study methods.

All interviews were conducted in person in Tanzanian hospitals during March and April in 2018 by the project partner. The author of this thesis has not conducted any interviews, but only used the data provided by the project partner to conduct a qualitative analysis. The interview data was provided in Microsoft Excel sheets and Word documents which have been arranged and analyzed by the author.

The semi-structured interviews consisted of the same questions for each user. The interview questions were selected to understand the user experience of the three hospital information systems. There were inconsistencies in the interview data: not all respondents answered all of the questions, which makes interpreting the results less reliable. Interview topics and questions are attached as Appendix 1.

All the interview data collected by the project partner has been anonymized. Hence, there was no need to process personal information, and no risk of data security issues.

4.2. Participants

Hospital personnel (n=35) including hospital managers, doctors, nurses, pharmacists, laboratory personnel, IT professionals, and support staff from seven different Tanzanian hospitals were interviewed for the study. Support staff covers medical and ward attendants, as well as personnel working in billing, registration, medical records, and reception. Variation in hospital size and location, as well as previous experience of using a HIS were considered in the selection of the hospitals and respondents to achieve as diverse representation of the target audience as possible.

The interview data did not contain any information on the age or gender of the participants. Hospital job roles and educational background have been recorded for some of the participants. The job roles of the participants can be seen in Table 1.

Occupation	Respondents
Medical Doctor	7
Nurse	3
Pharmacist	4
Management Personnel	5
Support Personnel (billing, reception etc)	7
IT Personnel	7
Technician	2

Table 1. Job roles of the respondents (n=35).

The educational background was recorded only for some of the participants. This data can be seen in Table 2. The individuals of unspecified educational background seen on the Table 1 are likely to have completed at least a diploma level of education as they are professionals working at a hospital.

Educational background	Respondents
Primary School	1
Secondary School	2
Diploma	6
Certificate	1
Bachelor's Degree	8
Master's Degree	1
Not specified	16

Table 2. The educational background of the respondents (n=35).

Table 3 below displays information on the sites where interviews were conducted. Seven hospitals were included in the study, spanning four different regions of Tanzania.

SN	Hospital	City	HIS in Use	Respondents
1	Sengerema CDH	Mwanza	AfyaPro	6
2	Moyo Safi Wa Maria Hospital	Dar es Salaam (Kimara)	AfyaPro	2
3	Arusha Lutheran Medical Centre	Arusha	Care2X	4
4	Tanzania Occupation Health Service	Dar es Salaam	Care2X	6
5	St Elizabeth Hospital	Arusha	GoT-HoMIS	6
6	Tumbi Hospital	Kibaha	GoT-HoMIS	5
7	Mt Meru Hospital	Arusha	GoT-HoMIS	6

Table 3. Information on the hospitals where interviews were carried out (n=35).

4.3. Qualitative Analysis

Qualitative textual analysis has been used as a method to analyze the data acquired through the interviews in this study. It is a useful method in studying the user experience of information systems. Qualitative methods are known to be beneficial in describing and interpreting experiences of individuals, which makes it a suitable method for our study. Responses from all user groups were collated and cross-checked by the project owner to achieve a complete understanding of user perceptions in regard to the three HIS products.

The interview notes were arranged and examined for themes based on the following categories: 1) operation of the systems, and perceived quality of their use, 2) the experienced benefits and challenges of the systems, and suggestions for improvement, 3) the learnability, training, and customer support of the systems, and 4) the extensiveness of the systems in regard to integrations and functionalities. There was no established theoretical framework used for these categories, as they were provided by the project partner. The data was scanned for words, phrases and themes that were occurring most commonly to draw conclusions about their relations.

As the data analysis is completed by the author alone without input from other researchers, the reliability of the analysis is hence reduced.

The results and the qualitative analysis of the interviews have been presented in Chapter 5.

5. Results and discussion

In this chapter, the results and the qualitative analysis of the interview data will be presented. User perceptions of each system, AfyaPro, Care2x, and GoTHoMIS, are presented under their own sub chapters. The study covered the 1) operation of the systems, and perceived quality of their use, 2) the perceived benefits and challenges of the systems, and suggestions for improvement, 3) the learnability, training, and customer support of the systems, and 4) the extensiveness of the systems in regard to integrations and functionalities. By integrations, we mean external systems that the HIS is connected to, such as laboratory equipment and third-party reporting systems. The interview questions are attached as Appendix 1. Furthermore, the findings will be discussed in the light of the related work presented in Chapter 3.

5.1. User perceptions of AfyaPro

Altogether 8 users were interviewed about their perceptions toward AfyaPro HIS. The users were from Sengerema hospital (n=6) and Moyo Safi hospital (n=2). The interviews were conducted with 2 ICT officers, hospital secretary, inpatient cashier, medical record clerk in charge, medical attendant, medical doctor in charge, and a laboratory technologist.

AfyaPro system was not used in all hospital departments. The doctors, laboratory and pharmacy personnel at Sengerema hospital were not using the system at all at the time of the interviews. However, they had experience of its use as it had been used before. Registration and billing were the only departments at Sengerema hospital where AfyaPro's all features were used. One of the respondents in Moyo Safi also mentioned that the hospital is aiming to start using GoTHoMIS, replacing AfyaPro. One respondent mentioned the issue of accessibility due to commonly occurring network problems. By accessibility we mean the availability of the system.

The reduction in the amount of manual work was seen as the biggest benefit in using the HIS as 5 respondents mentioned this. Six users mentioned that the system helped them in **tracking different things** such as patient records, statistical data on different departments, payment exemptions, and laboratory results. Some of the other benefits mentioned by individual respondents included improvement in patient flow, and increase in transparency and accountability which was seen to lead to increased revenue by 2 respondents.

As many as 6 of the users reported **manual work as a challenge**. This manual work especially concerned the **MTUHA** hospital reporting which is a standardized reporting system by the Tanzanian government. Hospitals are required to send the MTUHA reports to the higher medical authorities in Tanzania. As AfyaPro is not

integrated with the MTUHA reporting, the hospital personnel needs to complete additional work. The doctors at Sengerema hospital are not using the AfyaPro system at all for this reason. One of the respondents described the situation with following words: *"All doctors are not using the system currently, because of difficulty of preparing MTUHA reports, since the same data that is entered in the system should then be re-entered manually in the MTUHA physical books as per the Government requirements. So it seems like double work."*

It was also reported that maintaining the patient's physical files still required manual work from the employees. **Information often goes missing** as 3 respondents said that they have faced a situation where the patient's information disappeared for an unknown reason. Sometimes the system was not able to recognize the patient even though they were already registered. **Regularly occurring power cuts** were mentioned as a challenge by 2 respondents. Sometimes the power cuts may lead to **loss of patient data**, and require re-entry, which amounts to additional work. **Lack of personnel ICT skills** was seen as a challenge by 2 respondents. This was also expressed as the lack of "competitive" employees. Also too low number of computers seemed to be an issue, as 2 users said there are not enough computers for the staff to use.

Many individual suggestions for improving the system were mentioned by the study participants: the AfyaPro system should be converted from local to a web-based system so that it would be easier to manage it and even use on tablets, report generation for RCH (Reproductive and Child Health) should be added, the procedure for registration, billing, and admitting as well as discharging inpatients should be simplified, patient retrieval function should be improved, and finally, network infrastructure was hoped to be improved.

Easy learnability was mentioned by 2 participants. Six respondents reported that training was provided by the system developer or administration, but 4 respondents thought that the amount of **training is not sufficient**. They would require more training both for using the AfyaPro application as well as training in **basic computer use**.

Four respondents mentioned that there is a **lack of technical support** by the developers, whereas only 1 person said there is enough support. It was also mentioned by one of the respondents that the hospital needs to cover the living and transportation allowance for the developers in the time of support.

The AfyaPro system was reported to have **no integration with any other systems** by 4 participants. The major issue is the lack of integration with the MTUHA reporting system, as mentioned before. This causes manual work which was mentioned as a challenge by 6 participants. One participant mentioned that AfyaPro is integrated with DHIS2, which is a district health information system used in Tanzania, but that they did not have access to it on their user level (medical record personnel). Lack of DHIS2

integration was mentioned as a challenge by one other respondent. Another respondent mentioned that AfyaPro should be integrated with NHIF (National Health Insurance Fund in Tanzania) and X-ray machines in the laboratory.

5.2. User perceptions of Care2x

Altogether 10 users were interviewed about their perceptions toward Care2x HIS. The users were from Arusha Lutheran Medical Centre (ALMC) (n=4) and Tanzania Occupational Health Service (TOHS) (n=6). The interviews were conducted with an ICT officer, system administrator/programmer, medical laboratory technologist, 2 pharmacists, 2 medical doctors, nurse, receptionist, and a laboratory manager.

One of the respondents at TOHS mentioned that Care2x is not being used in the dressing, injection and antenatal clinic whereas other departments are using it. Dressing is a small clinic and it does not make sense to computerize it, according to one of the respondents.

Accessibility was said to be good by 2 respondents. One user said **the system was down on a weekly basis due to network issues**. It was also perceived as slow by one respondent.

Half of the interviewees reported that Care2x has simplified work and reduced the working time as the amount of **manual labor has reduced**. Two participants also mentioned that they had more time for the patients because of Care2x. Work was also reported to be easier, faster, and more accurate by one of the respondents. Half of the respondents said that the system has **improved keeping accurate patient data** and helped with the retrieval of the data. Other benefits mentioned by the participants included reduced loss of patient information, reduced waiting time for the patient, availability of reports.

Even though Care2x seemed to have contributed to the reduction in much of the manual work, the challenges reported concerned manual work as well. Seven respondents mentioned **challenges related to manual labor**. For example, during a **power cut**, manual work is still required. Patient consent forms, blood requests, laboratory supply orders, and fertility tests were still all manually handled. Challenges included **network problems** during which the system goes down entirely, which leads to **loss of data and waste of working time**. The rest of the challenges mentioned individually were mostly problems with the system usability, such as **incompletely filled patient records**, difficulties accessing certain information due to security measures, not being able to edit doctor's requests, lack of report customization, among others.

The respondents wished that the laboratory requests would have a time stamp that would allow the laboratory personnel to see when a test was requested and when it was

sent back. This is also one of the general performance indicators for hospitals. The users also mentioned that nurse charts should be added to the system. A problem with a webERP (online account and business management system) integration was also reported by one respondent. Other suggestions for improvement included adding guidelines on how to use the system, and to fix a bug that makes patient information disappear if the patient has been registered before midnight, and then admitted to the hospital after midnight.

Three interviewees felt that they got enough training to use Care2x, but it was mentioned by 2 interviewees that **more training was needed**. It was also mentioned that the staff needed training in **basic computer skills**, not only in using the system. One of the respondents mentioned that typing training would be required as some of the staff members are very slow to type with the keyboard. Six of the respondents said that the system was **easy to learn**. Two participants mentioned that it is harder for the older generation to learn to use the system. Support for Care2x was provided well by the developers as 7 interviewees thought the **availability of in-house technical support was good**.

Many **functions were reported to be missing** from Care2x. Full blood picture and nurse charts were both mentioned by 2 participants. A pharmacist wanted to see notifications when an item in the stock is running out. A nurse hoped for a role-based note-taking, and mentioned that **the notes currently get mixed between different users**. One of the respondents also felt that the staff should be notified of system changes inside the application. Now they are only notified during the meetings, or not at all. Other missing functionalities mentioned by individual users included clinical decision support systems, patient reminder system, screen refresh function for pharmacy, missing column in the urine analysis reporting, and the fact that notes cannot be edited after saving, as the users need to write an entirely new one.

In regard to integrations, one of the users mentioned that **only the CT-scan is integrated** and the images go directly to the system. Another respondent mentioned that the Care2x is integrated with the laboratory and other departments. Individual respondents said that there is a problem with the integration to webERP, and for viewing medical images users need to enter a password which sometimes causes trouble. It was also mentioned that a connection to insurance system should be added.

5.3. User perceptions of GoTHoMIS

Altogether 17 users were interviewed about their perceptions toward GoTHoMIS. The users were from St Elizabeth hospital (n=6), Tumbi hospital (n=5), and Mt Meru hospital (n=6). The interviews were conducted with 3 ICT officers, ICT technician, 2

pharmacists, 2 registration officers, 4 medical doctors, medical attendant, cashier, regional medical officer, ward attendant and quality officer.

The accessibility of the system was perceived good, but sometimes it was down for some departments, though this was a rare occurrence.

GoTHoMIS is a hospital information system created by the government of Tanzania. One of the perceived benefits of GoTHoMIS was the **integration with government's MTUHA reporting system**, which was mentioned by 3 respondents as a benefit. They also liked the **detailed patient history**, as 4 users mentioned it as one of the benefits. **Tracking various hospital metrics** was mentioned as a benefit by 4 participants, including monitoring patient turnaround time, stock balance tracking, and traceability of patient information. **Automation** of various hospital tasks was mentioned by 8 respondents, including easy medical stock management, simplified drug handling, and sending patient information to the laboratory and back. **Financial reporting** was mentioned by 4 respondents as one of the biggest benefits. GoTHoMIS also provided a central payment point which was beneficial to users. **Manual work was said to be reduced** as payment receipts were generated automatically by the system, and the number of paper files was reduced. Storing and sharing medical radiology images was made possible by the system, and misplacing of medical prescriptions and tests was not a problem anymore. Also drug theft had been reduced. **GoTHoMIS provided clear benefits to the patients** as well, as the queuing times were reduced and the speed of providing services to the patients was increased, as mentioned by some of the respondents.

Network issues and downtime were mentioned as some of the biggest challenges with GoTHoMIS by 5 interviewees. **Power cuts** were also mentioned by 4 interviewees. Missing diagnosis codes were mentioned by 3 respondents. Other challenges with GoTHoMIS included manual work which was mentioned by 4 participants. Manual work was still needed for inpatient wards, invoicing, laboratory results and medicines. Also, the MTUHA reporting system integration was said not to work well by one of the respondents. There were many individual usability issues, such as patient exemptions not being managed orderly, available medication not seen as available in the doctor's dashboard, disappearing prescriptions from a pharmacy dashboard, duplicate orders to cashiers, laboratory files not in PDF format as they should be, laboratory requests not being visible, hidden patient names due to security protocol, problems identifying whether patient is inpatient or outpatient during registration, and no means to cancel paid transaction.

In addition to the presented challenges, the respondents wished that system would be improved with an auto refresh feature, editable diagnoses, ICD10 code search,

adding more ICD10 codes, dropdown list for medical test results, notifications to alert new requests for pharmacy, and integration with laboratory analyzers.

Three respondents mentioned that the system was easy to learn. They also said it was only possible if they already had basic computer skills. One respondent said it was hard to learn. All users are trained to use GoTHoMIS, but 5 interviewees thought that **more training was needed,** including **basic computer use**. IT personnel of the hospital was trained by the system providers. It was mentioned by 3 respondents that the **technical support is instant** and there were no problems in getting it when needed. A respondent also reported that programmers are able to remotely access the system in case of an issue. Problems were said to be discussed in weekly staff meetings, where also technical support was given.

When interviewees were asked about the functions that the GoTHoMIS system is lacking, many individual things were mentioned. These included missing diagnosis and treatment functions from dental module. **It seems that many of the modules in GoTHoMIS are not in full working order**. It was mentioned that the hospital is currently not able to fully utilize the inpatient module, inventory module was under construction, CTC (Care Treatment Centre) module was not working, and a module for hospital secretary was also not working. The respondents also said that some more reports are needed such as 5+days report, and that the system does not comply with ICD9 standard which is used by the Ministry of Health in Tanzania. This should be considered as GoTHoMIS uses the ICD10.

In regards to integrations, many were in place, but GoTHoMIS also lacked necessary integrations. Probably the **most useful aspect of GoTHoMIS is its integration with the government's MTUHA reporting system**. Also, TAMISEMI and DHIS2 were mentioned to be integrated. It was said by 4 respondents that GoTHoMIS should be integrated with financial systems, such as **Government Electronic Payment Gateway (GePG)**. The payment system integrations were mostly missing, but a special CRDB (a commercial bank in Tanzania) card for payments was integrated to GoTHoMIS. The lack of integration with laboratory test equipment was seen as a problem, whereas the X-ray was already integrated. One person has to take a sample, and another one needs to key in the information to the system, while the other person has to approve the results. **System integration with the laboratory equipment would make the process easier and save time**. It was also mentioned that GoTHoMIS should be connected to a National level centralized data center. NHIF (National Hospital Insurance Fund) was not integrated into the system, which was also requested by the respondents.

5.4. Comparison interviews between Care2x and GoTHoMIS

The data included special interviews with hospital personnel from St Elizabeth hospital in Arusha. St Elizabeth hospital used Care2x before, but has then shifted to use mainly GoTHoMIS. They were directly asked how the two systems compare. At the time of the interviews, **they were still using Care2x alongside GoTHoMIS** for stocking and purchasing various items in the hospital such as equipment and pharmaceuticals. For all patient-related tasks they are using GoTHoMIS. The interviewees included a chief doctor, ICT technician, registration clerk, billing clerk, medical doctor, and a pharmacist. These respondents were able to provide valuable insights for comparing the two systems.

The data included an interview with a chief doctor who had altogether 15 years of experience working with Care2x and GoTHoMIS, so he was able to share his views comparing the two HIS products. According to the doctor, **Care2x is more developed and more advanced compared to GoTHoMIS** which is still a new system. Hence, he thought it was still too early to compare the two systems. GoT-HoMIS is easily updatable so he is hoping that it will become like Care2X in terms of service coverage in the future. He thinks that **GoTHoMIS is simple and user-friendly compared to Care2X**. Reporting is the most significant reason for St Elizabeth hospital shifting from Care2x to GoTHoMIS. The **reports generated by GoTHoMIS are compatible with the government's MTUHA reporting** schemes, whereas **Care2x does not conform to the scheme**. He also mentioned that government funded hospitals are nowadays required to shift to GoTHoMIS. However, this requirement did not affect their original decision, but rather just complimented it.

The second interviewee was an ICT technician who had worked at the hospital for 4 months. He said that Care2x also keeps patients records, just like GoTHoMIS, but tracing the patients' records that are already in the system is slightly difficult. He also mentioned that in Care2x the cashier is the only staff member able to cancel bills. However, GoTHoMIS allows the cancellation of bills for doctors, and this allows them to provide an alternative medication to patients. According to the ICT officer, one of the strengths of Care2x over GoTHoMIS is that Care2x is stronger in handling inventory-related issues. At the time of interview, the inventory module in GoTHoMIS was still under construction. At St Elizabeth hospital Care2x had already been customized to fit their environment because it had been in use there for long, so adapting GoTHoMIS to their environment, or adapting the hospital to the system, will take time.

The third interviewee from St Elizabeth hospital was a registration clerk who had worked at the hospital for 11 years. According to the third interviewee, GoTHoMIS is easier to use than Care2x. The registration module has been designed better as registering a patient in Care2x requires a lot more information. For example, two

contact numbers should be added at the same time, one number for the patient and another one for the patient's relative. This makes the process more complicated. The third interviewee also mentioned that in GoTHoMIS the patient's place of residence is automated, while in Care2x the input for residence is done manually. Care2x enables editing of patient records after wrong input, where GoTHoMIS does not. Overall, the interviewee prefers GoTHoMIS over Care2x.

The fourth interviewee from St Elizabeth hospital was a billing clerk. According to her, Care2x is better in billing than GoTHoMIS. Care2x had an ability to allow a user to be attended first and conduct payment later, but this is not possible in GoTHoMIS, which makes things more complicated. Care2x allows payments in advance and viewing them, while GoTHoMIS allows advance payments, but does not allow viewing them. This also makes the process more complicated, as they need to go see an accountant to view the advance payments. She also mentioned that in GoTHoMIS the patient needs to register before charging them is possible, whereas in Care2x the patient is given a number for the payment without the need of registering first. **Some modules are not yet fully functional in GoTHoMIS**, so patients still need to bring paper documents to the billing department, which need to be filled in the system. Overall, she prefers GoTHoMIS because it is fast and simplified compared to Care2x.

The fifth interviewee from St Elizabeth hospital was a medical doctor. He thinks **GoTHoMIS is still new and needs many improvements**. He also finds Care2x much faster to use than GoTHoMIS, because he has been used to it. He was not happy that Care2x was replaced with GoTHoMIS as Care2x had become a stable system. He thinks Care2x has a good arrangement of modules which is the reason for it being so fast in offering the services to the patients. Compared to Care2x, GoTHoMIS is slow in prescription of medicine, for example. He also compares the ICD10 (International Classification of Diseases, Tenth Revision) presentation, and says that Care2x is very good over GoTHoMIS in this aspect. **Overall, he thinks that Care2x is a better system**, but is hopeful that GoTHoMIS would become better in the future. Other things where he finds Care2x superior include laboratory work as it has eliminated paperwork, whereas in GoTHoMIS manual handling of documents is still required. At St Elizabeth Hospital they used to have a local server which was easily accessible, and hence it was easy to get consultation for various issues. However, GoTHoMIS server is not locally available, and it is hard to know who to consult. In case of technical issues, Care2x is easier because it only requires a local IT person to solve a problem. With GoTHoMIS it is more difficult as local IT people usually do not have expertise on it. With Care2x it is easy to view previous medications prescribed to the patient, whereas with GoTHoMIS viewing is not that easy: previous medications need to be searched separately. In Care2x a doctor makes his own choices to fill out the diagnosis, but in GoTHoMIS the

diagnosis is always pre-configured. Due to the pre-configuration, useful information about the diagnosis could be missing.

The sixth interviewee from St Elizabeth hospital was a pharmacist who has experience using Care2x for 3 years, and GoTHoMIS for 2 months. She prefers GoTHoMIS over Care2x because it **simplifies the management of inventory issues**. If given an option to choose one system over the other, she would choose GoTHoMIS as the best option. As one of the benefits, she mentions that in GoTHoMIS the information of new medicines is updatable, and as medicines are prescribed, the information about the current stock is automatically available. In GoTHoMIS the doctor cannot prescribe a medicine that is not in the inventory. She said that GoTHoMIS is very difficult compared to Care2x in that it requires more work for a service to be completed. When transferring stock to the windows, the stock information is sometimes not shown in GoTHoMIS. However, she prefers GoTHoMIS because it has a point of verification to know if medication is available and whether the actual price has been issued (to avoid overcharging). The other point of verification is that in case the patients have been unintentionally been given the wrong amount of medicine by a doctor, the pharmacist has a chance to rectify this problem.

5.5.   Analysis of the study results

So far we have presented the user perceptions in this chapter based on the interviews conducted in 7 Tanzanian hospitals with health care personnel and hospital management. This sub chapter will focus on analyzing the interview results and comparing the three hospital information systems (HIS) based on these user interviews.

Based on the interviews, we saw that there are many hospitals that have a HIS in place, but are not using it, or are using it **only partially in some of the departments**. The reasons mentioned varied from the system having "collapsed", or not providing the required features for the given department. This could likely lead to conclusions among the hospital personnel that a HIS is not useful. Without further details it is impossible to say what were all the contributing factors that led to such situations.

Aspect of use	AfyaPro	Care2x	GoTHoMIS
Most mentions of benefits	2	1	3
Most mentions of challenges	1	2	3
Most mentions of improvement suggestions	2	1	3
Most mentions of missing functions	n/a	1	2
Most mentions of lacking integrations	1	2	2
Most mentions for sufficient training	3	1	2
Most mentions for good customer support	3	1	2

Table 4. The three hospital information systems ranked based on the number of user perceptions reported about them.

Table 4 above provides an overall view of how the three hospital information systems were perceived by the users on various aspects. In Table 4, the three HIS products are ranked from 1 to 3 based on the number of mentioned perceptions by the users who participated in the interviews. Number 1 indicates the highest number of mentions. Such ranking gives an indication of how the systems were performing in the hospitals. Each hospital manager making a decision about which hospital information system to use should look at the advantages and disadvantages provided in this study, and reflect on the situation in their respective hospital. For example, if the hospital personnel includes a large number of people with low computer skills, it should be considered whether the HIS developer provides thorough customer support for its users.

Minor and major usability issues were present in all hospital information systems and were reported by all of the interviewed user groups. It would be important for the HIS developers to fix them as they can delay the work and even cause double work for many of the hospital personnel which causes a lot of frustration and loss of operational performance, ultimately leading to substandard experience for the patient.

Some of the usability-related problems reported by the respondents included issues such as data that disappears for no reason, and duplicate orders to cashiers. It is worth asking whether some of these types of problems are actually related to the system, or could they perhaps be user-induced, e.g. a user might have forgotten so save the information after filling out a form or made a double order by themselves.

Incompletely filled patient records were an example of perceived challenges given by some of the participants. While this can cause many frustrations to health care personnel who would need to understand a patient's situation, perhaps the issue could be rectified by requiring the user to fill out certain fields. This could be a customizable option so that the HIS administrator could adapt the forms according to the needs of the

hospital. This way, forms would get completed appropriately. The downside of this approach is that then the process is not flexible and takes more time. Perhaps HIS designers could consider voice user interfaces for filling out forms. In this approach, the importance of re-checking the information becomes highly important, and noisy hospital environments might provide additional issues.

Frequently occurring power cuts and network problems were mentioned as some of the major issues with HISs. In the event of those, the users were forced to resume manual labor and endure loss of important data. It would be recommended that the HIS developers would consider this factor, and create systems that can work seamlessly offline whenever an issue with the network is faced. The system could save the data offline and update it back online when possible.

Perceptions of each HIS will be analyzed separately below.

AfyaPro

AfyaPro seemed to bring a **lot of manual work** to its users. This is what the users mostly disliked about the system. One of the biggest issues was that the system is not compatible with the government of Tanzania's reporting system. This was seen as a hurdle by many participants, and as something that would make the user experience of the system worse. Despite the **lack of the important MTUHA integration**, users also had experienced a reduction in the amount of manual work in other areas such as **tracking patient records**. AfyaPro also seemed to lack many functionalities that would be important to the hospital personnel. It caused issues due to the lack of integration to the laboratory equipment which caused a lot of additional work especially for the laboratory personnel.

AfyaPro seems to be easy to learn for the users, but they still felt **the need for more training on the system, even in basic computer skills**. A situation where part of the hospital personnel is proficient with computers, and some are not, is inequitable and might contribute to unsustainable HIS use in the long run.

The fact that AfyaPro is not integrated with nearly any other systems caused discontent among the participants. If the hospital is required to provide MTUHA reports, then having this integration in the system would be really important. Many hospitals are shifting away from AfyaPro because it does not provide the integration with the MTUHA reports.

Care2x

Care2x was most praised out of the three systems in terms of **simplifying the daily hospital work flow** and reducing the time required for work. Care2x was also seen very

good in keeping accurate patient data and this way providing better service to the patients.

Care2x was also found **the most easy to use** between all three hospital information systems among all the user groups. It also got the best feedback about having sufficient training and customer support provided to the hospital in case of technical issues. It also had the **most number of perceived benefits** mentioned in terms of the system features. Despite the perceived benefits, Care2x still have a long way to go, as it also received the most mentions for improvement suggestions and missing functions. Together with GoTHoMIS, Care2x had the least amount of lacking integrations mentioned by the respondents, both faring better than AfyaPro in this regard.

GoTHoMIS

GoTHoMIS caused the least amount of headache to its users, as it received relatively the least amount of mentions about challenges. It also fared low on improvement suggestions, so it seems like the users of GoTHoMIS did not have as much to complain in terms of system functionalities as the users of the two other systems. GoTHoMIS users were also happier with the functions than the users of other systems, as they reported the least amount of functions, that they would like the system to have. However, GoTHoMIS gained the **least amount of mentions for perceived benefits**. It is the newest one of the three hospital information systems included in our study, so this could be one of the reasons for such findings as users might not be familiar with all the benefits yet. **Both Care2x and GoTHoMIS fared better than AfyaPro in terms of integrations**. Regarding customer support, GoTHoMIS earned the most mentions after Care2x, but it was still far off compared to Care2x in this regard. Users of GoTHoMIS felt that they need more training in using the system. However, the learnability was perceived easy by some of the participants.

Integration with the MTUHA reporting system is one of the biggest strengths of GoTHoMIS. **Detailed patient history** was also mentioned as one of the best things about GoTHoMIS, just like in Care2x. **Automation of various hospitals tasks and the possibility to track important metrics** were some of the parts mentioned positively about the use of GoTHoMIS.

5.6. Discussion

So far, this thesis has mapped out the benefits and challenges of hospital information systems and studied the user perceptions of three HIS products in Tanzanian hospitals. The literature review looked at studies regarding the perceived benefits and challenges of HIS adoption and use in developing countries, and how their design could be improved. In our user study, we have discovered several points for improving the

current HIS products that hospital decision-makers can benefit from when selecting a HIS.

The common challenges regarding the HIS adoption and use presented in our literature review were well represented in the user study. The interviewees often mentioned the hospital personnel's lack of basic computer skills and unreliable ICT infrastructure as perceived challenges with HIS use. These are important aspects that without a doubt have a major impact on the perceptions toward hospital information systems. Once the system is off due to a power cut or a network issue, and all patient data is lost requiring re-entry, the process can get very tedious for both the hospital personnel and the patient. Add to that, a queue of patients waiting simultaneously, and frustration is guaranteed.

Many hospital personnel have to work collaboratively, and sometimes relatively small things could become significant in an intense and fast-paced working environment. Slow typing speed, or even not being able to use a computer can be major factors in how well hospital information systems are adopted by the personnel. Hence, it is of utmost importance that the staff is not only thoroughly trained to use the HIS products, but also provided training in basic computer skills, whenever necessary. These factors were emphasized in the literature review as well (Busagala & Kawono, 2013; Kajirunga & Kalegele, 2015).

In our study we could see that the basic necessities are important aspects of user experience. Basic and advanced level training of HIS users, reliable ICT infrastructure, and customer support create the appropriate environment for the HIS. This should be considered by the decision-makers in the hospitals as a vital aspect of sustainable HIS use.

Many of the participants in our study, especially doctors, mentioned double documentation as a challenge with the HIS they were using, with an exception of the GoTHoMIS. It was also found in the literature that specifically electronic medical records can be a bottleneck in HIS use, since the lack of necessary integrations leads to double work (Tilahun & Fritz, 2015). This emphasizes the importance of the HIS having the required integrations, as the system might be completely abandoned if it does not fulfill the requirements of the users. This was also seen in our study results from Sengerema hospital, where doctors were not using their HIS at all for this reason. Creating MTUHA reports is a common task in Tanzanian hospitals, and an absolute necessity to be integrated with a HIS in Tanzania.

Partial use of HIS was one of the challenges seen both in the literature review (Kimollo et al., 2010) and the user study. Even though hospital information systems intend to cover all functionalities inside a hospital, the main purpose being increasing the collaboration and efficiency of the whole hospital, this is not always the case. In our

data, we saw that there were hospitals who used a HIS only in one or two of their departments. One of the hospitals even had two systems in use simultaneously, one for inventory-related tasks and another one for patient-related tasks. For a HIS to provide its full benefits to a hospital, it should be used in all hospital departments.

One of the perceived benefits our user study interviewees expressed was the decrease in financial malpractices thanks to the hospital information system. This also reflects the findings of our literature review where the same effect was found in Kenyan hospitals (Nkanata et al., 2018). This would certainly be seen as a positive effect by most, but could also cause discontent in HIS users with unlawful tendencies.

Regarding the HIS design, discussing individual functionalities of HISs without understanding the use context easily becomes too superficial. It is important that the designer is fully familiar with the local circumstances and user requirements. As Heeks (2002) pointed out, the design-actuality gap is a major determinant of success for ICT systems in developing countries. It should be acknowledged that even designers living and working in developing countries can be influenced by the HIS designs created for the developed country setting, and hence create biased designs inappropriate for the context they are meant for. Design-imposing applications are common when designers from developed countries design systems for developing country settings (Heeks, 2002). This approach is typical especially in donor-funded IS projects due to the dearth of time and funding. Heeks says that design divisibility is a key factor, i.e. the system should be designed in such a malleable way that it leaves room for local improvisations and opportunities for learning.

Since there is no universal blueprint for designing or implementing an information system, such as a hospital information system (HIS), in a developing country setting, we need to examine each situation separately and recognize the unique requirements attached to it. Only then we can really begin to bring true value to decision makers in selecting appropriate HIS and to designers creating information systems that match the user needs. This is why our user study is important in addressing the unique factors in the Tanzanian setting and at least partially avoiding problems caused by the country context gap. It is worth a mention, however, that the HISs included in our case study might be fully or partly created by designers who have not considered all of the dimensions of the actual setting where the HIS would be used resulting the HIS to be inappropriate for the context it is meant for.

6. Conclusion and Future Work

With the rise of health IT, hospital information systems (HIS) have become prevalent in developing countries, and they have a significant potential in improving the everyday work flow of hospital personnel, increasing the operational performance of a hospital, and even lead to better patient experience and improved health outcomes. However, developing countries face different problems than developed nations in the adoption and use of these systems. In Tanzania, hospitals have started adopting hospital information systems, which mainly work in silos. With so many different systems out there, it is difficult for decision-makers at hospitals to know which HIS to select.

The overall aim of our research was to study the user perceptions that influence the adoption and use of hospital information systems in developing countries. Our user study investigated the perceptions of hospital management and health care personnel in seven Tanzanian hospitals regarding three hospital information systems: AfyaPro, Care2x, and GoTHoMIS, providing valuable information for decision-makers in Tanzanian hospitals. The primary research question aimed to explore which issues in user experience support or hinder the adoption and use of electronic hospital information system in developing countries, which was explored in the literature review and the user study. The secondary research question explored what design implications can be drawn to help create better hospital information systems.

One of the strengths of our user study was that it involved all the internal user groups of HIS, including managers, doctors, nurses, pharmacists, laboratory personnel, IT professionals, and support staff. Hence, it provided an overall view of the three hospital information systems, covering perspectives of several user groups.

The user study mapped out user perceptions in four areas: 1.) perceived quality of use, 2.) benefits, challenges and suggestions for improvement, 3.) learnability, training and customer support, and finally 4.) the extensiveness of the system in regard to integrated modules and functionalities. The user study revealed that automation, reduction in manual work, and tracking various hospital metrics were perceived as major benefits of HIS. However, hospital personnel's lack of ICT skills, frequent power cuts, lack of necessary HIS integrations, and usability issues were perceived as challenges in HIS use. These were well reflected in the literature review, which makes the findings of the user study more reliable. The study was able to provide many pointers to hospital decision-makers to get a better idea of individual HIS features and how the products compare to each other. These pointers are also valuable for HIS designers wishing to improve the current systems.

The user study was conducted with Tanzanian hospitals. This thesis aimed to give information to decision-makers in Tanzanian hospitals for selecting a HIS. The results might not be applicable in other developing countries as each country and even each

hospital has its own unique requirements, even though many common denominators can be found.

The user study presented in this thesis included a small number of users (n=35). Studies that would be bigger in scope would be required for future research. Moreover, future studies could perhaps consider using an established theoretical framework, such as TAM (technology acceptance model) or UTAUT (unified theory of acceptance and use of technology). Using surveys based on these frameworks would be useful in gathering more structured insights about the user satisfaction level of a HIS.

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Appendix 1. Interview topics and questions

	Question
Hospital	
Department	
Job role	What is your job title / job role?
Education	What is your educational background? (Field and level)
Work experience in the organization (years)	How long have you worked for this hospital?
Overall working experience	How long working experience do you have in total? (previous relevant jobs)
How long have you used the system	How long have you used the system
How the system has changed the work	Since taking the system into use, how has your job changed?
Experience with other systems	Have you used other similar systems? For how long?
Benefits of the system	What is good in the system? What do you like about the system?
Challenges in the system	What is bad in the system?
What has been done to overcome challenges	Have you done something to overcome the bad things in the system? What / What have you done to overcome these issues?
Improvement wishes	How would you like the system to be improved?
Learnability	Was there something that was difficult to learn? What
Training	Did you get training to use the system? How was it? Was it sufficient? Do you need more training? What kind of training?
Support	What do you do when you encounter problems with the system? Do you get the help needed?
Accessibility	Is the system always available to you?
Manual / repetitive work	Do you still do some work manually on paper? What?
Worse/more difficult than before	Is there something that is worse, more difficult than before the system?
Missing functions	Is there something missing from the system?
Integrations	Is the system integrated to other systems relevant to you?
Problems with current integrations	Are the current integrations sufficient and working?
Missing integrations	Should the system be integrated to other systems?
Staff / computer ratio	How many staffs work in one shift? Do everybody use the system? How many computers do you have here? What kind of devices