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A model for post-implementation evaluation of health information systems: The case of the DHIS 2 in Kenya

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Declaration

I, James Karanu Gathogo, declare that this work has not been previously submitted and approved for the award of a degree by this or any other University. To the best of my knowledge and belief, the Thesis contains no material previously published or written by another person except where due reference is made in the thesis itself

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APPROVAL

This research project has been submitted as part of fulfillment of requirements for the Master of Science in Information Systems with my approval as the Supervisor.

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Abstract

The Kenyan government through the Ministry of Health (MoH) in its quest to improve the health outcomes of its citizenry, has embarked on a number of initiatives. One of these initiatives under the umbrella of eHealth is the District Health Information Software(DHIS 2). DHIS 2 is "an integrated, web-based, country owned and managed, national health information system that integrates quality data used at all levels to improve health service delivery"Douglis (2012) . The logic behind the emphasis of DHIS 2 is that with quality data, public health decision making will be more efficient and effective. Despite the importance of DHIS 2, no study has been done to evaluate the post-implementation of the system, particularly user perspective. DHIS 2 was a large investment and like any organisation, the MoH would be interested in knowing the impact the system has on its users. The objectives of this study were: to establish the user's perspective in evaluating a health information system (HIS) and present a set of evaluation factors that can be used in evaluating a HIS, identify a suitable evaluation model and, test the evaluation model using DHIS 2. We reviewed literature on information systems, health information systems, the information system(IS) user and IS success theories and models. The IS-Impact model was used as the theoretical foundation for this study. The model comprises four dimensions, which are Individual Impact, Organizational Impact, Information Quality and System Quality. The questionnaire was the main data collection tool with focus group discussions(FGDs) being used as complementary tool. A total of 135 reponses from questionnaires and transcribed data from 2 FGDs were used for analysis. The results indicate that 89% of the respondents were operational or day-to-day DHIS 2 users with System Quality being the strongest contributor to the IS-Impact model. In Individual Impact, the individual performance of the respondents on behalf of their organisation, most respondents stated that DHIS 2 had an impact in their performance. Under Organisation Impact, the impact of DHIS 2 at a broader, organisational level, most respondents felt that DHIS 2 has an impact particulalrly in achieving the MOH's objectives. In Information Quality, the quality of information that the system produces in reports and on screen, most respondents stated that it was high. However, respondents were divided on whether data from DHIS 2 was unique. Under System Quality where users were asked on their perception of DHIS 2 performance from a technical and design perspective, there were mixed views regarding system quality issues. The FGDs revealed that impact of DHIS 2 was due to comparison with the previous Excel-based system which was time-consuming and involved a lot of paperwork. On quality the FGDs revealed problems with lack of DHIS 2 integration with other systems and inconsistencies between data collection tools and the DHIS 2 data entry portal. The conceptual model was tested using tolerance, Variance Inflation Factor(VIF) and correlation co-efficients. The test results indicate that

30 measures are significant for measuring the impact of health information systems in Kenya. This demonstrates the validity of the model. Based on these findings, a model for post-implementation evaluation of health information systems is presented. It is recommended that the model needs to be extended further to include the context under which the system is based. For instance, comparative studies can be conducted to evaluate the success of the HIS in a rural setting as compared to an urban setting. Also, one of the limitations in this study was getting respondents who were in strategic management. This study's respondents were operational users i.e., they interacted with the system on a day to day basis. Strategic users as compared to operational users interact less with the system but are important because they decide on the resources required to achieve organisational objectives. Also, decisions made in the strategic level have long-term implications. Therefore, this model can be extended further to include strategic users.

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This thesis would not have been possible without the input of very special people

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Abbreviations

AIDS	Acquired ImmunoDeficiency Syndrome
CHRIO	County Health Records and Information Officer
DHIS 2	District Health Information Software 2
DHRIO	District Health Records and Information Officer
DHMT	District Health Management Team
GIS	Geographic Information System
HIS	Health Information System
HIV	Human Immunodeficiency Virus
ICT	Information and Communication Technology
IS	Information System
MFL	Master Facility List
MOH	Ministry of Health
VIF	Variance Inflation Factor

Chapter 1

Introduction

1.1 Background

The Kenyan government, aims to provide equitable and affordable health care at the highest affordable standard to all its citizens. However, to achieve this vision a number of challenges have been encountered. These include, shortage of skilled health care workers, public health threats such as polio and cholera which require a robust health surveillance system, service inequality, inadequate health infrastructure and equipment and an inadequate system of collecting, storing, processing and disseminating healthcare data. These challenges are currently being addressed through the Ministry of Health (MOH)'s collaborative efforts with various stakeholders. A number of initiatives have been rolled out in line with Kenya's Vision 2030 goal for the health sector, equitable and affordable healthcare at the highest achievable standard. One of these initiatives is eHealth where the MOHs vision is "to develop an efficient, accessible, equitable, secure and consumer friendly health care services enabled by ICT"(MoH Kenya, 2011). The eHealth strategy has identified the District Health Information Software 2 (DHIS 2) as the foremost priority in its endeavour to improve health service delivery through ICT.

1.2 Statement of the Problem

Kenya has been at the forefront of exploring ways through which ICT can work in providing effective and efficient services to its citizenry, including through eHealth. Indeed, future of eHealth in Kenya looks promising since a strategy is in place, the required infrastructure is being set-up and the programme has already been rolled out. The District Health Information System (DHIS 2) has been prioritised in the eHealth strategy in achieving effective service delivery. Indeed, Kenya was the first county in Sub-Saharan Africa to deploy a completely online national DHIS 2 (DHIS 2 In Action, 2013). However, no study, to the best of our knowledge, has been done to evaluate the post-implementation of the system, particularly from the perspective of the user. DHIS 2 was a large investment and like any organisation, the MoH would be interested in knowing the impact the system has on its users. Therefore, in response to this problem, our study proposes to establish what in the users perspective are parameters of DHIS 2 post-implementation evaluation and propose a model which can be used to evaluate the impact of the system.

1.3 Research Objectives

The overall objective of this study is to develop a model for post-implementation evaluation of health information systems. The specific objectives are to:

1. Establish the user's perspective in evaluating a health information system (HIS) and present a set of evaluation factors that can be used in evaluating a HIS.
2. Develop an IS evaluation model based on review of existing models.
3. Test the evaluation model using DHIS 2

1.4 Research Questions

1. What factors would a user of a HIS consider if they were to evaluate the success of the system?

2. What is the appropriate model for evaluating a HIS?

3. How applicable is the model in evaluating DHIS 2?

1.5 Justification of the Study

It is envisaged that the findings of this study will be useful in the following areas:

- The Ministry of Health which is currently implementing various eHealth initiatives in better understanding the users of the DHIS 2. By understanding the users' perspective of system effectiveness, the MoH will continually refine the DHIS 2 platform which will ensure expansion and well documented returns on Kenyas investments in health.
- Policy Deployment where more emphasis will be placed in evaluating IS success from a user perspective.
- Research could also contribute to the body of knowledge on evaluation of health information system effectiveness particularly in the setting of developing countries.

1.6 Scope of the Study

DHIS 2, like any web-based platform, is used by different people from different parts of the country. Currently, there is an active core group of 500 users. Though these users may be from non-governmental organisations, academia or in their individual capacities, majority are "officers in charge of data entry and data management at all levels of the country who use the system routinely" (Manya et al., 2012). This study will assess the effectiveness of the DHIS 2 from the perspective of these active users, who include: District and County Health Records and Information Officers, Senior Health Records and Information Officers, managers at the MoH and other users. Also, we will observe how data is collected at the facility level by heath workers. Our sample size will be 145 DHIS 2 users.

1.7 Limitations of the Study

1. The actual DHIS 2 users - According to the MoH's Health Information System(HIS) department, there are over 3,000 DHIS 2 users. The users can be divided into two, primary and secondary. The primary users, the core users of DHIS 2, are the Health Records and Information Offcers(HRIOs) who interact with DHIS 2 on a frequent basis. The secondary users do not use DHIS 2 as frequently as the DHRIOs. The bulk of the repondents of this study were HRIOs who at the time of the data collection were mostly based at the district level.

2. Devolution process - Kenya is currently undergoing restructuring on its governance structure where a larger part of service delivery is gradually being transferred from the central government to the county governments. This has not left out the Ministry of Health. During the period when this study was being conducted (November 2013 to January 2014), there was uncertainity whether health workers were under the national or county government(Wanambisi, 2013). This confusion posed a challenge in getting DHIS 2 users to fill up the questionnaire. We however endeavoured to call each user as per the contact list provided by the ministry's HIS department.

3. Sampling - A big part of the target population in this study were DHRIOs who are distributed over the 290 districts in Kenya. Though our plan was to derive a representative sample through random sampling, this was not the case. Purposive sampling was therefore was utilised.

1.8 Chapter Summaries

The remainder of the report is structured as follows:

- **Chapter 2 - Literature Review** - Reviews prior literature on information systems, health information systems, the IS users, IS success evaluation models and concludes with proposing a conceptual model.

- **Chapter 3 - Research Methodology**- Discusses research design, population and sampling size, data collection instruments and, data collection, preparation and analysis processes.

- **Chapter 4 - Results** - Presents results on respondents' demography, descriptive analysis of survey items, combination of quantitative and qualitative data and model testing.

- **Chapter 5 - Conclusion and Recommendation** - Presents a review of the research objectives, research assessment and makes recommendations for the Ministry of Health and further research work.

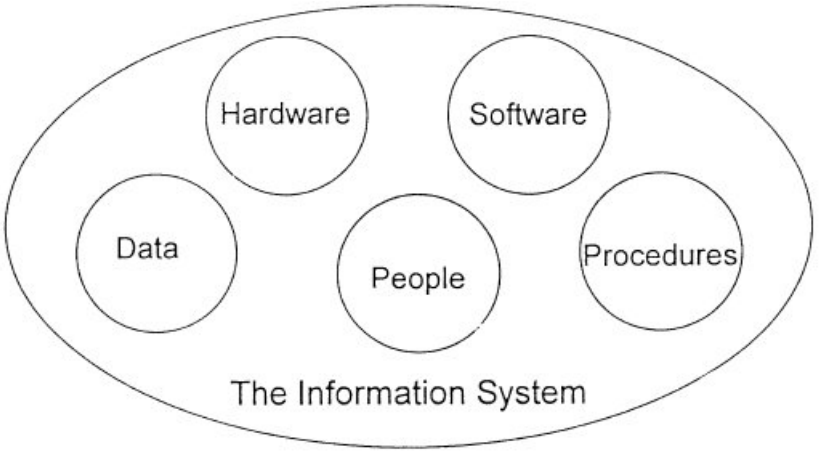
Chapter 2

Literature Review

2.1 Information Systems

The concept of Information Systems has its foundation from general systems theory where an entity is not only viewed on its own but in the context in which it is based in (Ackoff, 1979, Silver et al., 1995). An information system (IS) can be defined as a "set of interrelated components that collect(or retrieve), process, store and distribute information to support decision making,...control...problem analysis, complex subjects visualisation and creation of new products, in an organisation" (Laudon & Laudon, 2004). An IS, as shown in Figure 2.1 is composed of the *people* who interact with it, the physical devices or *hardware*, information processing instructions(*software*), *procedures* and *data*.

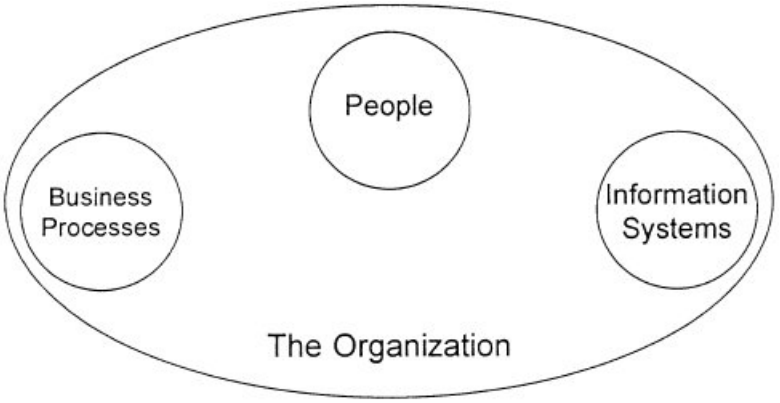
FIGURE 2.1: Information System Components



Source: Silver et al., 1995

Also, an IS does not exist in isolation, it plays a role within an environment as shown in Figure 2.2. This implies that IS exists not for the sake of the system itself but in the context of the environment that it is in. This environment has a significant effect on the IS particularly, particularly currently where it has become inceasingly complex and dynamic(Avison & Fitzgerald (2003)).

FIGURE 2.2: Information System in Context



Source: Silver et al., 1995

Laudon & Laudon (2004) cites input, processing, and output as the three functions in an information system that produces the information that organisations need to make decisions, control operations, analyse problems, and create new products or services. The Input function captures or collects raw data from within the organisation or from its external environment. *Processing* then converts this raw input into a more meaningful form. *Output* transfers the processed information to the people who will use it or to the activities for which it will be used. Also, *Feedback* is an overarching feature in IS which provides evaluation and correction to the input function.

Laudon & Laudon (2004) also categorises information according to the organisational level which they serve. These are:

- Executive support systems (ESS) at the strategic level
- Management information systems (MIS) and decision-support systems (DSS) at the management level
- Knowledge work systems (KWS) and office systems at the knowledge level
- Transaction processing systems (TPS) at the operational level.

This study concentrated on a type of management information system. According to Laudon & Laudon (2004), MIS primarily serves the management level of an organisation. This is through providing reports which outline current and historical performance. They are mainly suited for the internal environment and serve the functions of planning, controlling, and decision making at the management level. MIS depend on transaction processing systems for their data.

We proceed to discuss health information systems, a form of management information systems, as used in the public sector.

2.2 Health information systems

The use of Information and Communication Technology (ICT) in health care has gained widespread usage and is being integrated into health systems and services worldwide(WHO, 2006). This has not left out governments which have invested in health information systems (HIS) to help in decision making at facility, district and national levels.

A health information system can be defined as the "set of components and procedures organised with the objective of generating information that will improve health management decisions at all levels of the health system"(Sauerborn & Lippeveld, 2000). It is important to note that the ultimate objective is to contribute "high-quality and efficient patient care"(Haux, 2006) as compared to having a HIS that works seamlessly and makes everyone happy yet does not improve the health outcomes.

In discussing the eras through which health information systems have evolved, Haux (2006) suggests that there are five important lines of development, namely:

- A shift from a largely manual to a computer-based processing and storage, accompanied by increasing amounts of public health data
- Change from HISs that focus on individual health facilities to those that have regional and national level outlook
- Access to HISs by the general public as compared to use by health care professionals only

- Widening the use of HIS data to inform health care planning, clinical and epidemiological research
- Focus on the HIS as a strategic tool over and above its technical role.

The HIS architectural styles have also changed from being facility-centred to architectures that transcend institutions, districts, regions and even nations(Haux, 2006). To make this a reality, current architectures utilise cloud-based infrastructure where the HIS platform is hosted in a central server. We next explore DHIS 2 in Kenya which utilises this architecture.

2.2.1 The District Health Information System in Kenya

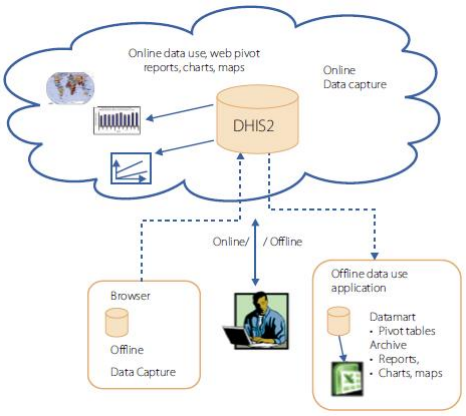
The District Health Information Software (DHIS 2) is "an integrated, web-based, country owned and managed, national health information system that integrates quality data used at all levels to improve health service delivery"(Douglis, 2012).

DHIS 2 was borne out several reviews that were done over a ten year period. These reviews identified a number of issues as identified by Manya et al. (2012) including, duplication of efforts due to multiple health information systems being implemented around the country, difficulty in gauging progress in the health sector, difficulty in determining intra-district reporting rates, limited analysis capabilities and often conflicting statistics of the Excel-based databases and lack of ownership of the existing HIS.

Based on these challenges and upon reviewing various alternatives, Kenya adopted the District Health Information Software - Version 2.11 (DHIS 2). DHIS 2 is built on Java-based frameworks which is Free and Open Source Software (FOSS) and is web-based. DHIS 2 can run in most operating systems, both on online or offline mode. Figure 2.3 demonstrates this semi-online capability which comes in handy where internet connectivity is erratic. Due to its open architecture, it can be integrated with other applications. DHIS 2, as at October 2012, has been adopted as a nation-wide HIS software by Kenya, Tanzania, Uganda, Rwanda, Ghana, Liberia, and Bangladesh(DHIS 2, 2013a).

The day to day use of the DHIS 2 is done by district health records information officers, hospital health records information officers and the district health management

FIGURE 2.3: DHIS 2 Semi-Online Data Capture and Analysis



Source: Braa & Sahay, 2012

team members. All have undergone training on how to effectively manage public health information using DHIS 2. The system has been described as "easy to use" and "user friendly"by users (Manya et al., 2012). There, however, is need to get the perspective of users, on their view of the system with the ultimate objective of continual refinement of DHIS 2 methods and tools.

2.3 The IS User

When evaluating the success of an information system it is important to do so from the perspective of various levels within an organisation(Cameron, 1980). An information system serving a large organisation has different stakeholders each with varied aims and views on what the system should do. Also, different stakeholders, which Sedera et al. (2007) refers to as "employment cohorts due to the intra-organizational focus" often differ on how they evaluate an information system. This is because one employment cohort may have conflicting experiences from another(DeLone & McLean, 1992).

Anthony (1965, 67) provides an explanation for the different employment cohorts that Sedera et al. (2007) refers to. In any organisation, the levels of employment can be classified under the headings: strategic, management and operational.

The strategic level is tasked with formulation and revision of objectives and policies that the organisation will abide by. Also, this level requires deciding on the resources required to achieve organisational objectives. Decisions made in this level have long-term

implications. The number of persons involved in this level is small with the end product being workable policies and the quest to leave a legacy. The nature of information here is problem-specific, predictive, derived from external sources and is less accurate.

Managers are responsible for ensuring that the necessary resources are sourced and used effectively and efficiently in accomplishment of organisational objectives. The time horizon of decisions made tends to be shorter than that of the strategic level. The number of people at this level is larger and managers tend to work within policies spelt out in policies. The nature of information here is more integrated, more accurate, internal and historical than at the strategic level.

At the operational level, stakeholders ensure that specific tasks are carried out effectively and efficiently. The users tasks are precise, specific to the operation, often non-financial and conducted in real time. Their time horizon is constricted within day to day activities.

Sedera et al. (2007) provides a summary of the three employment cohorts as shown in Table 2.1 below.

Sedera et al. (2007) recommends that in evaluating IS success one needs to gather multiple perceptions from all employment cohorts, however due to organisational constraints one can make useful observations by gathering data from one user cohort.

TABLE 2.1: Employment Cohorts and Related Tasks

Activity	Strategic	Management	Operational
Focus of Plans	Futuristic, One aspect at a time	Whole organization	Single task / transaction
Complexity	Many variables	Less complex	Simple, rule based
Degree of Structure	Unstructured, irregular	Rhythmic, procedural	Structured
Nature of Information	Tailor made, more external and predictive	Integrated, internal but holistic	Task specific, real time
Time Horizon	Long term	Long, medium to short	Short

Source: Sedera et al., 2007

In this study we evaluate the success of the DHIS 2 from the perspective of the user based on strategic, managerial and operational perspectives.

2.4 Information Systems Success Evaluation

The measurement of IS success is a field that has gained considerable interest from both practitioners and researchers. Organisations, even in economic downtimes, are increasingly spending more on IT (Gartner, 2013). It is therefore prudent that organisations find out the returns of their investments.

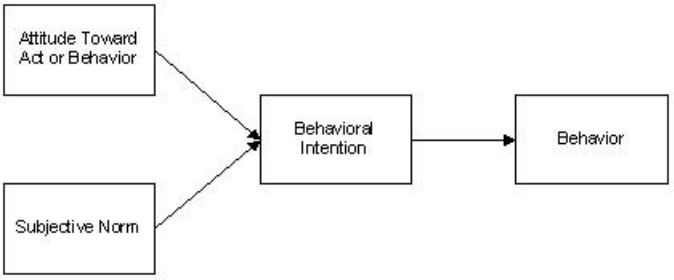
The success or effectiveness of information systems can be defined in two different ways as suggested by Hamilton & Chervany (1981). Firstly, the goal-centred view measures the effectiveness of an IS by comparing how well its performance meets the objectives set by management. Secondly, the system-resource approach considers the users perspective on whether the IS is serving their needs to facilitate communication, improve job satisfaction, or fulfil other needs beyond the primary organisational objectives. This study will adopt more of the system-resource approach where will be evaluating the success of the DHIS 2 from the view of the user.

Researchers in the IS field have developed a number of models and theories to evaluate and explain what makes an information system effective or successful. The most cited models include Technology Acceptance Model (TAM), Delone and Mclean Success Model(DM) and the IS-Impact Measurement Model.

2.4.1 Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) was developed as an extension of the Theory of Reasoned Action (TRA). TRA, developed by Ajzen & Fishbein (1980), as shown in Figure 2.4 posits that a person's behavioural intention is determined by their attitude about the behaviour and subjective norms. Attitude about a behaviour is defined an individual's positive or negative perception towards performing the said behaviour; subjective norm is an individuals perception on whether other people important to them think that the behaviour should be performed Fishbein & Ajzen (1975). Therefore an individuals attitude coupled with social pressure determine whether the individual intends to perform the action which consequently will lead to the performing the said behaviour.

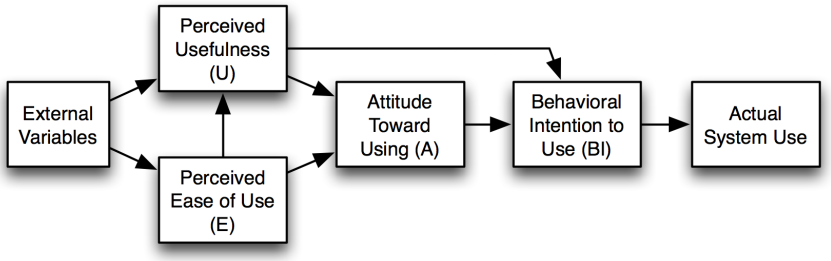
FIGURE 2.4: Theory of Reasoned Action (TRA) Model



Source: Fishbein & Ajzen, 1975

TAM replaces many of TRAs attitude measures with the two technology acceptance measures, perceived ease of use, and perceived usefulness as illustrated in Figure 2.5 below. Subjective norm, that was in TRA, were left out of TAM because "of its uncertain theoretical and psychometric status"(Davis et al., 1989).TAM, like TRA, postulates that an individuals intention to use a particular technology is driven by their attitude towards the said technology.

FIGURE 2.5: Technology Acceptance Model (TAM)



Source: Davis et al., 1989

Davis (1989) defines Perceived usefulness (U) "the degree to which a person believes that using a particular system would enhance his or her job performance" while Perceived ease of use (E) as "the degree to which a person believes that using a particular system would be free from effort". Both U and E consequently have a significant impact on a user's attitude toward using a particular system (A). Next, A and U determine the Behavioural intentions to use (BI). BI finally determines actual system use. Davis (1989), Taylor & Todd (1995) assert that BI is the strongest predictor of actual use. Therefore it is assumed that once a user decides or intends to use the system, they will eventually use it.

Though TAM was not specifically developed for the health sector, it has received varied support from researchers. Holden & Karsh (2010) used TAM to review 16 data sets analysed in over 20 studies of clinicians using health IT for patient care. Yarbrough & Smith (2007) conducted studies of physicians acceptance and use of health IT, which included four datasets that have been statistically analyzed using TAM as a theoretical base and propose a research model that builds on TAM.

TAM has received criticism on the assumption that behavioural intention is a predictor of use. Salovaara & Tamminen (2009) point out that though a technology may be accepted by a user initially, it may later be thrown away due to factors beyond their control. Salovaara & Tamminen (2009) assert that TAM is not sensitive to different use contexts. Lee et al. (2003), Legris et al. (2003) question the research approach that has been used in TAM where many studies base their measures on self-reported use and users who have barely interacted with the system. Also, the technology studied under TAM have been described by Venkatesh et al. (2003) as "relatively simply, individual-oriented information technologies as opposed to more complex and sophisticated organisational technologies that are the focus of managerial concern" a view that is supported by Legris et al. (2003) who concludes that the type of software needs to be "business process applications".

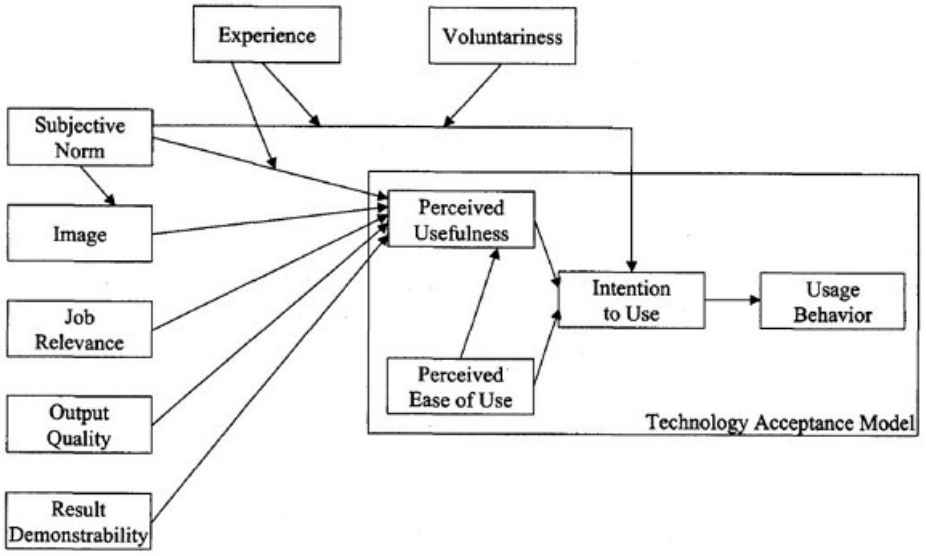
TAM has been praised for being simple to understand and practical (Taylor & Todd, 1995). Despite its shortcomings, TAM as a pioneer model has proven to be a useful theoretical model in understanding and explaining the behaviour in information system adoption. Also, it has been consistent in proving that perceived usefulness of a system is a strong determinant of intent to use (Venkatesh & Davis, 2000).

TAM was letter extended by Venkatesh & Davis (2000) to TAM 2. TAM2 was formulated to "include additional key determinants of TAM's perceived usefulness and usage intention constructs, and to understand how the effects of these determinants change with increasing user experience over time with the target system." (Venkatesh & Davis, 2000).

Figure 2.6 shows a visual depiction of TAM2. Perceived usefulness is a function of subjective norm, image, job relevance, output quality and result demonstrability. Subjective norm is an individuals perception on whether other people important to them think that the behaviour should be performed, image is the level to which the use of a new system

is perceived to enhance one's status in one's social system, job relevance is an individual's perception on how a said innovation is relevant to their job, output quality is an individuals perception on how well the system performs their job tasks well, and result demonstrability is credible evidence out of the perceived results of using the system.

FIGURE 2.6: Technology Acceptance Model 2 (TAM 2)



Source: Venkatesh & Davis, 2000

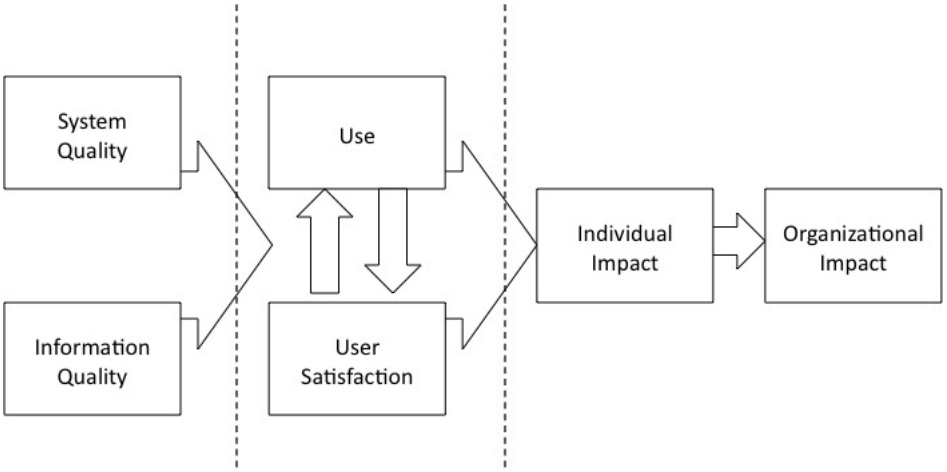
2.4.2 Delone and Mclean Success Model (DM), 1992

In 1992, Delone and McLean formulated a success model in an attempt to bring the different dimensions of IS success together in a comprehensive framework. Delone and McLean synthesised the views of earlier success models, including TAM, and categorised IS success into six major inter-related dimensions namely, system quality, information quality, use, user satisfaction, individual impact and organisational impact.

The six dimensions came out of Delone and McLean's review of all those empirical studies that had attempted to measure some aspects of MIS success in several publications. In total 180 studies were reviewed.DeLone & McLean (1992) examined these six dimensions at three levels as defined by Shannon & Weaver (1949). The technical level focuses on the information system itself by examining its accuracy and efficiency, the semantic level examines whether the information conveyed by the system is as intended and the effectiveness level is the impact of the information from the system on the receiver.

Figure 2.7 illustrates the six dimensions of the Delone and McLean success model. System quality examines the success of the information system at the technical level while information quality studies the system at the semantic level, and use, user satisfaction, individual impact and organisational impact look at the effectiveness or influence level.

FIGURE 2.7: The Delone and McLean IS success model



Source: DeLone & McLean, 1992

Further to their proposed model, DeLone & McLean (1992) "further development and validation before it could serve as a basis for the selection of appropriate I/S measures". A number of IS researchers heeded this call and proposed changes to the model. Motivated by Delone and McLean's call. Seddon & Kiew (2007) examined part of the IS success model and evidence of their inter-relationship. The four constructs that were studied included: system quality, information quality, use and user satisfaction. In their study, Seddon and Kiew modified the "use" dimension to "usefulness". These three constructs, system quality, information quality and usefulness explained 75% of the variance in the overall user satisfaction construct. Seddon & Kiew (2007) further suggested that in cases where the IS use is mandatory, it is better usefulness is a better construct than use. However, Delone & McLean (2003) maintained that the use construct needed to be retained because it could vary even in a mandatory setting.

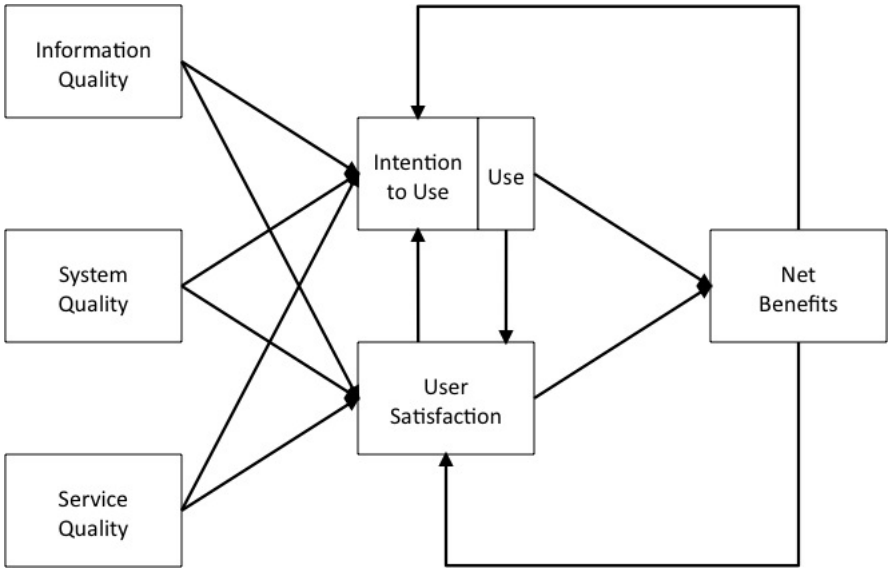
Noting that the Delone and McLean model as a pioneer in IS success measurement and crediting it for imposing "some order on IS researchers' choices of success measures", Seddon et al. (1999) critiqued the model for not recognising explicitly that different stakeholders in any organisation may validly come to different conclusions about the effectiveness of the same system that they are using.

2.4.3 Updated Delone and Mclean Success Model (DM), 2003

Ten years after the publication of their first model and based on the evaluation of the many contributions to it, DeLone and McLean proposed an updated IS success model Delone & McLean (2003).

In their updated model(see Figure 2.8), Delone and McLean added Service Quality as one important dimension. In addition, they added Intention to Use as an alternative measure because it is important to measure attitude depending on the situation. Finally, they combined Individual and Organizational Impact to one dimension, and called it Net Benefits; to widen the impacts of IS also to groups, industries and nations, depending on the context.

FIGURE 2.8: The Updated Delone and Mclean Success Model(DM)



Source: Delone & McLean, 2003

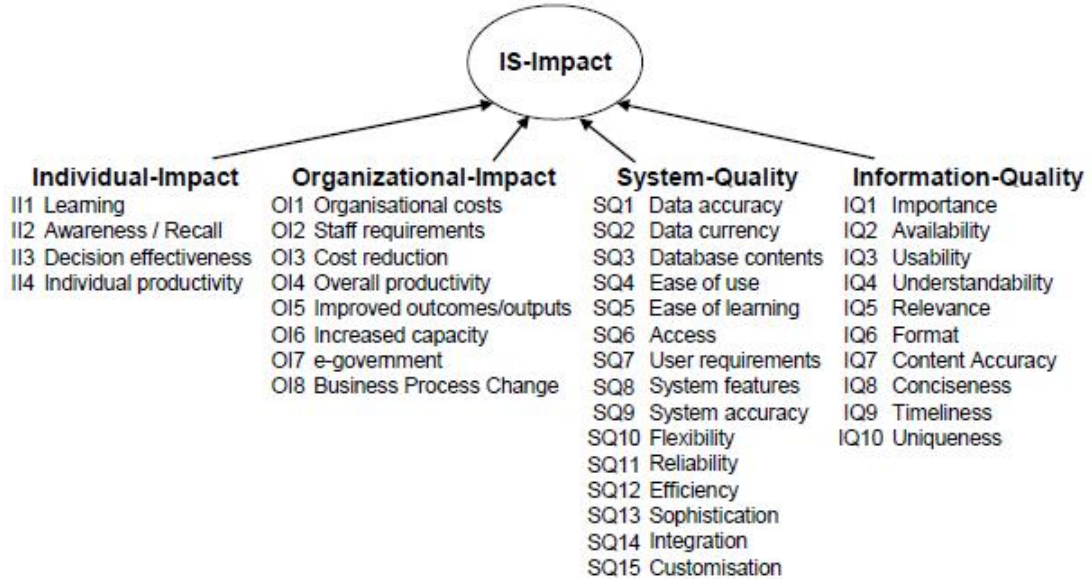
2.4.4 IS-Impact Measurement Model

Building on the Delone and McLean model and taking into considerations its weakness in addressing the perceptions of all system stakeholders, Gable et al. (2008) proposed the IS-Impact measurement model. The model was borne out of the observation that there was "little consensus among practitioners or researchers on how best to measure the impact of IS in organisations"(Gable et al., 2008). IS-impact of an information is

defined as "a measure at a point in time, of the stream of net benefits from the IS, to-date and anticipated, as perceived by all key-user-groups".

In their research approach, Gable et al. (2008) first formulated a conceptual model as shown in IS-Impact. The model was then validated through two phases namely, exploratory and confirmatory phase. In the exploratory phase an identification survey was done where success constructs were identified which became the basis of an a-priori model. The a-priori model had four constructs with a total of 37 measures as depicted in Figure 2.9 and was divided into two, the Impact half consisting of Individual-Impact and Organizational-Impact dimensions, and the Quality half comprising of System-Quality and Information-Quality dimensions. The model was then operationalised in a specification survey whose instrument contained the 37 measures. The confirmation phase finally validated the proposed model.

FIGURE 2.9: IS-Impact A-priori Model

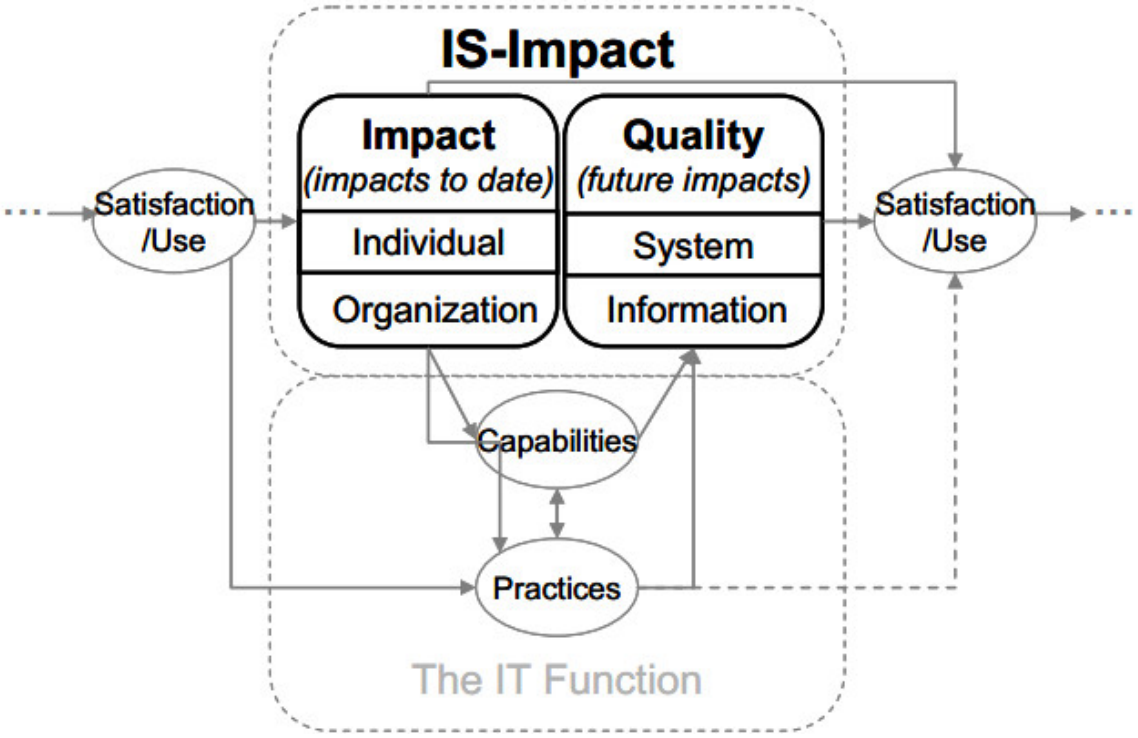


Source: Gable et al., 2008

Gable et al. (2008) provide the following definitions for the IS-Impact model: Individual-Impact is "a measure of the extent to which the IS has influenced the capabilities and effectiveness on behalf of the organisation, of key-users", Organizational-Impact is a "measure of the extent to which the IS has promoted improvement in organisational results and capabilities", Information-Quality is "a measure of the quality of IS outputs: namely, the quality of the information the system produces in reports and on-screen", and System-Quality is "a measure of the performance of from a technical and design

perspective". The final model based on the confirmation survey includes 4 dimensions in two halves as shown in The final model based on the confirmation survey includes 4 dimensions in two halves as shown in . The Impact dimension explains the impact to date whereas the quality dimension measures the future impact of the system. As will be seen in Figure 2.10 though, the IS-Impact Measurement Model is based on the Delone and McLeans model the 'Use' construct has been left out of the model.

FIGURE 2.10: IS-Impact Conceptual Model



Source: Gable et al., 2008

The IS-Impact Measurement Model has been tested by various researchers. Cao & Elias (2009) conducted two exploratory case studies in China and Malaysia. The IS-Impact model was developed in Australia therefore this was an opportunity to test the framework in a different setting and in different language. Twenty nine respondents from a Chinese private company and seventeen respondents from a state government in Malaysia were involved in these studies. Findings indicated that most of existing IS-Impact constructs were applicable to Chinese and Malaysian contexts. A similar study was conducted by Alkhalaf et al. (2013) to measure the impact of e-learning systems in universities from Saudi Arabia from the students' perspective and confirmed the validity of the IS-Impact model.

2.5 Conceptual Model

In developing our research model, we adopted the approach used by Seddon et al. (1999) where they recommend that one should clearly answer the seven questions posed by Cameron (1980) before commencing an IS evaluation. Seddon et al. (1999) posits that the seven questions, though initially applied to measuring organisational effectiveness, are relevant in measuring IS effectiveness.

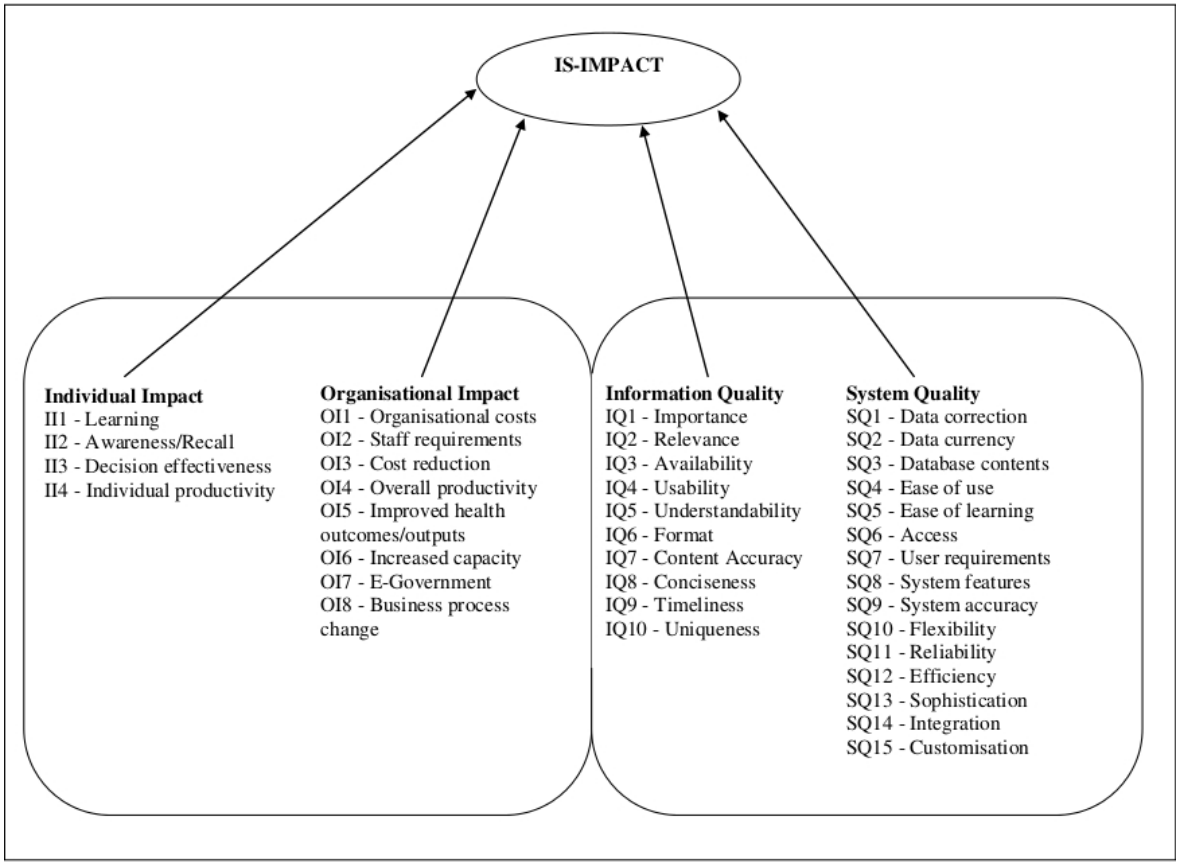
TABLE 2.2: Seven questions to answer when evaluating information systems

Seven questions for measuring organizational performance	Answers in this study for evaluating investment in district health information systems
From whose perspective is effectiveness being judged?	The user
What is the domain of activity?	Health Information System
What is the level of analysis?	Functional and operational
What is the purpose of evaluation?	System improvement
What time frame is employed?	Short - 2 years after the DHIS 2 became operational
What types of data are to be used?	Perceptual and observational
Against which referent is effectiveness to be judged?	Certain desirable characteristics adapted from the IS-Impact model

Source: Cameron, 1980

Our research model in Figure 2.11 has been adopted from the IS-Impact model. This is because the IS-Impact model was originally developed and validated from the perspective of public sector employees in Australia. This model is therefore suitable for measuring the effectiveness of the DHIS 2 from the perspective of the user.

FIGURE 2.11: Conceptual Model with 37 Items



Source: Research

The following variables were measured as depicted in Table 2.3 below: individual impact, organisational impact, information quality and system quality. The constructs were measured using the following scales: individual impact - 4-item scale, organisational impact - 8-item scale, information quality - 10-item scale and system quality - 15-item scale. All items were measured using a five-point likert type scale that ranges from "strongly disagree" to "strongly agree".

TABLE 2.3: Variables and Metrics

Construct/Variable	**Code**	**Items/Statement**	**Measurement Scale**
Individual impact	II1	I have learnt much through the presence of DHIS 2	Likert scale, 1-5
	II2	DHIS 2 enhances my awareness and recall of job related information	
	II3	DHIS 2 enhances my effectiveness in the job	
	II4	DHIS 2 increases my productivity	
Organisational impact	OI1	DHIS 2 is cost effective	Likert scale, 1-5
	OI2	DHIS 2 has resulted in reduced staff costs	
	OI3	DHIS 2 has resulted in cost reductions (e.g. inventory holding costs, administration expenses, etc.)	
	OI4	DHIS 2 has resulted in overall productivity improvement	
	OI5	DHIS 2 has resulted in improved health outcomes or outputs	
	OI6	DHIS 2 has resulted in an increased capacity to manage a growing volume of activity (e.g. transactions, population growth, etc.)	
	OI7	DHIS 2 has resulted in better positioning for e-Government	
	OI8	DHIS 2 has resulted in improved business processes	

Construct/Variable	**Code**	**Items/Statement**	**Measurement Scale**
Information quality	IQ1	Information available from DHIS is important	Likert scale, 1-5
	IQ2	DHIS provides output that seems to be exactly what is needed	
	IQ3	Information needed from DHIS is always available	
	IQ4	Information from DHIS is in a form that is readily usable	
	IQ5	Information from DHIS is easy to understand	
	IQ6	Information from DHIS appears readable, clear and well formatted	
	IQ7	Though data from DHIS may be accurate, outputs sometimes are not	
	IQ8	Information from DHIS is concise	
	IQ9	Information from DHIS is always timely	
	IQ10	Information from DHIS is unavailable elsewhere	
System quality	SQ1	Data from DHIS often needs correction	Likert scale, 1-5
	SQ2	Data from DHIS is current enough	
	SQ3	DHIS is missing key data	
	SQ4	DHIS is easy to use	
	SQ5	DHIS is easy to learn	
	SQ6	It is often difficult to get access to information that is in the DHIS system	
	SQ7	DHIS meets MoH requirements	
	SQ8	DHIS includes necessary features and functions	
	SQ9	DHIS always does what it should	
	SQ10	The DHIS user interface can be easily adapted to ones personal approach	

Construct/Variable	**Code**	**Items/Statement**	**Measurement Scale**
	SQ11	The DHIS system is always up-and-running as necessary	
	SQ12	The DHIS system responds quickly enough	
	SQ13	DHIS requires only the minimum number of fields and screens to achieve a task	
	SQ14	All data within DHIS is fully integrated and consistent	
	SQ15	DHIS can be easily modified, corrected or improved	

Chapter 3

Research Methodology

3.1 Research Design

In this project, we were evaluating the post-implementation of the DHIS 2 from the perspective of the user. Based on the literature review in Chapter 2, our research model was derived from the IS-impact measurement model. In this research four variables were identified. Our aim was to use a cross-sectional approach and provide a "snapshot" of system quality, information quality, individual impact and organisational impact. A descriptive research design, where data was collected at one point in time, was adopted. Descriptive research was deemed appropriate since it is better at collecting information that describes the world as it is (Wellington & Szczerbinski, 2007).

3.2 Population and Sampling Size

Our sample size was composed of 135 DHIS 2 users.

Population is the "complete set of individuals, cases or objects with some common observable characteristics"(Mugenda & Mugenda, 2003). Our study targeted DHIS 2 users. These users include District and County Health Records and Information Officers, Senior Health Records and Information Officers, managers at the MoH and other users. Therefore the sample was obtained from these users.

A sample is representative of the population to be studied. There are several ways in determining the sample size including, adopting sample sizes used in similar studies, using a census for small populations and using tested formulas. In our study we calculated the sample based on the formula provided by Yamane (1967, 886). A list of 500 DHIS 2 users was provided by the MoH's Health Information Systems (HIS) department. The expected sample size was calculated from this list as shown below:

$$n = \frac{N}{1 + N(e)^2} \tag{3.1}$$

Where n is the sample size, N is the population size, and e is the level of precision. When this formula is applied to a population of 500.

$$n = \frac{N}{1 + N(e)^2} = \frac{500}{1 + 500(0.07)^2} = 145 \quad individuals \tag{3.2}$$

We adopted a level of precision of $\pm 7\%$.

The list provided by HIS contained user names, email and telephone contacts of DHIS 2 users. We randomly identified 145 users who we contacted to fill in the questionnaire. Though these users may be from non-governmental organisations, academia or in their individual capacities, majority are "officers in charge of data entry and data management at all levels of the country who use the system routinely" (Manya et al., 2012). The officers in charge of data entry and management are the DHRIOs. Currently there are 290 districts in Kenya with one DHRIO representing a district. Therefore, though our target population was 500 active users, we realised later in the study that the active DHIS 2 users were actually DHRIOs who are 290 in number. In the end, we invited all these 290 DHRIOs to participate in survey. These DHRIOs in turn have had challenges in their data management roles. For example when we called them during the survey, some told us that they had no airtime for their modems. Also, at the time of doing this research, there was uncertainity regarding whether DHRIOs were under the national government or counties. This made it difficult for some DHRIOs to concentrate on completing the survey.

3.3 Instruments

A number of data collection tools were used in this study. These are questionnaires, focus group discussions and observation

3.3.1 Questionnaires

Considering this was a descriptive study that targeted DHIS 2 users who are based in different parts of the country, the questionnaire method was used. From the studies reviewed in the literature review, most used questionnaires to collect data. To guarantee validity, the questionnaires were pre-tested using 20 DHIS 2 users.

The questionnaire is a data collection instrument consisting of questions and statements that are printed or typed on a form with the aim of collecting data from people (Kothari, 2004). It is used to obtain information about the population(Mugenda & Mugenda, 2003). In the questionnaire, one can either have a close-ended or open-ended questions.

Kothari (2004) posits that the questionnaire as a data collection instrument has the following advantages:

- They are cost-effective particularly where the population is uneven spatially;
- Respondents have sufficient time to give well thought out answers;
- Respondents, who are not easily approachable, can also be reached conveniently;
- Large samples can be made use of and thus the results can be made more dependable and reliable.

The disadvantages of this method are:

- There is a risk of low return rate of the forms;
- It can only be administered to educated respondents who must agree first;
- The researcher may no longer have control of the questionnaire once it is sent, it may get lost;

- Once the tool has been sent it is difficult to change the approach implying that it is inflexible;
- It is difficult to determine whether a respondent interpreted the questions as the researcher intended.

The use of questionnaires was applicable to our study because most DHIS 2 users are dispersed geographically. It eliminates bias since the same form will be used for all respondents. Since DHIS 2 are trained personnel, this study assumed that the respondent have attained at least college-level education. It is the most applicable instrument considering time and resource constraints. To make it easier for the respondents, the questionnaire was made available online. For those who had problems accessing the online questionnaire, a Microsoft Word version was emailed to them. All questions were compulsory. The variables were measured using a 5-point likert-type scale. The questionnaire contained a mixture of positive and negative statements. This was to prevent a response bias. A response bias is the "systematic tendency to respond to a range of questionnaire items on some basis other than the specific item content"(Lavrakas, 2008). Reversing the wording in some of the survey items is one of the recommended methods of preventing response bias(Peer & Gamliel, 2011). In reversed statements, respondents are expected to have lower scores if they have higher scores in the positive statements.

3.3.2 Focus Group Discussion

A focus group is "a group of individuals selected and assembled by researchers to discuss and comment on, from personal experience, the topic that is the subject of the research" (Powell & Single, 1996). To qualify as a focus group discussion the following conditions need to be met: "participants should have a specific experience of or opinion about the topic under investigation, an explicit interview guide should used; subjective experiences of participants should be explored in relation to predetermined research questions" (Gibbs, 1997).

Focus group discussions(FGDs) "draw upon respondents attitudes, feelings, beliefs, experiences and reactions in a way in which would not be feasible using other methods" (Gibbs, 1997). As a qualitative method, FGDs can be used as a "self-contained

method"(Morgan, 1996) or as a complement to other research methods such as questionnaires listed above.

FGDs are useful where the researcher is of the opinion that attitudes, feelings and beliefs of a subject can best be revealed out of a homogeneous group out of interaction and spurring one another. Their aim is to obtain "a multiplicity of views and emotional processes within a group context"(Gibbs, 1997) which may be difficult to obtain in other survey instruments. FGDs are also useful when one wants to provide exploratory or preliminary insights on a subject (Wellington & Szczerbinski, 2007) or investigate the degree of consensus on a given topic(Gibbs, 1997).

Though they are "the richest source of knowledge about peoples understanding of themselves and the life around them"(Wellington & Szczerbinski, 2007), FGDs are limited in a number of aspects. It is difficult for the researcher to determine the quality of the data produced as compared to interviews or questionnaires. This is because the questions in FGDs are open-ended and one may have little control over the discussions about from ensuring that participants are focussing on the topic (Gibbs, 1997). Also, depending solely on information gathered from FGDs to make generalisations on why people behave the way they do could make the research findings inaccurate(Wellington & Szczerbinski, 2007).

To overcome these limitations, we used FGDs as a qualitative follow-up method to the primary questionnaire instrument as recommended by Morgan (1996).

This study had 2 focus groups. The focus groups comprised DHRIOs from Nairobi and Kiambu counties. Each group had 4 members each.

3.4 Ethical Considerations

The respondents were protected by seeking their consent before administering the research. This involved communicating to them via email or telephone prior to involving them. Permission to conduct the research was also sought from the Principal Secretary in the Ministry of Health. We explained why we are conducting the research and what

were the expected outcomes. The information shared with us was, and remains, confidential and will not be divulged without the respondents consent. Further, it was not compulsory for one to provide their names.

3.5 Data Collection Process

3.5.1 Approvals

To embark on this study, a proposal was submitted to the University of Nairobi, School of Computing and Informatics. The proposal detailed what the research entailed and how we planned to conduct it. The proposal was accepted and an introduction letter issued to assist in data collection. This was followed by requesting the Ministry of Health through the Principal Secretary for authorisation to collect data from DHIS 2 users. The request was approved and the study assigned to the HIS department. Following the approvals, we were issued with contacts(emails and telephone numbers) of DHIS 2 users.

3.5.2 Pre-testing of Questionnaire

To ascertain the clarity and wording of the survey questions, the questionnaire was administered to twenty randomly selected DHIS 2 users. It was also reviewed by HIS staff and experienced researchers. Overall, the respondents found the instructions and survey questions clear and easy to understand. There was however a suggestion to include a section on user feedback on specific DHIS 2 features. Four questions were included in the final questionnaire asking the respondents how satisfied they were with these features namely, data collection, data entry, data aggregation/consolidation and data reporting. Though these feature questions were added to the questionnaire its important to clarify that they are not part of the conceptual model in this study. The response from these 4 questions was used in making recommendations on DHIS 2 to the Ministry of Health.

3.5.3 Questionnaire Administration

Following the valuable feedback obtained from pre-testing and changes made to the survey instrument, it was now ready to be administered to DHIS 2 users. Emails were sent to the 500 active DHIS 2 users directing them to fill in the questionnaire on the link provided. Follow-up was done through text messages and phone calls.

3.6 Data Preparation

All questions were compulsory. Since this was an online questionnaire, validation constraints were set on all fields such that an incomplete form could not be submitted. Therefore, there was no case of incomplete questionnaires. For respondents who had difficulties accessing the online questionnaire, we sent emailed them a Microsoft Word version. These, however, were very few. There was also no need of keying in the data since all that was required was to export the data from the questionnaire portal to comma-separated values(csv) format for analysis.

Also, as mention in Section 3.3.1 above, the questionnaire had a mixture of positive and negative statements to prevent response bias. There were 6 items which were negatively worded. The scale used with these items were the same as the positive statements. However in the case of the negative statements, a high percentage of agreeing meant lower scores if the item was positive and vice versa. All scores of the six items were reversed using the Microsoft Excel's 'CHOOSE' feature. Therefore a score of 1 becomes 5, 2 becomes 4, 3 does not change, 4 becomes 2 and 5 becomes 1.

3.7 Data Analysis

3.7.1 Measurement of Variables and Measurement Metrics

The main instrument was the questionnaire which was distributed to various DHIS 2 users. Questions in the questionnaires were closed-format type.

3.7.2 Descriptive Analysis of Quantitative Data

A summary of the responses received from the questionnaires for each variable were computed on an item by item basis. The likert scale had five levels namely, Strongly Disagree, Disagree, Neutral, Agree and Strongly Agree.

We then performed various descriptive statistical operations on these measures. For all statements, we obtained the percentage of DHIS 2 users who agree or disagree on a specific item. Out of this we were able to tell the proportion of users who feel that DHIS 2 had an impact or not and those of the view that its quality was high or not. Also, we computed other statistical measures such as mean, mode, median and standard deviation.

3.7.3 Validity Tests

In this section we describe how we proceeded to find out how applicable the IS-Impact model is in evaluating DHIS 2. This is one of the objectives of this study. Testing was done on the data that was collected from DHIS 2 users. Our model is composed of 37 items which were operationalised(quantified and made observable) through a survey administered to DHIS 2 users. We will therefore validate our model using guidelines spelt out mainly by Diamantopoulos & Winklhofer (2001) and other researchers. There are various through which validity can be tested. This study has employed 2 forms of validity tests, i.e., content and construct validity.

Content validity is the "measure of the degree to which data collected using a particular instrument represents a specific domain of indicators or content of a particular concept"(Mugenda & Mugenda, 2003). Therefore in our study, content validity seeks to ascertain whether the items in our questionnaire fully represented individual impact, organisational impact, system quality and information quality. Foxcroft et al. (2004) state that content validity is assessed using a panel of experts in a particular field who review the items in the instrument. The experts then comment on whether the items accurately cover the phenomenon being studied. It is therefore a subjective process. In our study, content validity was assured through pre-testing of the questionnaire with 20 users. We got valuable feedback from the pre-test which later informed the design of the final questionnaire. We re-worded some items and also included four measures which

some users felt would be important to include. Also, the IS-Impact model, from which most constructs are derived from, has been rigorously undergone validity tests(Cao & Elias, 2009, Gable et al., 2008). This, in actual sense, is in line with Cronbach & Meehl (1955)'s statement that content validity is "established deductively, by defining a universe of items and sampling systematically within this universe to establish the test".

Construct validity is the "extent to which an operationalisation measures the concept it is supposed to measure"(Bagozzi et al., 1991). There are two types of construct validity, namely, convergent and discriminant validity. In convergent validity we look at the extent to which an operationalisation concurs or converges with other operationalisations that it is similar to. Discriminant validity is the converse, we examine the extent to which an operationalisation does not concur with other operationalisations that it theoretically should not be similar to(Campbell & Fiske, 1959).

To conduct construct validation, we adopted Diamantopoulos & Winklhofer (2001)'s guidelines where they suggest 2 tests: multicollinearity and external validity.

Multicollinearity is the undesirable situation where the correlations among the two or more explanatory variables variables are strong. Too much collinearity among items implies that they likely contain redundant information. There are many ways to detect multicollinearity. In our case, we conducted a a regression test where we regressed predictor variables with a dependent variable. We then obtained the tolerance and variance inflation factor(VIF) output from this regression analysis.

$$VIF = \frac{1}{1 - R_i^2} \tag{3.3}$$

where R_i^2 is the coefficient of determination

Tolerance is the reciprocal of the VIF.

$$Tolerance = \frac{1}{VIF} = 1 - R_i^2 \tag{3.4}$$

Tolerance is a measure of collinearity and is the proportion of a variable's variance that is not accounted for by the other independent variables in the equation. A small tolerance value(less than 0.10), is an indication that multiple correlations with other variables

are high, a possibility that there is multicollinearity(Allison, 1999). Variance inflation factors (VIF) measure how much the variance of the estimated coefficients are increased over the case of no correlation among the X variables. A VIF value of 10 and above indicates a multicollinearity problem(Petter et al., 2007). Tolerance is the inverse of VIF. Most statistical programs such as SPSS and R calculate VIF and tolerance values. This analysis was done in R. We first obtained the VIF values then got the tolerance values by inversing VIF values.

For the external validity test, Diamantopoulos & Winklhofer (2001) suggest that this can be done by correlating each item to another external item, global or criterion items, and only those indicators that are significantly correlated with variable in question should be retained. The external item summarises the essence of the construct that the index purports to measure. For instance, the criterion items for individual impact, organisational impact, system quality and information quality were C2, C3, C4 and C5 respectively. This analysis was also done in R.

3.7.4 Analysis of Qualitative Data

Qualitative data, unlike quantitative, is mostly in text form. In our case, we analysed data obtained from focus group discussions.Taylor-Powell & Renner (2003) provide three steps in analysing qualitative data which we adopted. Firstly, we got to know our data very well by listening to the FGD recordings many times, writing down impressions we get from the data and assess the quality of the data collected. Secondly, we wrote down questions which we wanted answered from the FGDs. Thirdly, we classified the FGD discussions according to themes. Our themes were based on the four constructs constituting the IS-Impact model namely, Individual Impact, Organisational Impact, Information Quality and System Quality.

3.7.5 Combination of Analysed Quantitative and Qualitative Data

In this study, triangulation was used to combine the analysed quantitative and qualitative data. Triangulation is the utilisation of more than one approach in order to analyse a research question(Guion et al., 2011). Triangulation "gives a more detailed and balanced picture of the situation"(Altrichter et al., 2013). Denzin (2009) suggests four

types of triangulation: data source triangulation is the collection of data from different data sources; investigator triangulation is the use of two or more researchers in collecting and interpreting data; theoretical triangulation is the "pitting alternative theories against the same body of data"; and methodological triangulation which refers to use of multiple methods to gather data. Methodological triangulation can take two forms: 'within-method' and 'between/across-method'. The within-method uses one method but different strategies are employed within it. The between-method uses two or more distinct methods in one study.

Our study used the between-method form of methodological triangulation to collect and analyse data. The use of qualitative data was used as a follow-up on the quantitative data collected through questionnaires. Quantitative reveals the "what" and qualitative brings out the "why" (Adams, 2007). Therefore for our study, our quantitative data was used to explain the impact and quality of the DHIS 2 from the perspective of the user while qualitative data revealed the reasons behind these perspectives.

Chapter 4

Results and Discussion

In this chapter, results and analysis will be discussed. Microsoft Excel was used to clean the data and save it in a comma separate value (CSV) format, ready for analysis.R, a language and environment for statistical computing (R Core Team, 2013), was used for analysis of data.

4.1 Respondents' Demography

Out of the 500 respondents contacted, 135 filled in the online questionnaire and these were found valid for use in the quantitative analysis process.

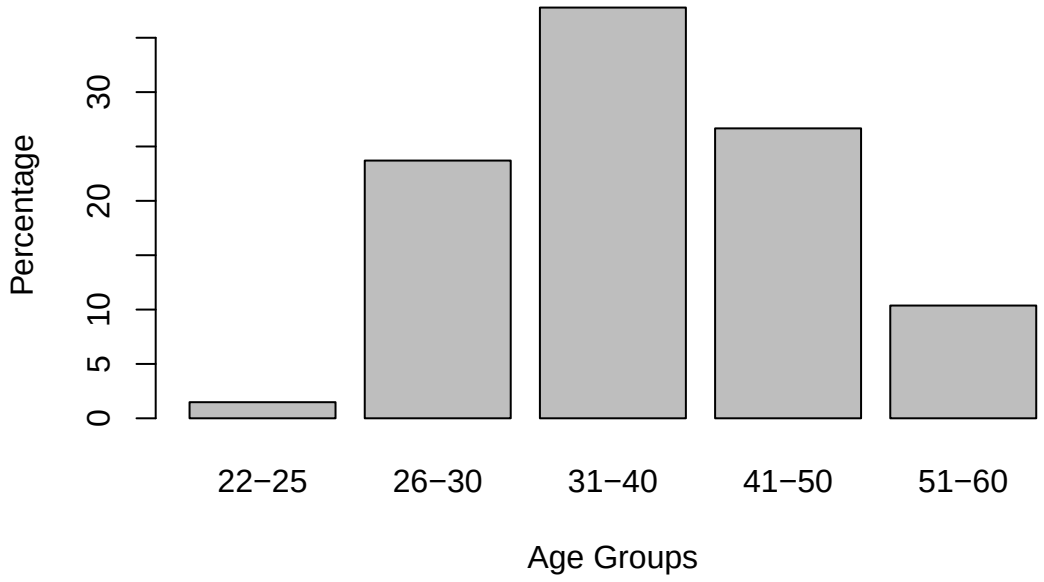
In Section A of the questionnaire, respondent were asked to provide the following information: job title, age category, gender, district, county, how long they had been using DHIS 2 and how often they used it. All fields in Section A were mandatory. We did not collect the names of the respondents. The respondents were however asked to provide an email address in case they wanted to receive a copy of the preliminary findings of the study. This section provides the general characteristics of the respondents.

4.1.1 Distribution According to Age

The respondents were categorised according to age groups as shown in Figure 4.1. The 26 to 30 years age group accounted for 24% of the respondents while the 31 to 40 year bracket accounted for 38%. The 41 to 50 years age group accounted for 27% of the

respondents and 51 to 60 years bracket was 10%.The results tend to suggest that DHIS 2 users range from ages 26 to 60 with a big part(62%) being between 26 and 40 years, a sign that this is a relatively young user base.

FIGURE 4.1: Distribution by Age Group



Source: Research

4.1.2 Distribution According to Gender

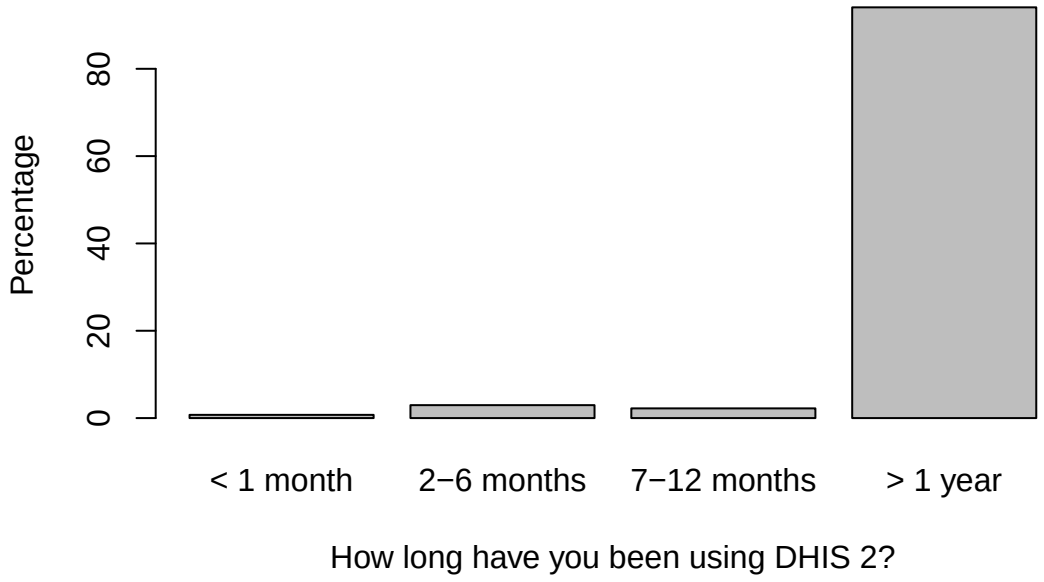
Females accounted for 39.3% of the total number of respondents whereas males were 60.7%.

4.1.3 Distribution According to DHIS 2 Duration of Use

Figure 4.2 shows the length of time that the respondents have used DHIS 2.In the survey, the respondents were asked to state how long they had been using DHIS 2. 1% or 1 of the respondents stated that they had been using DHIS 2 for less than 1 month. 3% or 4 respondents indicated that they had used DHIS 2 for a duration of 2 to 6 months while 3 or 2% respondents stated 7 to 12 months. 127 or 94% stated that they had used DHIS

2 for more than 1 year.From these statistics, we can deduce that most respondents have experience in the use of DHIS 2 and are therefore well conversant with it.

FIGURE 4.2: Distribution According to DHIS 2 Duration of Use



Source: Research

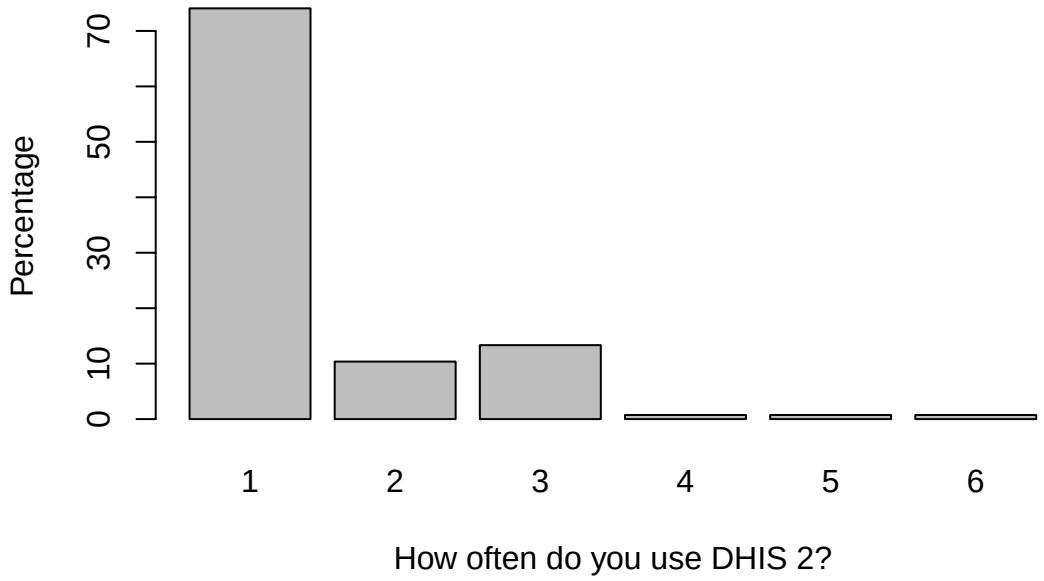
4.1.4 Distribution According to DHIS 2 Frequency of Use

The frequency of use statistics as shown in Figure 4.3 indicate that 100(74%) respondents use DHIS 2 once a week or more often. Those who use DHIS 2 2 to 3 times a month were 14(10%) while 18(13%) respondents stated that they use DHIS 2 once a month. The remaining 3% or 3 respondents indicated that they used DHIS 2 every 2 to 3 months, 2-3 times in a year and once a year or less often. We can therefore conclude that most of the DHIS 2 users were frequent users of DHIS 2.

4.1.5 Classification of Respondents According to Job Title

Table 4.1 shows the job titles of the respondents. Overall, the respondents of this survey covers eleven(11) job titles. From the table it is evident that most respondents are Health

FIGURE 4.3: Distribution According to DHIS 2 Frequency of Use



1=More than a week, 2=2-3 times a month, 3=Once a month, 4=Every 2-3 months, 5=2-3 times a year, 6=Once a year or less often Source: Research

Records and Information Officers(HRIOs) who interact with DHIS 2 on a frequent basis. DHIS 2 registered users comprise many job titles. The initial intention of the survey was that all cadres would participate. We sent the questionnaire to all registered DHIS 2 users, however it is those who use the system on a day to day basis who responded.

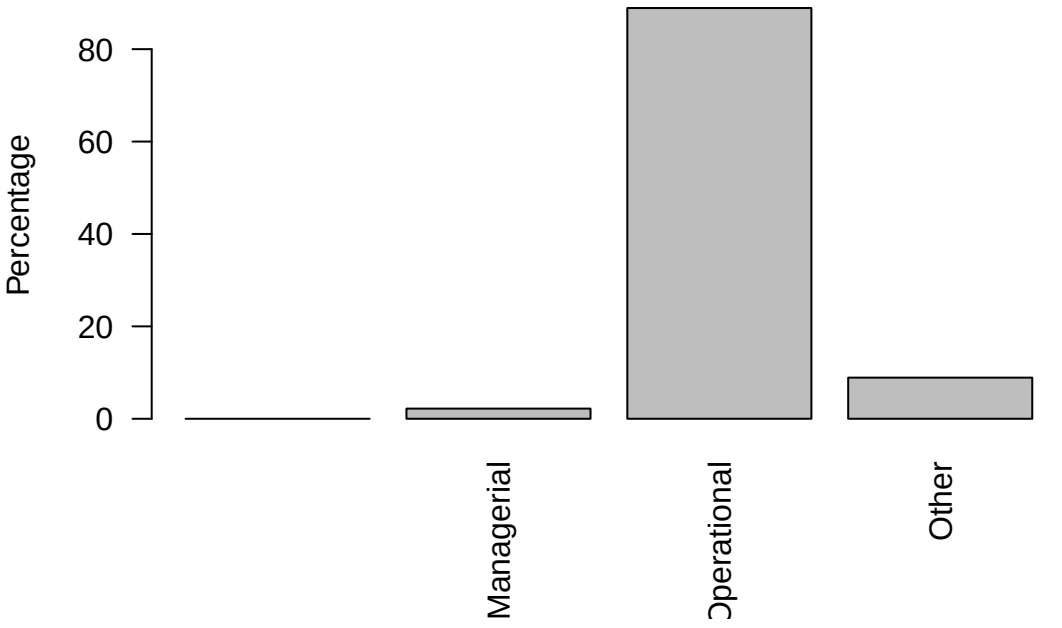
Further, Figure 4.4 below shows classification of respondents according to their employment cohorts. HRIOs were classified under 'Operational'. Monitoring and Evaluation staff were grouped under 'managerial'. The rest of the cadres were classified under 'Other'. A high percentage of respondents(89%) were from the 'Operational' employment cohort. A possible explanation for this is that most prospective respondents opted not to do the survey because they did not use DHIS 2 frequently. This was confirmed when we were making follow up calls where respondents said that the last time they used DHIS 2 was when it was being introduced to their district in 2011.

TABLE 4.1: Classification of Respondents According to Job Title

Job Title	**Total**	**Category/Cohort**
Health Records and Information Officer	117	Operational
Monitoring and Evaluation Officer	5	Management
District Medical Officer of Health	3	Other
Occupational Therapist	2	Other
Community Health Worker	2	Other
Administrator	1	Other
District Aids and STI Co-ordinator	1	Other
Nursing Officer	1	Other
Nutrition Officer	1	Other
Program Officer	1	Other
Pharmaceutical Technologist	1	Other
Total	**135**	

Source: Research

FIGURE 4.4: Distribution According to Employment Cohorts



Source: Research

4.2 Descriptive Analysis of the Items

In this section, we provide a descriptive analysis of Section B of the questionnaire.Section B contained 56 mandatory questions. The questions covered aspects of DHIS 2 impact, quality, satisfaction and views on specific features. Out of the 56 questions, 52 constitute the measures of the IS-Impact model.

The following sub-sections provide descriptive statistics of all Section B constructs.The descriptive analysis covers the following aspects:

1. Individual response summary - The likert scale in the questionnaire had 5 levels of response, namely, strongly disagree, disagree, neutral, agree and strongly agree. 'Strongly Disagree' and 'Disagree' were summed up and presented as 'Disagree' while 'Strongly Agree' and 'Agree' were added to represent 'Agree'. Under each response level, we computed the percentages of responses.

2. Mean value of each response - This is the weighted average based on the weight assigned to each answer choice.

3. Standard deviation of each response

4. Skewness - This is an indicator used in distribution analysis as a sign of asymmetry and depicts the how items are clustered around the average(Kothari, 2004). If the skewness is greater than 0, this is a positive or right skewed distribution implying that most values are concentrated on left of the mean, with extreme values to the right.If the skewness is less than 0, it is referred to as a negative or left skewed distribution meaning that most values are concentrated on the right of the mean, with extreme values to the left. When the skewness value is 0 this means that the distribution is symmetrical around the mean and mean is equal to the median(Mugenda & Mugenda, 2003).

4.2.1 Individual Impact of DHIS 2

The respondents were requested to indicate their level of agreement with four statements on individual impact. Table 4.2 presents the statistics for each of the items measuring aspects of DHIS 2 individual impact.

TABLE 4.2: Statistics of Individual Impact Items

D=Disagree, N=Neutral, A=Agree, SDev=Standard Deviation, SK=Skewness

ID	Question	D	N	A	M	SDev	SK
II1	I have learnt much through the presence of DHIS 2	2.2%	1.5%	96.2%	4.4	0.74	-2.12
II2	DHIS 2 enhances my awareness and recall of job related information	0.7%	0.7%	98.5%	4.43	0.59	-1.33
II3	DHIS 2 enhances my effectiveness in the job	1.4%	3%	95.6%	4.5	0.67	-1.7
II4	DHIS 2 increases my productivity	2.9%	4.4%	92.6%	4.42	0.75	-1.6

Source: Research

The responses are summarised as follows:

- **Learning** - A big percentage of the respondents(96.2%) agreed implying that most DHIS 2 users find it as a useful learning tool.
- **Awareness/Recall** - 98.5% of the respondents felt that DHIS 2 enhanced their awareness and recall of job-related information
- **Decision effectiveness** - 95.6% felt that DHIS 2 increased their job effectiveness
- **Individual productivity** - 92.6% indicated that their productivity had increased due to DHIS 2.

Overall, all individual impact items were found to have negatively skewed distributions an indication that the scores are concentrated on the right of the mean or the high end of the scale. All mean values are greater than than the middle scale(more than 3) implying that DHIS 2 has a high individual impact according the respondents.

4.2.2 Organisational Impact of DHIS 2

Table 4.3 shows the descriptive statistics for organisational impact items. The respondents were requested to indicate their level of agreement with eight statements on organisational impact, i.e., at a broader organisational level.

The responses are summarised as follows:

TABLE 4.3: Statistics of Organisational Impact Items

D=Disagree, N=Neutral, A=Agree, SDev=Standard Deviation, SK=Skewness

ID	Question	D	N	A	M	SDev	SK
OI1	DHIS 2 is cost effective	6.6%	7.4%	86%	4.14	0.85	-1.14
OI2	DHIS 2 has resulted in reduced staff costs	28.1%	31.1%	40.8%	3.17	1.08	-0.12
OI3	DHIS 2 has resulted in cost reductions (e.g. inventory holding costs administration expenses etc.)	12.6%	19.3%	68.1%	3.72	0.96	-0.73
OI4	DHIS 2 has resulted in overall productivity improvement	1.5%	10.4%	88.1%	4.25	0.7	-0.64
OI5	DHIS 2 has resulted in improved health outcomes or outputs	3%	10.4%	86.7%	4.2	0.74	-0.77
OI6	DHIS 2 has resulted in an increased capacity to manage a growing volume of activity (e.g. transactions population growth etc.)	6.6%	16.3%	77%	3.99	0.88	-0.78
OI7	DHIS 2 has resulted in better positioning for e-Government.	0.7%	13.3%	86%	4.16	0.7	-0.74
OI8	DHIS 2 has resulted in improved organisational processes	0.7%	10.4%	88.9%	4.21	0.65	-0.4

Source: Research

- **Organisational costs** - 86% agreed, 6.6% disagreed and 7.4% were neutral that DHIS 2 is effective.
- **Staff requirements** - 40.8% agreed, 28.1% disagreed and 31.1% were neutral that DHIS 2 has reduced staff costs.
- **Cost reduction** - 68.1% agreed, 12.6% disagreed and 19.3% were neutral that DHIS 2 has resulted in cost reductions.
- **Overall productivity** - 88.1% agreed, 1.5% disagreed and 10.4% were neutral that DHIS 2 has resulted in overall productivity improvement
- **Improved health outcomes** - 86.7% agreed, 3% disagreed and 10.4% were neutral that DHIS 2 has resulted in improved health outcomes or outputs.

- **Increased capacity** - 77% agreed, 6.6% disagreed and 16.3% were neutral that DHIS 2 has resulted in an increased capacity to manage a growing volume of activity
- **E-Government** - 86% agreed, 0.7% disagreed and 13.3% were neutral that DHIS 2 has resulted in better positioning for e-Government.
- **Business process change** - 88.9% agreed, 0.7% disagreed and 10.4% were neutral that DHIS 2 has resulted in improved organisational processes.

Overall, all organisational impact items, apart from staff requirements, were found to have negatively skewed distributions an indication that the scores are concentrated on the right of the mean or the high end of the scale. All mean values are greater than than the middle scale(more than 3) implying that DHIS 2 has a high organisational impact according the respondents.

4.2.3 Information Quality of DHIS 2

On measuring information quality, the quality of the information the system produces in reports and on-screen, the respondents were asked 10 questions. As shown in Table 4.4, apart from uniqueness, a high percentage agreed with the statements.

The responses are summarised as follows:

- **Importance** - 98.5% agreed, 0% disagreed and 1.5% were neutral that information available from DHIS 2 is important.
- **Relevance** - 80% agreed, 5.9% disagreed, and 14.1% were neutral that DHIS 2 provides output that seems to be exactly what is needed.
- **Availability** - 66.6% agreed, 20.7% disagreed and 12.6% were neutral that information needed from DHIS 2 is always available.
- **Usability** - 85.2% agreed, 2.2% disagreed and 12.6% were neutral that information from DHIS 2 is in a form that is readily usable.
- **Understandability** - 88.2% agreed, 2.2% disagreed and 9.6% were neutral that information from DHIS 2 is easy to understand.

Table 4.4: Statistics of Information Quality Items

D=Disagree, N=Neutral, A=Agree, SDev=Standard Deviation, SK=Skewness

ID	Question	D	N	A	M	SDev	SK
IQ1	Information available from DHIS 2 is important	0%	1.5%	98.5%	4.53	0.53	-0.43
IQ2	DHIS 2 provides output that seems to be exactly what is needed	5.9%	14.1%	80%	3.96	0.77	-0.7
IQ3	Information needed from DHIS 2 is always available	20.7%	12.6%	66.6%	3.73	1.14	-0.58
IQ4	Information from DHIS 2 is in a form that is readily usable	2.2%	12.6%	85.2%	4.19	0.74	-0.65
IQ5	Information from DHIS 2 is easy to understand	2.2%	9.6%	88.2%	4.21	0.71	-0.7
IQ6	Information from DHIS 2 appears readable clear and well formatted	4.4%	7.4%	88.2%	4.1	0.72	-0.88
IQ7	Though data from DHIS 2 may be accurate, outputs sometimes are accurate(Reversed)	11.1%	21.5%	67.4%	3.67	0.92	-0.86
IQ8	Information from DHIS 2 is concise	8.1%	19.3%	72.6%	3.79	0.81	-0.75
IQ9	Information from DHIS 2 is always timely	25.2%	19.3%	55.6%	3.47	1.13	-0.29
IQ10	Information from DHIS 2 is unavailable elsewhere	40.7%	19.3%	40%	2.97	1.23	-0.02

Source: Research

- **Format** - 88.2% agreed, 4.4% disagreed and 7.4% were neutral that information from DHIS 2 appears readable clear and well formatted.
- **Content Accuracy** - 67.4% agreed, 11.1% disagreed and 21.5% were neutral on the accuracy of DHIS 2 output.
- **Conciseness** - 72.6% agreed, 8.1% disagreed and 19.3% were neutral that information from DHIS 2 is concise.
- **Timeliness** - 55.6% agreed, 25.2% disagreed and 19.3% were neutral that information from DHIS 2 is always timely.
- **Uniqueness** - 40% agreed, 40.7% disagreed and 19.3% were neutral that information from DHIS 2 is unavailable elsewhere

Overall, all information quality items, apart from uniqueness, were found to have negatively skewed distributions an indication that the scores are concentrated on the right of the mean or the high end of the scale. Also, apart from uniqueness(with a mean of 2.97 respectively), all mean values are greater than the middle scale(more than 3) implying that DHIS 2 has high information quality according the respondents.

4.2.4 System Quality of DHIS 2

Table 4.5 shows the descriptive statistics for system quality items. The respondents were requested to indicate their level of agreement with fifteen statements on system quality, i.e., how the system performs from a technical and design perspective.

There were mixed feelings on agreement of system quality as can be seen hereafter:

- **Data correction** - 48.9% agreed, 33.3% disagreed and 17.8% were neutral that data from DHIS 2 is correct.
- **Data currency** - 42.2% agreed, 38.5% disagreed and 19.3% were neutral that data from DHIS 2 is current enough.
- **Database contents** - 38.5% agreed, 31.1% disagreed and 30.4% were neutral that DHIS 2 is not missing key data.
- **Ease of use** - 86.7% agreed, 5.2% disagreed and 8.1% were neutral that DHIS 2 is easy to use.
- **Ease of learning** - 86.6% agreed, 5.2% disagreed and 8.1% were neutral that DHIS 2 is easy to learn.
- **Access** - 81.5% agreed, 11.8% disagreed and 6.7% were neutral that it is often easy to get access to information that is in the DHIS 2 system.
- **User requirements** - 84.4% agreed, 5.1% disagreed and 10.4% were neutral that DHIS 2 meets their department/organisation requirements.
- **System features** - 81.5% agreed, 5.9% disagreed and 12.6% were neutral that DHIS 2 includes necessary features and functions.

- **System accuracy** - 67.5% agreed, 12.6% disagreed and 20% were neutral that DHIS 2 always does what it should.
- **Flexibility** - 61.5% agreed, 11.1% disagreed and 27.4% were neutral that the DHIS 2 user interface can be easily adapted to ones personal approach.
- **Reliability** - 51.1% agreed, 25.2% disagreed and 23.7% were neutral that the DHIS 2 system is always up-and-running as necessary.
- **Efficiency** - 60.7% agreed, 17.8% disagreed and 21.5% were neutral that the DHIS 2 system responds quickly enough.
- **Sophistication** - 59.3% agreed, 14.8% disagreed and 25.9% were neutral that DHIS 2 requires only the minimum number of fields and screens to achieve a task.
- **Integration** - 68.9% agreed, 17.8% disagreed and 13.3% were neutral that all data within DHIS 2 is fully integrated and consistent.
- **Customisation** - 66.6% agreed, 15.6% disagreed and 17.8% were neutral that DHIS 2 can be easily modified corrected or improved.

This mixed perception is explained from the focus group discussion report in Section 4.6 below.

Overall, in terms of skewness the SQ2 and SQ3 have values (0.05 and -0.08 respectively) that are close to 0 indicating a near-perfect normal distribution which in turn implies that respondents are divided on the data currency and database contents of DHIS 2. Also, all mean values are greater than the middle scale(more than 3) implying that DHIS 2 has high system quality according the respondents

TABLE 4.5: Statistics of System Quality Items

D=Disagree, N=Neutral, A=Agree, SDev=Standard Deviation, SK=Skewness

ID	Question	D	N	A	M	SDev	SK
SQ1	Data from DHIS 2 often does not need correction(Reversed)	33.3%	17.8%	48.9%	3.22	1.12	-0.15
SQ2	Data from DHIS 2 is current enough	38.5%	19.3%	42.2%	3.08	1.08	0.05
SQ3	DHIS 2 is not missing key data(Reversed)	31.1%	30.4%	38.5%	3.1	1.06	-0.08
SQ4	DHIS 2 is easy to use	5.2%	8.1%	86.7%	4.14	0.77	-0.91
SQ5	DHIS 2 is easy to learn	5.2%	8.1%	86.6%	4.11	0.76	-0.89
SQ6	It is often easy to get access to information that is in the DHIS 2 system (Reversed)	11.8%	6.7%	81.5%	3.92	0.9	-1.01
SQ7	DHIS 2 meets my department/organisation requirements	5.1%	10.4%	84.4%	3.99	0.75	-1.05
SQ8	DHIS 2 includes necessary features and functions	5.9%	12.6%	81.5%	3.87	0.68	-0.98
SQ9	DHIS 2 always does what it should	12.6%	20%	67.5%	3.66	0.87	-0.66
SQ10	The DHIS 2 user interface can be easily adapted to ones personal approach	11.1%	27.4%	61.5%	3.57	0.86	-0.74
SQ11	The DHIS 2 system is always up-and-running as necessary	25.2%	23.7%	51.1%	3.3	1.02	-0.37
SQ12	The DHIS 2 system responds quickly enough	17.8%	21.5%	60.7%	3.5	0.91	-0.6
SQ13	DHIS 2 requires only the minimum number of fields and screens to achieve a task	14.8%	25.9%	59.3%	3.51	0.83	-0.47
SQ14	All data within DHIS 2 is fully integrated and consistent	17.8%	13.3%	68.9%	3.59	0.92	-0.8
SQ15	DHIS 2 can be easily modified corrected or improved	15.6%	17.8%	66.6%	3.67	1.01	-0.71

Source: Research

4.3 Descriptive Report for the DHIS 2 Feature Measures

Respondents were asked their level of satisfaction on 4 key DHIS 2 features. These are: data collection, data entry, data aggregation/consolidation and reporting. Table 4.6 shows the analysis.

TABLE 4.6: Statistics of DHIS 2 Feature Measures

U=Unsatisfied, N=Neutral, S=Satisfied, SDev=Standard Deviation, SK=Skewness

ID	Question	U	N	S	M	SDev	SK
F1	Data collection	8.9%	14.8%	76.3%	3.84	0.8	-0.73
F2	Data entry	5.9%	5.2%	88.8%	4.1	0.78	-1.23
F3	Data aggregation/consolidation	8.9%	11.9%	79.3%	3.88	0.8	-0.82
F4	Reporting	4.4%	10.4%	85.2%	4.07	0.76	-1.01

Source: Research

A high percentage of respondents were satisfied with DHIS 2 features: data collection(76.3%), data entry(88.8%), data aggregation/consolidation(79.3%) and reporting(85.2%).Overall, all measures of DHIS 2 individual measures have negatively skewed distributions an indication that the scores are concentrated on the right of the mean or the high end of the scale. All mean values are greater than the middle scale(more than 3) implying that the respondents are satisfied with the various DHIS 2 features.

4.4 Descriptive Report for the Criterion Measures

Table 4.7 shows the statistics of the global or criterion measures. All items are negatively skewed distributions an indication that the scores are concentrated on the right of the mean or the high end of the scale. The mean scores of all criterion measures are above 3.

TABLE 4.7: Statistics of Criterion Measures

D=Disagree, N=Neutral, A=Agree, SDev=Standard Deviation, SK=Skewness

ID	Question	D	N	A	M	SDev	SK
C1	Overall, DHIS 2 is satisfactory	1.5%	10.4%	88.1%	4.04	0.58	-0.46
C2	Overall, the impact of DHIS 2 on me has been positive.	0.7%	4.4%	94.8%	4.22	0.56	-0.22
C3	Overall, the impact of DHIS 2 on my department/organisation has been positive	1.5%	5.2%	93.3%	4.19	0.59	-0.5
C4	Overall, the DHIS System Quality is satisfactory	5.9%	15.6%	78.5%	3.85	0.71	-0.79
C5	Overall the Information Quality of DHIS 2 is satisfactory	7.4%	15.6%	77%	3.83	0.75	-0.78
C6	Overall the System Quality of DHIS 2 is satisfactory	5.9%	18.5%	75.6%	3.81	0.71	-0.69
C7	DHIS 2 is good	1.5%	1.5%	97.1%	4.26	0.56	-0.51
C8	DHIS 2 has positively affected the organisation's performance(Reversed)	6.6%	1.5%	91.9%	4.31	0.83	-1.55
C9	DHIS 2 has no problem	52.6%	23%	24.4%	2.66	1.05	0.4
C10	I have received many benefits/advantages from DHIS 2	0.7%	4.4%	94.8%	4.2	0.58	-0.95

Source: Research

4.5 Descriptive Report for the Satisfaction Measures

Table 4.8 shows the statistics of the satisfaction measures. All items are negatively skewed distributions an indication that the scores are concentrated on the right of the mean or the high end of the scale. The mean scores of all satisfaction measures are above 3.

TABLE 4.8: Statistics of Satisfaction Measures

D=Disagree, N=Neutral, A=Agree, SDev=Standard Deviation, SK=Skewness

ID	Question	D	N	A	M	SDev	SK
S1	Overall, DHIS 2 is satisfactory	4.4%	11.1%	84.4%	3.95	0.66	-0.87
S2	I am satisfied with DHIS 2	8.1%	20.7%	71.1%	3.76	0.78	-0.58
S3	I am happy with DHIS 2 (Reversed)	82.2%	5.2%	12.6%	1.95	0.98	1.05
S4	I like DHIS 2	1.5%	6.7%	91.9%	4.28	0.65	-0.67

Source: Research

4.6 Focus Group Discussions

Focus group discussions were used in this study as a follow-up to the quantitative data collected using questionnaires. Our findings are summarised in Table 4.9 below.

Table 4.9: Focus Group Discussion Summary

Theme	**Comments from participants**
Individual Impact	It is the best health information system that I have used so far, though some areas need improvement To some extent, the amount of paper work has reduced Out of DHIS reports, continuous medical education is done for facility staff
Organisational Impact	We use information from DHIS 2 to make decisions pertaining to our area Through DHIS 2 it is easier to track progress for each facility Between 1st and 5th of every month we are busy entering data into DHIS 2 because reports need to submitted by the 5th of every month Most facilities do not have computers and/or internet connection, making the DHRIO to enter data to DHIS 2 themselves If the system is down there are delays in entering data The positives attributes of DHIS 2 outweigh the negatives
Information Quality	Some facilities delay in entering their data in DHIS 2 Sometimes when the system is down and you call the national office, you find that the people are responsible are out in the field On Wednesday(08 Jan 2014), Thursday(09 Jan 2014) I couldn't access the system Inclusion of new facilities lowers the reporting rate thereby rendering the output inaccurate Sometimes we are told, at county level, to remove new health facilities from DHIS 2 because they lower the reporting rate

Theme	**Comments from participants**
	Some facilities, particularly private ones in urban centres, are not mandated to provide data e.g., on curative services.
	We are not informed when they are opened. We sometimes find these facilities by accident
	Some large public facilities also don't provide their data consistently and we can't force them to do so
	I may be having 2 different sets of data collection tools, from HIS and NASCOP(National AIDS and STI Control Programme). It is confusing sometimes what to use
System Quality	It is very user friendly
	I find the dashboard very useful, I can monitor what is of interest to me
	The data visualiser makes it easy for one to prepare for presentations
	Geographic Information System(GIS) enables one to spatially identify coverage pertaining to a particular indicator
	Validation rules enable me to identify discrepancies in the data entered
	Pivot tables enables me to quickly summarise and arrange data according to its dimensions
	Sometimes one has to check whether the data entered in DHIS 2 is correct or valid
	Some DHMT members don't understand what DHIS 2 is all about, yet they have DHIS 2 user accounts
	You may enter data in offline mode but it may not show up when you try upload when its online
	When entering data, one is required to manually enter the totals
	Some people who design DHIS 2 don't understand the tools that are used to collect data. They don't really understand the indicators
	The most difficult tool to fill at the facility level is 731(HIV/AIDS)
	Data visualiser is very basic, more features needed and is slow in loading

Theme	Comments from participants
	Some districts don't have geocodes provided for them therefore the GIS feature is not being utilised as is supposed too
	If you want to delete a record, you would have to delete text from each cell and not the whole record itself
	When I have a problem and I call HIS, they tell me that they are in Mombasa or Machakos. I therefore have to wait until they are back for my problem to be solved

4.7 Combination of Analysed Quantitative and Qualitative Data

Our study adopted a mixed method approach where quantitative techniques(questionnaire) were employed in one phase and qualitative(focus group discussions(FGDs)) used in the other. The use of qualitative data was used as a follow-up on the quantitative data collected through questionnaires. Quantitative reveals the "what" and qualitative brings out the "why" (Adams, 2007). Therefore for our study, our quantitative data was used to explain the impact and quality of the DHIS 2 from the perspective of the user while qualitative data revealed the reasons and patterns behind these perspectives. We summarise the results in Table 4.10 below.

4.8 Model Testing

In this section we proceed to find out how applicable the IS-Impact model is in evaluating DHIS 2. This is one of the objectives of this study. Testing was done on the data that was collected from DHIS 2 users. Our model is composed of 37 items which were operationalised(quantified and made observable) through a survey administered to DHIS 2 users.

In our questionnaire, 4 criterion measures were included for validation purposes. These measures summarised each of the dimensions in the IS-Impact model namely, individual impact, organisational impact, system quality and information quality.

- Overall the impact of DHIS 2 on me has been positive
- Overall, the impact of DHIS 2 on my department/organisation has been positive.
- Overall, the DHIS System Quality is satisfactory
- Overall the Information Quality of DHIS 2 is satisfactory

Two tests were conducted to test the model used in this study, i.e., multicollinearity test and the external validity test. Both tests used the criterion measures described above and results are shown in the following sub-sections.

Table 4.10: Quantitative and Qualitative Results Comparison

Theme	**Outcome(Quantitative)**	**Corresponding qualitative outcome**
Individual Impact	Most respondents agreed that DHIS 2 had made an impact i.e., it had influenced their capabilities and effectiveness. All Individual Impact items scored mean values that were greater than the middle scale (>3).	Respondents were in agreement that DHIS 2 was so far the best health information system they had used. It had improved effectiveness since decisions were now based on better quality data. However, most said that some areas in DHIS 2 needed improvement.
Organisational Impact	Most of the respondents concurred that DHIS 2 had made an impact at a broader organisational level. All Organisational Impact items scored mean values that were greater than the middle scale(>3)	Respondents agreed that DHIS 2 had made improved decision making at their respective districts leading to improved health outcomes. It is now easier to track the progress of each health facility. However, the effectiveness of DHIS 2 is hampered due to some facilities not having computers and/or reliable internet connection.
Information Quality	Respondents were positive about the quality of the content that DHIS 2 produces. Respondents were however divided on the uniqueness of information of DHIS 2	Respondents were positive about the Information Quality of DHIS 2. Respondents noted that content from DHIS 2 sometimes be current due to delays in entering data at facility level.
System Quality	Most respondents agreed on the high quality of DHIS 2 from a technical and design perspective. All System Quality items scored mean values that were greater than the middle scale (>3)	Respondents stated that DHIS 2 was user friendly and found the dashboard and data visualiser particularly useful. However, respondents emphasised the need for a dedicated helpdesk to address user problems promptly.

Source: Research

4.8.1 Multicollinearity Test

The multicollinearity test was done by regressing the 37 items in the questionnaire with a criterion measure. We were interested in the tolerance and Variance Inflation Factor(VIF) values. Items with tolerance values of less than 0.10 and VIF values of 10 and above indicates a multicollinearity problem implying that these would be removed from our conceptual model.

Table 4.11 shows the tolerance and VIF values for each item as per the analysis done. As the table shows no item has a tolerance value of less than 0.10. Also no item has a value of more than 10. This is an indication that the collinearity is not present implying that no item contains redundant information. This is a further confirmation that each item distinctly represents different aspects of the four dimensions that comprise our conceptual model.

4.8.2 External Validity Test - Correlation Analysis

In this section we examine how well the items capture the construct, by conducting an external validity test. This was through correlating each of the items with their respective global or criterion measures. A criterion item summarises all the items in a dimension doe example system quality. Table 4.12 shows the correlation matrices of the 37 items obtained by correlating them with their criterion measures. It also shows the lower and upper limits of the 95% confidence interval i.e., the values which define the range of a confidence interval.

In our study, the correlation coefficient that was used is the "product moment correlation coefficient", popularly known as a "Pearson's r". A correlation coefficient measures the degree of linear relation between 2 values and ranges between -1 and +1. 1 denotes a perfect linear relationship with positive slope between the two variables, while -1 is a perfect linear relationship with a negative slope between the 2 variables. 0 correlation coefficient implies that there is no linear relationship between the 2 variables. Apart from the indicating the confidence intervals, we also show the 95% confidence intervals around the correlation coefficient. We adopt confidence intervals here as a reliability interval estimate due to the reality of sampling error-researchers would be more confident with interval estimates as compared to point estimates(Gardner & Altman, 1986). Therefore,

TABLE 4.11: VIF and Tolerance values for the 37 IS-Impact measures

Items	Tolerance	VIF	Comments/Remarks
II1 - Learning	0.639	1.565	No collinearity
II2 - Awareness/Recall	0.523	1.913	No collinearity
II3 - Decision effectiveness	0.417	2.396	No collinearity
II4 - Individual productivity	0.462	2.164	No collinearity
OI1 - Organisational costs	0.792	1.262	No collinearity
OI2 - Staff requirements	0.776	1.289	No collinearity
OI3 - Cost reduction	0.552	1.813	No collinearity
OI4 - Overall productivity	0.498	2.008	No collinearity
OI5 - Improved health outcomes/outputs	0.557	1.795	No collinearity
OI6 - Increased capacity	0.545	1.836	No collinearity
OI7 - E-Government	0.637	1.571	No collinearity
OI8 - Business process change	0.589	1.698	No collinearity
IQ1 - Importance	0.799	1.251	No collinearity
IQ2 - Relevance	0.685	1.459	No collinearity
IQ3 - Availability	0.638	1.567	No collinearity
IQ4 - Usability	0.59	1.696	No collinearity
IQ5 - Understandability	0.485	2.06	No collinearity
IQ6 - Format	0.44	2.275	No collinearity
IQ7 - Content Accuracy	0.914	1.094	No collinearity
IQ8 - Conciseness	0.695	1.439	No collinearity
IQ9 - Timeliness	0.701	1.426	No collinearity
IQ10 - Uniqueness	0.906	1.104	No collinearity
SQ1 - Data correction	0.818	1.223	No collinearity
SQ2 - Data currency	0.845	1.184	No collinearity
SQ3 - Database contents	0.699	1.431	No collinearity
SQ4 - Ease of use	0.284	3.52	No collinearity
SQ5 - Ease of learning	0.284	3.522	No collinearity
SQ6 - Access	0.758	1.319	No collinearity
SQ7 - User requirements	0.682	1.467	No collinearity
SQ8 - System features	0.57	1.755	No collinearity
SQ9 - System accuracy	0.541	1.849	No collinearity
SQ10 - Flexibility	0.779	1.283	No collinearity
SQ11 - Reliability	0.49	2.042	No collinearity
SQ12 - Efficiency	0.545	1.834	No collinearity
SQ13 - Sophistication	0.7	1.429	No collinearity
SQ14 - Integration	0.649	1.54	No collinearity
SQ15 - Customisation	0.766	1.306	No collinearity

Source: Research

a zero slope implies that there is no association between the 2 variables. In our case, if there is zero within our 95% confidence interval, it implies that this item is not statistically significant and should be dropped from the conceptual model. However, if the confidence interval does not overlap zero, the effect is said to be statistically significant implying that the item should be retained.

From Table 4.12, all the items in Individual Impact(II1 to II4) have positive correlation coefficients. Also, the 95% confidence intervals do not overlap through a zero implying statistical significance. In Organisational Impact, apart from OI2(Staff requirements) whose confidence interval overlaps with zero, all items have positive correlation coefficients. Under Information Quality, item IQ7, content accuracy, has a negative correlation coefficient with the confidence interval passing through zero. Under System Quality, the following items were not statistically significant, SQ1(Data correction), SQ3(Database contents), SQ10(Flexibility) and SQ15(Customisation).

Overall, 7 items were found not to have non-significant correlations with their respective criterion measures. This could indicate that they are not strong predictors for measuring Organisational Impact, Information Quality and System Quality. Conversely, 30 items are significant for measuring the impact of information systems in Kenya.

4.8.3 Strongest Contributor to IS-Impact Model

Path diagram that estimates the magnitude and significance of hypothesised causal connections between sets of variables. In our case it helps establish which construct makes the strongest contribution to IS-Impact. As seen in Figure 4.5, System Quality makes the strongest contribution.

4.9 The Resulting Model

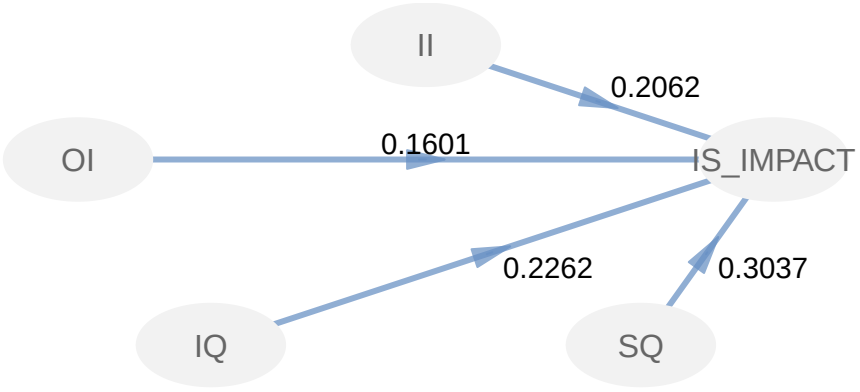
In this section, we conclude by proposing a research model for evaluating health information systems. Our conceptual model was based on the IS-Impact model. The model was operationalised in a quantitative survey conducted on DHIS 2 users. Focus group discussions involving selected DHIS 2 users were conducted in order to explain the reasons and patterns behind the responses.

TABLE 4.12: Correlation Matrix of the 37 IS-Impact Measures with their Respective Criterion Measures

Items	Correlation Coefficient	95% Confidence Intervals - [lower limit, upper limit]
II1 - Learning	0.4	0.25 , 0.53
II2 - Awareness/Recall	0.25	0.09 , 0.4
II3 - Decision effectiveness	0.38	0.23 , 0.52
II4 - Individual productivity	0.37	0.21 , 0.5
OI1 - Organisational costs	0.21	0.05 , 0.37
OI2 - Staff requirements	0.16	-0.01 , 0.32
OI3 - Cost reduction	0.27	0.1 , 0.42
OI4 - Overall productivity	0.42	0.27 , 0.55
OI5 - Improved health outcomes/outputs	0.35	0.2 , 0.49
OI6 - Increased capacity	0.39	0.24 , 0.53
OI7 - E-Government	0.32	0.16 , 0.46
OI8 - Business process change	0.34	0.18 , 0.48
IQ1 - Importance	0.25	0.08 , 0.4
IQ2 - Relevance	0.28	0.12 , 0.43
IQ3 - Availability	0.28	0.11 , 0.43
IQ4 - Usability	0.15	-0.01 , 0.32
IQ5 - Understandability	0.38	0.23 , 0.52
IQ6 - Format	0.37	0.21 , 0.51
IQ7 - Content Accuracy	-0.07	-0.24 , 0.1
IQ8 - Conciseness	0.38	0.23 , 0.52
IQ9 - Timeliness	0.23	0.06 , 0.38
IQ10 - Uniqueness	-0.06	-0.23 , 0.11
SQ1 - Data correction	-0.16	-0.32 , 0.01
SQ2 - Data currency	0.17	0 , 0.33
SQ3 - Database contents	0.16	-0.01 , 0.32
SQ4 - Ease of use	0.38	0.22 , 0.52
SQ5 - Ease of learning	0.31	0.15 , 0.45
SQ6 - Access	0.16	-0.01 , 0.32
SQ7 - User requirements	0.25	0.09 , 0.4
SQ8 - System features	0.27	0.11 , 0.42
SQ9 - System accuracy	0.36	0.2 , 0.5
SQ10 - Flexibility	0.09	-0.08 , 0.26
SQ11 - Reliability	0.34	0.18 , 0.48
SQ12 - Efficiency	0.28	0.11 , 0.43
SQ13 - Sophistication	0.14	-0.03 , 0.3
SQ14 - Integration	0.43	0.28 , 0.56
SQ15 - Customisation	0.16	-0.01 , 0.32

Source: Research

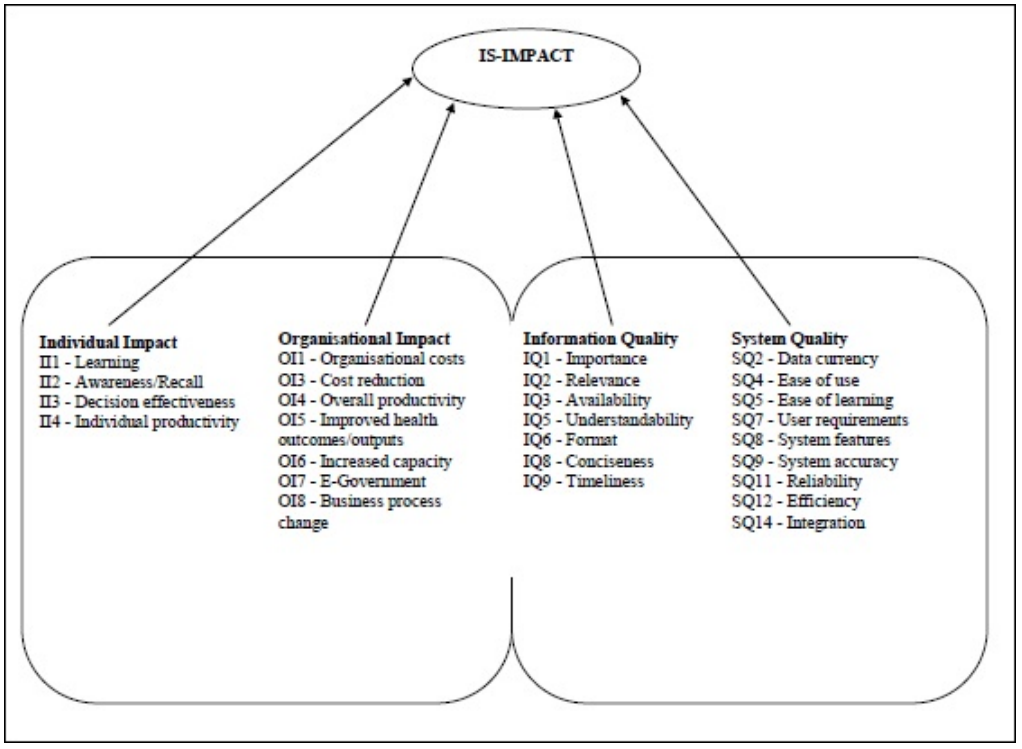
FIGURE 4.5: Path Co-efficients



Source: Research

The validity of the dimensions and measures of the IS-Impact model in the Kenyan context was tested using multicollinearity and external validity tests. The multicollinearity test revealed that there was no collinearity implying that no items contained redundant information, each item distinctly represents different aspects of the four dimensions that comprised the conceptual model. The external validity test whose results can be seen in Table 4.12 shows that 30 items are significant for measuring the impact of information systems in Kenya. Figure 4.6 below presents the conceptual model with 30 measures, based on the findings of the research.

FIGURE 4.6: Resulting Conceptual Model



Source: Research

Chapter 5

Conclusion and Recommendations

The preceding chapters(1-4) of this report demonstrated how the IS-Impact model was identified the theoretical framework for our study. We then proceeded to operationalise the items in the model by administering a survey to DHIS 2 users in Kenya. Based on our findings revised model of IS-Impact was proposed. In this chapter, we conclude by revisiting the research objectives and questions, perform a self-assessment of the study and make recommendations for further DHIS 2 improvement and research work.

5.1 Research Objectives

Objective 1: Establish the user's perspective in evaluating a health information system (HIS) and present a set of evaluation factors that can be used in evaluating a HIS

The matching research question for this objective was: *What factors would a user of a HIS consider if they were to evaluate the success of the system?* This is addressed in chapter 2 where we distinctly noted that the evaluation of an information system can vary among different individual cadres. Sedera et al. (2007) refers to these different cadres of individuals in an organisation as "employment cohorts". The results indicate that 89% of the respondents were from the 'Operational' cohort. Therefore the user perspective,

though originally intended to be from all employment cohorts, has been established from operational users who are comprised of Records and Information Officers.

Our results (see Figure 4.5) indicate that System quality provided the strongest contribution to IS-Impact implying that the respondents are more concerned with system quality issues of DHIS 2. This is in line with the findings of Gable et al. (2008) and Sedera et al. (2007) where they attribute this to operational users' direct experience with an information system.

Objective 2: Develop an IS evaluation model based on review of existing models

This objective involved answering the research question: *What is the appropriate model for evaluating a HIS?*. As explained in Chapter 2, we reviewed varied literature on information system success evaluation. We evaluated the following conceptual frameworks: Technology Acceptance Model(Davis et al., 1989), Delone and Mclean Success Model(DeLone & McLean, 1992), Updated Delone and Mclean Success Model(Delone & McLean, 2003) and the IS-Impact Measure Model(Gable et al., 2008). The IS-Impact measurement model, initially developed and tested in Australia, was adopted as the conceptual framework in this study. This is because it is a robust, thoroughly validated IS evaluation model that had been tested on different types of information systems across various cadres of users. However, compared to the original model, the context for this study was different in terms of the type of system being evaluated and the environment in which the respondents were based.

The study design is discussed in Chapter 3 where the main instrument was the questionnaire. The instrument consisted of 37 measures for measuring IS-Impact and 7 measures for testing the model. Data was then collected from an online-administered questionnaire. 135 responses were found to be valid and were used for data analysis. As a follow-up measure, our study employed focus group discussions to explain the user perspective behind responses provided in the questionnaires. The results of descriptive and qualitative data analyses are shown in Chapter 4 and are summarised in the paragraphs below:

In Individual Impact, we were measuring how DHIS 2 has influenced the individual performance of the respondents on behalf of their organisations or department. From the quantitative analysis, most respondents stated that DHIS 2 had an impact in their performance(see Table 4.2). This was further supported by the FGD where participants stated that DHIS 2 was superior in quality and impact compared to the previous Excel-based stem. Since this now less paperwork compared to the older system, users are able to concentrate on more productive activities.

Under Organisational Impact, the impact of DHIS 2 at a broader, organisational level was being measured. Most respondents felt that DHIS 2 had an impact particularly in achieving the Ministry of Health's objectives(see Table 4.3). This was supported in the FGDs where participants stated that decisions at the district level are now data driven. It is now faster to generate visual data for progress reporting when DHMTs meet. Consequently the quality of service delivery has also improved.

In Information Quality, the respondents were asked on the quality level of DHIS 2 outputs, that is, the quality of information that the system produces in reports and on screen. Overall, a high percentage of users agreed that the quality of DHIS 2 output was high(see Table 4.4). However, users were divided on the uniqueness of the information emanating from DHIS 2. 40.7% felt that this information was available elsewhere, 19.3% were neutral and 40% agreed that this information was unique to DHIS 2. A possible explanation for this from the FGD discussion is that, DHIS 2 is yet to be fully integrated with other systems such as the Master Facility List(MFL) and OpenMRS implying that there could be redundancy, that is, the same data being collected more than once.

Under System Quality, users were asked questions on how the system performed from a technical and design perspective. Overall, most users felt that the system quality of DHIS 2 was high(see Table 4.5). However there were mixed perceptions regarding system quality issues. For instance, 33.3% felt that data from DHIS 2 sometimes need correction and 38.5% felt that data from DHIS 2 was not current enough. This mixed perception can be explained by the fact that the hard copy data collection forms sometimes are not the same with the online form. The FGD participants cited the following forms: 713(nutrition monthly reporting) and 731(HIV/AIDS). Such inconsistencies sometimes confuse those entering data, possibly explaining why the respondents were doubtful of the correctness of the data. Also, regarding how current the data is; the FGD participants

particularly those from urban areas like Nairobi stated that they had low reporting rates because private facilities were not submitting their data to the DHRIOs. The DHRIOs cannot force these private health facilities to submit their data, thus the feeling that the data in DHIS 2 may not be current enough.

Objective 3: Test the evaluation model using DHIS 2

This objective applied to the following research question: *How applicable is the model in evaluating DHIS 2?*. Two tests were conducted to assess the validity of the model as recommended by Diamantopoulos & Winklhofer (2001) and other researchers. The test results were based on tolerance, Variance Inflation Factor(VIF) and correlation coefficients and indicate that 27 measures are significant for measuring the impact of health information systems in Kenya. This demonstrates the validity of the model. Based on the findings, Figure 4.6 shows the resulting framework with 27 measures.

5.2 Research Assessment

We adopt Whetten (1989)'s seven questions which can help a researcher in assessing whether their work constitutes a theoretical contribution. Though these questions originally apply to the organisational science field, they provide a background through which we can reflect on our study

1. *What's new? Does this work make a significant, value-added contribution to current thinking?*

   This study applied the IS-Impact model in evaluating the success of DHIS 2 in the Kenyan context. The IS-Impact model was originally developed and tested in Australia. The model has been applied in different settings. However, to the best of our knowledge, this is the first study in Kenya that reviews the national health information system (DHIS 2) using the IS-Impact model. Therefore through this study, the generalisability of the IS-Impact model has been extended to include a national health information system and its validity upheld.

2. *So what? Will the research change health information systems evaluation?*

   Majority of the respondents(89%) in this study were operational users meaning

that they had direct experience with DHIS 2. Out of this study, we found out that users were more concerned about System Quality issues(see Figure 4.5) as compared to Information Quality, Individual Impact and Organisational Impact. These System Quality issues include: system features, ease of use, ease of learning and system accuracy. This was confirmed in the focus group discussions where respondents stated that the concern on System Quality had to do with the environment or setting in which they(respondents) work in. For example, respondents mentioned about lack of communication in cases when DHIS 2 was down or lack of funds to purchase modem airtime. Therefore, this study has exposed the need to also consider the context in which users are based in - a consideration for further research.

3. *Why so? Are the underlying logic and supportive evidence compelling?*

   This study is based on a sound methodological approach and a well tested research design and conforms to acceptable levels of measurement. The variables used in the conceptual framework were as a result of synthesis of other IS success models. The main evidence in the study was generated from data collected through questionnaires. The quantitative data was used to explain the impact and quality of the DHIS 2 from the perspective of the user while qualitative data revealed the reasons behind these perspectives.

4. *Is the research well done?*

   This study is based on a rigorous and tested framework. Also, data collection was conducted considering research best practices. A mixed method approach was adopted where quantitative and qualitative data collection techniques were used. Questionnaires were used to collect quantitative data. The questionnaires were pre-tested with 20 DHIS 2 users with their views informing the final questionnaire design. The list of respondents was obtained from the Ministry of Health, an indication that these were bona fide DHIS 2 users. Most of the respondents are dispersed in the 290 districts in Kenya an indication that the findings are representative of the DHIS 2 user population that was under study. Focus group discussions were used as a follow-up measure to provide insight to the quantitative results. The model was also tested using multicollinearity and external validity tests.

5. *Is the report well written?*

   The report follows guidelines set by the School of Computing and Informatics. The structure of this report starts from the Introduction where the objectives of the study are stated and the background, justification of the study provided. We then proceed to review the theoretical background of the study where the following topics are discussed: information systems in general, health information system, the IS user and IS success evaluation models. The literature review section concludes by proposing the IS-Impact model as the conceptual framework for this study. We then proceed to discuss how we conducted this research by explaining data collection and analysis. The results are then presented and discussed followed by validity tests. There is therefore this report's format is consistent with standards expected of academic writing. The main ideas can also be easily accessed.

6. *Why now? Is this topic of contemporary interest to scholars in this area?*

   Kenya was the first county in Sub-Saharan Africa to deploy a completely online national health information system (DHIS 2, 2013b). However, no study, to the best of our knowledge, has been done to evaluate the post-implementation of the system, particularly from the perspective of the user. This is therefore a study that can interest health information system researchers who have an interest in the African setting.

7. *Who cares? Who is interested in this topic?*

   DHIS 2 was a large investment and like any organisation, the MoH in Kenya would be interested in knowing the impact the system has on its users. The findings of this research could help the MoH in further improving DHIS 2, ultimately improving health outcomes. The study could also be instrumental in informing policy formulation discussions. Also, this study could be replicated in other countries such as Ghana, Zambia and Uganda which are currently implementing DHIS 2.

5.3 Conclusion

5.3.1 Recommendations for the Ministry of Health

Overall, our findings demonstrate that DHIS 2 has had a positive impact on both its users and the Ministry of Health. It is indeed a welcome departure from the previous Excel-based that was used previously. No information system is devoid of further improvements. The following recommendations are based on feedback received from the survey administered and focus group discussions.

1. *DHIS 2 Design* - The technical design team should comprise individual(s) with previous experience entering and managing data at district or facility level. For example some validation rules are not applicable to the Kenyan setting, a possible indication that the programmers are not conversant with the data collection format at the district level

2. *User Support* - Consider creating a help desk which users can report problems and get solutions immediately. Respondents state that in the current set-up, when one has a problem and they may find the contact person at HIS is out of the office on official duty.

3. *County Super-Users* - Create super users or a focal person at county level such that users don't have to call the national office when they have problems. This way, they can get faster responses from the county level. Currently, CHRIOs have to depend on DHRIOs for data, something which they could easily get if they were allocated user rights to access data pertaining districts in their respective counties.

4. *Personal Initiative* - DHRIOs should also become more conversant with DHIS 2. This is a personal initiative that involves reading the DHIS 2 manual or asking for help from their peers.

A condensed version of this report(see Appendix .2 below for the report) was shared with members of the Division of Health Informatics at the Ministry of Health on 25th June 2014. The division comprises the following departments: Health Information Systems, eHealth and, Monitoring and Evaluation. Division members noted that:

- Being the first study evaluating the implementation of DHIS 2 in Kenya, this was a bold and welcome step. The study is a foundation for subsequent research
- More effort should have been put on reaching DHIS 2 users particularly those in marginalised areas in Kenya. Their perception on DHIS 2 could be different from those who work near urban areas which have fewer challenges
- Subsequent studies should place emphasis on reaching all users particularly decision makers

5.3.2 Recommendation for Further Research Work

The field of IS success evaluation and specifically health information systems is one where more research is required. In this research a model for post-implementation evaluation of health information systems(HIS) is proposed. However, the model needs to be extended further to include the context under which the system is based. For instance, comparative studies can be conducted to evaluate the success of the HIS in a rural setting as compared to an urban setting. Also, one of the limitations in this study was getting respondents who were in strategic management. This study's respondents were operational users i.e., they interacted with the system on a day to day basis. Strategic users as compared to operational users interact less with the system but are important because they decide on the resources required to achieve organisational objectives. Also, decisions made in the strategic level have long-term implications. Therefore, this model can be extended further to include strategic users.

References

Ackoff, R. L. (1979). The future of operational research is past. *Journal of the operational research society*, (pp. 93–104).

Adams, J. (2007). *Research methods for graduate business and social science students*. New Delhi; Response Books; Thousand Oaks, Calif.: SAGE Publications.

Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behavior*. Prentice-Hall.

Alkhalaf, S., Drew, S., & Nguyen, A. (2013). Validation of the IS impact model for measuring the impact of e-learning systems in KSA universities: Student perspective. arXiv e-print 1301.0648.

Allison, P. D. (1999). *Multiple regression: A primer*. Pine Forge Press.

Altrichter, H., Feldman, A., Posch, P., & Somekh, B. (2013). *Teachers investigate their work: An introduction to action research across the professions*. Routledge.

Anthony, R. N. (1965). *Planning and control systems: a framework for analysis*. Boston, Mass.: Division of Research, Graduate School of Business Administration, Harvard University.

Avison, D., & Fitzgerald, G. (2003). *Information systems development: methodologies, techniques and tools*. McGraw Hill.

Bagozzi, R. P., Yi, Y., & Phillips, L. W. (1991). Assessing construct validity in organizational research. *Administrative science quarterly*, (pp. 421–458).

Braa, J., & Sahay, S. (2012). Integrated health information architecture: power to the users : design, development, and use. New Delhi: Matrix Publishers.

Cameron, K. (1980). Critical questions in assessing organizational effectiveness. *Organizational dynamics*, *9*(2), 66–80.

Campbell, D. T., & Fiske, D. W. (1959). Convergent and discriminant validation by the multitrait-multimethod matrix. *Psychological bulletin*, *56*(2), 81.

Cao, L., & Elias, N. F. (2009). Validating the IS-Impact model : two exploratory case studies in china and malaysia. In R. Bapna, & V. Sambamurthy (Eds.) *Proceedings of the Pacific Asia Conference on Information Systems 2009*, (pp. 1–14). Hotel Novotel, Hyderabad, India: Association for Information Systems (AIS).

Cronbach, L. J., & Meehl, P. E. (1955). Construct validity in psychological tests. *Psychological bulletin*, *52*(4), 281.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, *13*(3), 319.

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). User acceptance of computer technology: A comparison of two theoretical models. *Management Science*, *35*(8), 982–1003.

DeLone, W. H., & McLean, E. R. (1992). Information systems success: The quest for the dependent variable. *Information Systems Research*, *3*(1), 60–95.

Delone, W. H., & McLean, E. R. (2003). The DeLone and McLean model of information systems success: A ten-year update. *J. Manage. Inf. Syst.*, *19*(4), 930.

Denzin, N. K. (2009). *The research act: a theoretical introduction to sociological methods*. New Brunswick, NJ: AldineTransaction.

DHIS 2 (2013a). DHIS 2 Documentation.
URL http://www.dhis2.org/documentation(accessedDecember18,2013)

DHIS 2 (2013b). DHIS 2 in action.
URL http://www.dhis2.org/inaction(accessedDecember18,2013)

Diamantopoulos, A., & Winklhofer, H. M. (2001). Index construction with formative indicators: An alternative to scale development. *Journal of Marketing Research*, *38*(2), 269–277.

Douglis, C. (2012). USAID/Kenya | Health Management Information System. URL http://kenya.usaid.gov/programs/health/1213(accessedJanuary09, 2014)

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior: an introduction to theory and research*. Reading, Mass.: Addison-Wesley Pub. Co.

Foxcroft, C., Paterson, H., Le Roux, N., & Herbst, D. (2004). Psychological assessment in south africa: A needs analysis. *The test use patterns and needs of psychological assessment practitioners. Final Report*.

Gable, G. G., Sedera, D., & Chan, T. (2008). Re-conceptualizing information system success : the IS-Impact measurement model. *Journal of the Association for Information Systems*, *9*(7), 377–408.

Gardner, M. J., & Altman, D. G. (1986). Confidence intervals rather than p values: estimation rather than hypothesis testing. *British medical journal (Clinical research ed.)*, *292*(6522), 746.

Gartner (2013). Gartner says worldwide IT spending on pace to reach $3.7 trillion in 2013.
URL http://www.gartner.com/newsroom/id/2537815

Gibbs, A. (1997). Focus groups. *Social research update*, *19*(8).

Guion, L. A., Diehl, D. C., & McDonald, D. (2011). Triangulation: Establishing the validity of qualitative studies.

Hamilton, S., & Chervany, N. L. (1981). Evaluating information system effectiveness - part i: Comparing evaluation approaches. *MIS Quarterly*, *5*(3), 55.

Haux, R. (2006). Health information systems past, present, future. *International Journal of Medical Informatics*, *75*(34), 268–281.

Holden, R. J., & Karsh, B.-T. (2010). The technology acceptance model: Its past and its future in health care. *Journal of Biomedical Informatics*, *43*(1), 159–172.

Kothari, C. R. (2004). *Research Methodology: Methods and Techniques*. New Age International.

Laudon, K. C., & Laudon, J. (2004). Management information systems: managing the digital firm. *New Jersey*, *8*.

Lavrakas, P. J. (2008). *Encyclopedia of survey research methods*. SAGE Publications, Incorporated.

Lee, Y., Kozar, K. A., & Larsen, K. R. T. (2003). The technology acceptance model: Past, present, and future. *Communications of the Association for Information Systems*, *12*(1).

Legris, P., Ingham, J., & Collerette, P. (2003). Why do people use information technology? a critical review of the technology acceptance model. *Information & Management*, *40*(3), 191–204.

Manya, A., Braa, J., verland, L., Titlestad, O., Mumo, J., & Nzioka, C. (2012). National Roll out of District Health Information Software (DHIS 2) in kenya, 2011 Central Server and Cloud based Infrastructure. Dar es Salaam, Tanzania.

MoH Kenya (2011). Kenya National e-health Strategy: 2011-2017.

Morgan, D. L. (1996). Focus groups. *Annual review of sociology*, (pp. 129–152).

Mugenda, O. M., & Mugenda, A. G. (2003). *Research Methods: Quantitative and Qualitative Approaches*. Nairobi, Kenya: African Centre for Technology Studies (ACTS).

Peer, E., & Gamliel, E. (2011). Too reliable to be true? response bias as a potential source of inflation in paper-and-pencil questionnaire reliability. *Practical Assessment, Research & Evaluation*, *16*(9), 2.

Petter, S., Straub, D., & Rai, A. (2007). Specifying formative constructs in information systems research. *Mis Quarterly*, *31*(4), 623–656.

Powell, R. A., & Single, H. M. (1996). Focus groups. *International journal for quality in health care*, *8*(5), 499–504.

R Core Team (2013). *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna, Austria.
URL http://www.R-project.org/

Salovaara, A., & Tamminen, S. (2009). Acceptance or appropriation? a design-oriented critique of technology acceptance models. In H. Isomki, & P. Saariluoma (Eds.) *Future Interaction Design II*, (pp. 157–173). Springer London.

Sauerborn, R., & Lippeveld, T. (2000). Why health information systems? *Design and Implementation of Health Information Systems, ed. T. Lippeveld, R. Sauerborn, and C. Bodart. Geneva: World Health Organization*.

Seddon, P., & Kiew, M.-Y. (2007). A partial test and development of delone and mclean's model of IS success. *Australasian Journal of Information Systems*, *4*(1).

Seddon, P. B., Staples, S., Patnayakuni, R., & Bowtell, M. (1999). Dimensions of information systems success. *Commun. AIS*, *2*(3es).

Sedera, D., Tan, F., & Dey, S. (2007). Identifying and evaluating the importance of multiple stakeholders perspective in measuring ES-Success. In *Faculty of Science and Technology*. Gothenburg Sweden: Association of Information Systems - AIS.

Shannon, C. E., & Weaver, W. (1949). The mathematical theory of communication (urbana, IL. *University of Illinois Press*, *19*(7), 1.

Silver, M. S., Markus, M. L., & Beath, C. M. (1995). The information technology interaction model: a foundation for the mba core course. *MIS quarterly*, (pp. 361–390).

Taylor, S., & Todd, P. A. (1995). Understanding information technology usage: A test of competing models. *Information Systems Research*, *6*(2), 144–176.

Taylor-Powell, E., & Renner, M. (2003). *Analyzing qualitative data*. University of Wisconsin–Extension, Cooperative Extension.

Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management Science*, *46*(2), 186–204.

Venkatesh, V., Morris, M., Davis, G., & Davis, F. (2003). User acceptance of information technology: Toward a unified view. *Management Information Systems Quarterly*, *27*(3).

Wanambisi, L. (2013). Kenya: Governors seek senate help over devolution impasse. *AllAfrica*.

Wellington, J. J., & Szczerbinski, M. (2007). *Research methods for the social sciences*. London; New York: Continuum International Pub. Group.

Whetten, D. A. (1989). What constitutes a theoretical contribution? *Academy of Management Review*, *14*(4), 490–495.

WHO (2006). Building foundations for e-health: progress of member states. *Report of the WHO Global Observatory for eHealth, WHO, Geneva*.

Yamane, T. (1967). Statistics: An introductory analysis. *Harper and Row, New York*.

Yarbrough, A. K., & Smith, T. B. (2007). Technology acceptance among physicians a new take on TAM. *Medical Care Research and Review*, *64*(6), 650–672. PMID: 17717378.

Appendix A - Questionnaire

Survey: DHIS Survey

District Health Information Software - Version 2 (DHIS 2) Evaluation Survey

Introduction
Since 2011, the Ministry of Health (MoH) has invested significant resources in developing the District Health Information Software 2 (DHIS 2). The impact of DHIS 2 is now being experienced across the country. All active DHIS 2 are being contacted and encouraged to participate in this survey.

Purpose of the Survey
The purpose of this survey is to identify the impacts of DHIS 2 from the perspective of the user. This survey is being conducted as Masters in Information Systems project at the University of Nairobi. Approval has been obtained from the MoH to conduct this survey. Please see the approval on this link - DHIS 2 survey approval

We seek to learn from your experiences with DHIS 2. Insights into your experiences with DHIS 2 will be valuable in highlighting where the Ministry of Health should be focusing their attention with regards to DHIS 2 improvement, today and in future. Analysis of negative impacts will provide the basis of strategies for improvements. Positive impacts may be replicated or extended in other countries.

General Instructions for Completing the Questionnaire
- It will take approximately 10-15 minutes to complete the online questionnaire.
- Please answer the questions truthfully. Remember there are no right or wrong answers.
- Please answer all questions

Your participation in this study is completely voluntary. There are no foreseeable risks associated with this project. However, if you feel uncomfortable answering any questions, you can withdraw from the survey at any point. It is very important for us to learn your opinions.

Your survey responses will be strictly confidential and data from this research will be reported only in the aggregate. Your information will be coded and will remain confidential. If you have questions at any time about the survey or the procedures, you may contact James Gathogo on the addresses specified below.

Thank you very much for your time and support. Please start with the survey now by clicking on the Continue button below.

James Gathogo
School of Computing and Informatics
University of Nairobi
0720847745
jgathogo@students.uonbi.ac.ke or james@gathogo.co.ke

☐ **I Agree**

SECTION A: Respondent Information

Job title *

In which category is your age? *

- ○ 18-21
- ○ 22-25
- ○ 26-30
- ○ 31-40

- ○ 41-50
- ○ 51-60
- ○ 61 or over

What is your gender? *
- ○ Female
- ○ Male

District *

County *

How long have you been using DHIS 2? *
- ○ Less than 1 month
- ○ 2 to 6 months
- ○ 7 to 12 months
- ○ More than 1 year

How often do you use DHIS 2? *
- ○ Once a week or more often
- ○ 2 to 3 times a month
- ○ Once a month
- ○ Every 2-3 months
- ○ 2-3 times a year
- ○ Once a year or less often

If you want to receive a copy the preliminary findings of this study please provide your email address

SECTION B: DHIS 2 Evaluation

Please indicate your level of agreement with the statements below by selecting an appropriate answer in the choices provided

Individual impact - how DHIS 2 has influenced your individual performance

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
I have learnt much through the presence of DHIS 2 *	○	○	○	○	○
DHIS 2 enhances my awareness and recall of job related information *	○	○	○	○	○
DHIS 2 enhances my effectiveness in the job *	○	○	○	○	○
DHIS 2 increases my productivity *	○	○	○	○	○

Organisational Impact - impact of DHIS 2 at a broader, organisational level

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
DHIS 2 is cost effective *	○	○	○	○	○
DHIS 2 has resulted in reduced staff costs *	○	○	○	○	○
DHIS 2 has resulted in cost reductions (e.g. inventory holding costs, administration expenses, etc.) *	○	○	○	○	○
DHIS 2 has resulted in overall productivity improvement *	○	○	○	○	○
DHIS 2 has resulted in improved health outcomes or outputs *	○	○	○	○	○
DHIS 2 has resulted in an increased capacity to manage a growing volume of activity (e.g. transactions, population growth, etc.) *	○	○	○	○	○
DHIS 2 has resulted in better positioning for e-Government. *	○	○	○	○	○
DHIS 2 has resulted in improved organisational processes *	○	○	○	○	○

Information Quality - quality of DHIS 2 outputs, namely, the quality of the information the system produces in reports and on-screen

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Information available from DHIS 2 is important *	○	○	○	○	○
DHIS 2 provides output that seems to be exactly what is needed *	○	○	○	○	○
Information needed from DHIS 2 is always available *	○	○	○	○	○
Information from DHIS 2 is in a form that is readily usable *	○	○	○	○	○
Information from DHIS 2 is easy to understand *	○	○	○	○	○
Information from DHIS 2 appears readable, clear and well formatted *	○	○	○	○	○

Though data from DHIS 2 may be accurate, outputs sometimes are not *	○	○	○	○	○
Information from DHIS 2 is concise *	○	○	○	○	○
Information from DHIS 2 is always timely *	○	○	○	○	○
Information from DHIS 2 is unavailable elsewhere *	○	○	○	○	○

System Quality - a multifaceted construct designed to capture how the system performs from a technical and design perspective

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Data from DHIS 2 often needs correction *	○	○	○	○	○
Data from DHIS 2 is current enough *	○	○	○	○	○
DHIS 2 is missing key data *	○	○	○	○	○
DHIS 2 is easy to use *	○	○	○	○	○
DHIS 2 is easy to learn *	○	○	○	○	○
It is often difficult to get access to information that is in the DHIS 2 system *	○	○	○	○	○
DHIS 2 meets my department/organisation requirements *	○	○	○	○	○
DHIS 2 includes necessary features and functions *	○	○	○	○	○
DHIS 2 always does what it should *	○	○	○	○	○
The DHIS 2 user interface can be easily adapted to one's personal approach *	○	○	○	○	○
The DHIS 2 system is always up-and-running as necessary *	○	○	○	○	○
The DHIS 2 system responds quickly enough *	○	○	○	○	○
DHIS 2 requires only the minimum number of fields and screens to achieve a task *	○	○	○	○	○
All data within DHIS 2 is fully integrated and consistent *	○	○	○	○	○
DHIS 2 can be easily modified, corrected or improved. *	○	○	○	○	○

Satisfaction - refers to your feelings towards DHIS2

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Overall, DHIS 2 is satisfactory *	○	○	○	○	○
I am satisfied with DHIS 2 *	○	○	○	○	○
I am not happy with DHIS 2 *	○	○	○	○	○
I like DHIS 2 *	○	○	○	○	○

How satisfied are you with the following functions provided DHIS 2

	Very Unsatisfied	Unsatisfied	Neutral	Satisfied	Very Satisfied
Data collection *	○	○	○	○	○
Data entry *	○	○	○	○	○
Data aggregation/consolidation *	○	○	○	○	○
Reporting *	○	○	○	○	○

Overall

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Overall, DHIS 2 is satisfactory *	○	○	○	○	○
Overall, the impact of DHIS 2 on *me* has been positive. *	○	○	○	○	○
Overall, the impact of DHIS 2 on the *my department/organisation* has been positive. *	○	○	○	○	○
Overall, the DHIS System Quality is satisfactory *	○	○	○	○	○
Overall the Information Quality of DHIS 2 is satisfactory *	○	○	○	○	○
Overall the System Quality of DHIS 2 is satisfactory *	○	○	○	○	○
DHIS 2 is good *	○	○	○	○	○
DHIS 2 has negatively affected the organisation's performance *	○	○	○	○	○
DHIS 2 has no problem *	○	○	○	○	○
I have received many benefits/advantages from DHIS 2 *	○	○	○	○	○

Comments/Suggestions:

District Health Information Software - Version 2 (DHIS 2) Evaluation Survey

Appendix B - Focus Group Guide

.1 Preliminaries

- Welcoming
  - Introduce myself and research assistant
  - Invite focus group (FG) members to introduce themselves name and district
  - Introduce topic and explain why we are here i.e., discuss and comment on your personal experience of DHIS 2
- Guidelines
  - No right or wrong answers, only differing points of view
  - The information we collect will be treated as confidential and only for the purposes of research
  - We're tape recording, one person speaking at a time. Request for permission first.
  - We're on a first name basis
  - You don't need to agree with others, but you must listen respectfully as others share their views
  - Mobile phones - Ask FG members turn off their phones. If this is not possible and one must respond to a call, please do so as quietly as possible and rejoin us as quickly as you can.
  - My role as moderator will be to guide the discussion
  - Talk to each other
  - FG discussion will at most last one hour.
  - Any question before we begin?

.2 Questions

1. What are you general comments about DHIS 2? Do you find it useful?
   (a) How has it improved service delivery at the district, county and national levels?
   (b) Do you think it has influenced decision making at the district, county and national levels?
2. How and when do you use DHIS 2? When did you start using DHIS 2?
3. Tell me about positive experiences you have had with DHIS 2?
   (a) What features do you find most useful?
   (b) Is DHIS 2 easy to use?
   (c) How was the learning process like? Are you confident that you know how to use the system?
   (d) What added functionality and feature would you like to see in DHIS 2? Explain
4. Tell me about disappointments you have had with DHIS 2?
   (a) What were you not able to do?
   (b) Was there somebody to help?
   (c) Was your problem solved?
5. Suppose that you were in charge and could make one change that would make DHIS 2 better. What would you do?
6. What can each one of us do to make the DHIS 2 better?
7. Is there anything else we havent discussed yet that you think is important for the purposes of this study?

Appendix C - Letters of Authorisation

UNIVERSITY OF NAIROBI
SCHOOL OF COMPUTING AND INFORMATICS

Telephone: **4447870/4444919/4446544**
Telefax: **4447870**
Email: **moturi@uonbi.ac.ke**

P. O. Box 30197
Nairobi
Kenya

18-Oct-13

Principal Secretary
Ministry of Health

James Karanu Gathogo (P56/78997/2009) - MSC PROJECT

The above named is a bona fide student in the MSc in Information Systems programme of this University. As part of the requirement for the programme, the student is carrying out a final project entitled: **A model for post-implementation evaluation of health information systems: The case of DHIS 2 in Kenya.** This project involves gathering relevant data from District Health Information System 2(DHIS 2) users in Kenya. You have been identified as a source of the required data. We are therefore requesting that you accord the student the necessary assistance. Your assistance will be highly appreciated.

Yours faithfully,

CHRISTOPHER A MOTURI
DEPUTY DIRECTOR
SCHOOL OF COMPUTING & INFORMATICS

School of Computing and Informatics
University of Nairobi,
Nairobi, Kenya

Approved 24/10/13

Dr Kimanya
For Information

Approved

Dr. Kimanya - Head HRS

18th October 2013

The Principal Secretary
Ministry of Health
Nairobi, Kenya

Dear Sir/Madam,

Request for permission to conduct research on DHIS 2

My name is James Karanu Gathogo, and I am an MSc in Information Systems student at the University of Nairobi, School of Computing and Informatics. The research I wish to conduct for my Master involves the evaluation of the Kenya District Health Information Software 2(DHIS 2) from the perspective of the users. This project will be conducted under the supervision of Dr. Daniel O. Ochieng (School of Computing and Informatics, University of Nairobi).

I am hereby seeking your consent to administer online self-administered questionnaires and conduct focus group discussions (FGD) with the various DHIS 2 users including DHRIOs, CHRIOs and other users in the Ministry of Health.

I have provided you with a copy of my project proposal which includes a copy of the questionnaire, the FGD guide and an introduction letter from the School of Computing and Informatics.

Upon completion of the study, I undertake to provide the Ministry of Health with a bound copy of the full research report. If you require any further information, please do not hesitate to contact me on the contacts provided below. Thank you for your time and consideration in this matter.

Yours sincerely,

James Karanu Gathogo
0720847745
Email: jgathogo@students.uonbi.ac.ke or james@gathogo.co.ke

Appendix D - Study Report Presented to the MoH

The Impact of DHIS 2 in Kenya - A User Perspective

James Gathogo* Dr. Daniel O. Ochieng†

June 25, 2014

Contents

List of Figures

List of Tables

*This report is a summary of an MSc. in Information Systems Project done by James Gathogo under the School of Computing and Informatics at the University of Nairobi

†Project Supervisor, University of Nairobi - School of Computing and Informatics

1 Introduction

1.1 Introduction to the Study

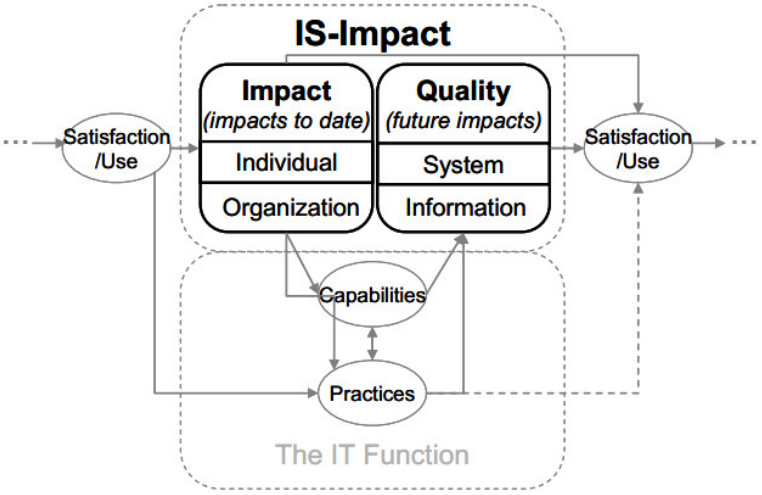
The Kenyan government through the Ministry of Health (MoH) in its quest to improve the health outcomes of its citizenry, has embarked on a number of initiatives. One of these initiatives under the umbrella of eHealth is the District Health Information Software(DHIS 2). DHIS 2 is "an integrated, web-based, country owned and managed, national health information system that integrates quality data used at all levels to improve health service delivery". The logic behind the emphasis of DHIS 2 is that with quality data, public health decision making will be more efficient and effective. This study evaluated the post-implementation DHIS 2, particularly from the perspective of the user. DHIS 2 was a large investment and like any organisation, the MoH would be interested in knowing the impact the system has on its users. The objectives of this study were:

- To establish the user's perspective in evaluating a health information system (HIS) and present a set of evaluation factors that can be used in evaluating a HIS
- Develop an IS evaluation model based on review of existing models
- Test the evaluation model using DHIS 2.

1.2 IS-Impact Model Overview

The IS-Impact model, developed by Gable, Sedera and Chan in 2008, was used as the theoretical foundation for this study. The IS-Impact model is measurement model that was developed to evaluate the impact of information systems(IS) in organisations. It provides a 'snapshot' or a measure at a point in time, of the stream of net benefits from the IS, to-date and anticipated, as perceived by all key-user-groups. It consists of two dimensions(see Figure 1, the Impact half consisting of Individual-Impact and Organizational-Impact dimensions, and the Quality half comprising of System-Quality and Information-Quality dimensions. The Impact dimension explains the impact to date whereas the quality dimension measures the future potential of the system.

Figure 1: IS-Impact Conceptual Model



The four dimensions are briefly defined below:

- **Individual-Impact** is a measure of the extent to which the IS has influenced the capabilities and effectiveness on behalf of the organisation, of key-users
- **Organizational-Impact** is a measure of the extent to which the IS has promoted improvement in organisational results and capabilities
- **Information-Quality** is a measure of the quality of IS outputs: namely, the quality of the information the system produces in reports and on-screen
- **System-Quality** is a measure of the performance of from a technical and design perspective

The IS-Impact model was developed in Australia therefore this was an opportunity to test the framework in a different setting.

1.3 Study Stakeholders

When evaluating the success of an information system it is important to do so from the perspective of various levels within an organisation. An information system serving a large organisation has different stakeholders each with varied aims and views on what the system should do.These levels are sometimes referred to as 'employment cohorts'. Studies have shown that one employment cohort may have conflicting experiences from another as shown in Table 1 below where the levels of employment can be classified under the headings: strategic, management and operational.

Table 1: Employment Cohorts and Related Tasks

Activity	Strategic	Management	Operational
Focus of Plans	Futuristic, One aspect at a time	Whole organization	Single task / transaction
Complexity	Many variables	Less complex	Simple, rule based
Degree of Structure	Unstructured, irregular	Rhythmic, procedural	Structured
Nature of Information	Tailor made, more external and predictive	Integrated, internal but holistic	Task specific, real time
Time Horizon	Long term	Long, medium to short	Short

When evaluating IS success one needs to gather multiple perceptions from all employment cohorts. However due to organisational constraints one can make useful observations by gathering data from one user cohort.

In case of DHIS 2, examples of roles for each of the cohorts may include:

- **Strategic**: Division heads, County Executives for Health
- **Managerial**: County Health Records and Information Officers, Monitoring and Evaluation Officers
- **Operational**: District Health Records and Information Officer

2 The Impact of DHIS 2

2.1 Methodology - How the Study was Done

The survey was conducted between December 2013 and January 2014. Two data collection strategies were utilised: questionnaires and focus group discussions(FGDs). FGDs were used as qualitative follow-up method to the primary questionnaire instrument. An online questionnaire was used where respondents were directed to the website containing the survey questions. For those who had problems accessing the online questionnaire, a Microsoft Word version was emailed to them. All questions were compulsory.

A user list was provided by the Ministry of Health containing user names, email and telephone contacts of DHIS 2 users. We randomly identified 145 users who we contacted to fill in the questionnaire. Though these users were from non-governmental organisations, academia or in their individual capacities, majority who responded were DHRIOs who use the system routinely. Though our target population was 500 active users from the three employment cohorts(strategic, managerial and operational), we realised later in the study that the active DHIS 2 users were actually DHRIOs who were 290 in number. In the end, we invited all these 290 DHRIOs to participate in survey. These DHRIOs in turn have had challenges in their data management roles. For example when we called them during the survey, some told us that they had no airtime for their modems. Also, at the time of doing this research, there was uncertainity regarding whether DHRIOs were under the national government or counties. This made it difficult for some DHRIOs to concentrate on completing the survey.

Out of the respondents contacted, 135 filled in the online questionnaire and these were found valid for use in the quantitative analysis process.

The survey contained 41 items. The respondents were required to show their level of agreement with the survey statements by choosing whether they strongly disagred, disagree, neutral, agree or strongly agree.

- 4 items for measuring the impact of DHIS 2 on the individual
- 8 items for measuring the impact of DHIS 2 on the organisation(from the perspective of the respondent)
- 10 items for measuring the quality of the information produced by DHIS 2
- 15 items for measuring the quality of DHIS 2 from a design and technical perspective
- 4 items for assessing level of satisfaction on 4 key DHIS 2 features namely, data collection, data entry, data aggregation/consolidation and reporting

2.2 Findings and Discussions

2.2.1 Respondents' Demography

In Section A of the questionnaire, respondent were asked to provide the following information: job title, age category, gender, district, county, how long they had been using DHIS 2 and how often they used it. All fields in Section A were mandatory. We did not collect the names of the respondents. The respondents were however asked to provide an email address in case they wanted to receive a copy of the preliminary findings of the study. This section provides the general characteristics of the respondents.

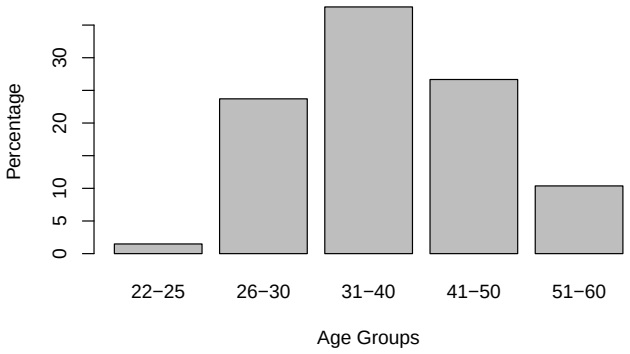
1. **Distribution According to Age** - The respondents were categorised according to age groups as shown in Figure 2. The results tend to suggest that DHIS 2 users range from ages 26 to 60 with a big part(62%) being between 26 and 40 years, a sign that this is a relatively young user base.

2. **Distribution According to Gender** - Females accounted for 39.3% of the total number of respondents whereas males were 60.7%.

3. **Distribution According to DHIS 2 Frequency of Use** - Most respondents were frequent users of DHIS 2. See Figure 3

4. **Classification of Respondents According to Job Title** - Most respondents as shown in Table 2 are Health Records and Information Officers(HRIOs) who interact with DHIS 2 on a frequent basis. Further, Figure 4 shows classification of respondents according to their employment cohorts. HRIOs were classified under 'Operational'. Monitoring and Evaluation staff were grouped under 'managerial'. The rest of the cadres were classified under 'Other'. A high percentage of respondents(89%) were from the 'Operational' employment cohort. A possible explanation for this is that most prospective respondents opted not to do the survey because they did not use DHIS 2 frequently. This was confirmed when we were making follow up calls where respondents said that the last time they used DHIS 2 was when it was being introduced to their district in 2011.

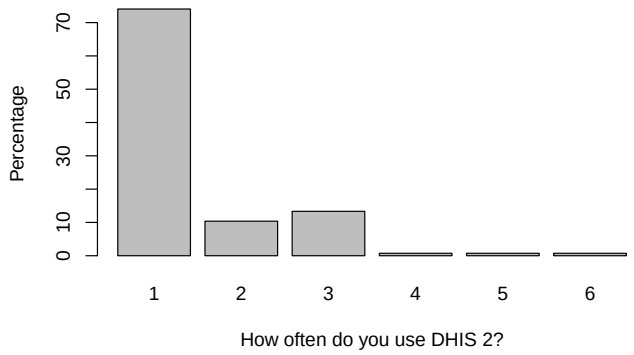
Figure 2: Distribution by Age Group



2.2.2 Overall scores

The overall scores were obtained through calculating the average of respondent scores in each dimension. As demonstrated in Figure 5, all dimension scores are above the middle scale(more than 3). This shows that respondents feel that DHIS 2 has a positive impact. These scores are summarised as follows:

Figure 3: Distribution According to DHIS 2 Frequency of Use



1=More than a week, 2=2-3 times a month, 3=Once a month, 4=Every 2-3 months, 5=2-3 times a year, 6=Once a year or less often

Figure 4: Distribution According to Employment Cohorts

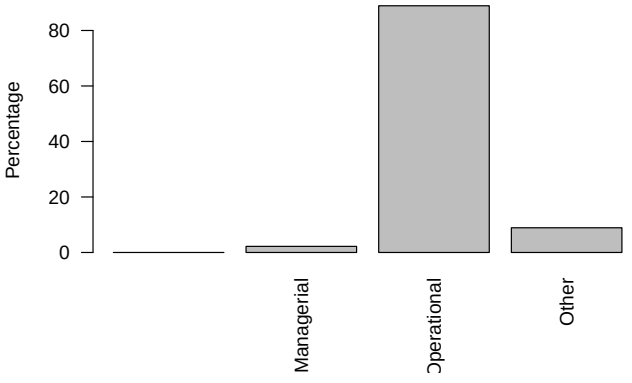


Table 2: Classification of Respondents According to Job Title

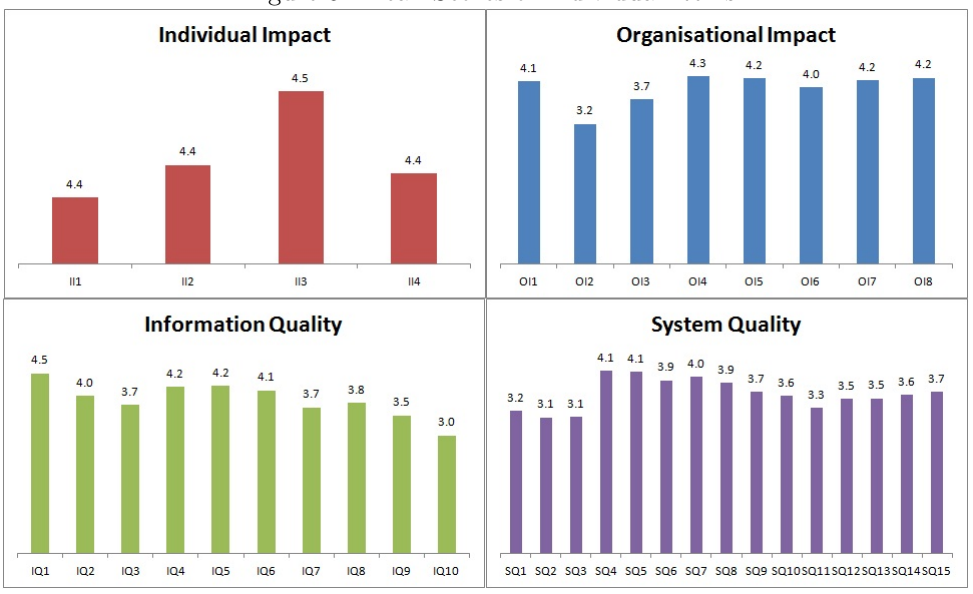
Job Title	**Total**	**Category/Cohort**
Health Records and Information Officer	117	Operational
Monitoring and Evaluation Officer	5	Management
District Medical Officer of Health	3	Other
Occupational Therapist	2	Other
Community Health Worker	2	Other
Administrator	1	Other
District Aids and STI Co-ordinator	1	Other
Nursing Officer	1	Other
Nutrition Officer	1	Other
Program Officer	1	Other
Pharmaceutical Technologist	1	Other
Total	**135**	

Figure 5: Overall scores

2.2.3 Perceptions of DHIS 2 based on Individual Items

The survey contained 41 items(see Appendix A below). Each item measures a specific item. The score of each item demonstrates the perception of the respondents. These scores also exhibit areas that need improvement. Table 6 shows the mean scores of each item.

Figure 6: Mean Scores of Individual Items



1. In **Individual Impact**, we were measuring how DHIS 2 has influenced the individual performance of the respondents on behalf of their organisations or department. From the quantitative analysis, most respondents stated that DHIS 2 had an impact in their performance. This was further supported by the FGD where participants stated that DHIS 2 was superior in quality and impact compared to the previous Excel-based stem. Since this now less paperwork compared to the older system, users are able to concentrate on more productive activities.

2. Under **Organisational Impact**, the impact of DHIS 2 at a broader, organisational level was being measured. Most respondents felt that DHIS 2 had an impact particularly in achieving the Ministry of Health's objectives. This was supported in the FGDs where participants stated that decisions at the district level are now data driven. It is now faster to generate visual data for progress reporting when DHMTs meet. Consequently the quality of service delivery has also improved.

3. In **Information Quality**, the respondents were asked on the quality level of DHIS 2 outputs, that is, the quality of information that the system produces in reports and on screen. Overall, a high percentage of users agreed that the quality of DHIS 2 output was high. However, users were divided on the uniqueness of the information emanating from DHIS 2. 40.7% felt that this information was available elsewhere, 19.3% were neutral and 40% agreed that this information was unique to DHIS 2. A possible explanation for this from the FGD discussion is that, DHIS 2 is yet to be fully integrated with other systems such as the Master Facility List(MFL) and OpenMRS implying that there could be redundancy, that is, the same data being collected more than once.

4. Under **System Quality**, users were asked questions on how the system performed from a technical and design perspective. Overall, most users felt that the system quality of DHIS 2 was high.

However there were mixed perceptions regarding system quality issues. For instance, 33.3% felt that data from DHIS 2 sometimes need correction and 38.5% felt that data from DHIS 2 was not current enough. This mixed perception can be explained by the fact that the hard copy data collection forms sometimes are not the same with the online form. The FGD participants cited the following forms: 713(nutrition monthly reporting) and 731(HIV/AIDS). Such inconsistencies sometimes confuse those entering data, possibly explaining why the respondents were doubtful of the correctness of the data. Also, regarding how current the data is; the FGD participants particularly those from urban areas like Nairobi stated that they had low reporting rates because private facilities were not submitting their data to the DHRIOs. The DHRIOs cannot force these private health facilities to submit their data, thus the feeling that the data in DHIS 2 may not be current enough.

3 Recommendations for the Ministry of Health

Overall, our findings demonstrate that DHIS 2 has had a positive impact on both its users and the Ministry of Health. It is indeed a welcome departure from the previous Excel-based that was used previously. No information system is devoid of further improvements. The following recommendations are based on feedback received from the survey administered and focus group discussions.

(a) *DHIS 2 Design* - The technical design team should comprise individual(s) with previous experience entering and managing data at district or facility level. For example some validation rules are not applicable to the Kenyan setting, a possible indication that the programmers are not conversant with the data collection format at the district level

(b) *User Support* - Consider creating a help desk which users can report problems and get solutions immediately. Respondents state that in the current set-up, when one has a problem and they may find the contact person at HIS is out of the office on official duty.

(c) *County Super-Users* - Create super users or a focal person at county level such that users don't have to call the national office when they have problems. This way, they can get faster responses from the county level. Currently, CHRIOs have to depend on DHRIOs for data, something which they could easily get if they were allocated user rights to access data pertaining districts in their respective counties.

(d) *Personal Initiative* - DHRIOs should also become more conversant with DHIS 2. This is a personal initiative that involves reading the DHIS 2 manual or asking for help from their peers.

References

Gable, G. G., Sedera, D., & Chan, T. (2008). Re-conceptualizing information system success : the IS-Impact measurement model. *Journal of the Association for Information Systems*, *9*(7), 377–408.

Manya, A., Braa, J., Øverland, L., Titlestad, O., Mumo, J., & Nzioka, C. (2012). National Roll out of District Health Information Software (DHIS 2) in kenya, 2011 – Central Server and Cloud based Infrastructure. Dar es Salaam, Tanzania.

MoH Kenya (2011). Kenya National e-health Strategy: 2011-2017.

Appendix

A Construct Measures(Questionnaire Items)

The following variables were measured as depicted below: individual impact, organisational impact, information quality and system quality. The constructs were measured using the following scales: individual impact - 4-item scale, organisational impact - 8-item scale, information quality - 10-item scale and system quality - 15-item scale. All items were measured using a five-point likert type scale that ranges from "strongly disagree" to "strongly agree".

Individual Impact

- II1:(Learning) - I have learnt much through the presence of DHIS 2
- II2:(Awareness/Recall) - DHIS 2 enhances my awareness and recall of job related information
- II3:(Decision effectiveness) - DHIS 2 enhances my effectiveness in the job
- II4:(Individual productivity) - DHIS 2 has influenced your individual performance DHIS 2 increases my productivity

Organisational Impact

- OI1:(Organisational costs) - DHIS 2 is cost effective
- OI2:(Staff requirements) - DHIS 2 has resulted in reduced staff costs
- OI3:(Cost reduction) - DHIS 2 has resulted in cost reductions (e.g. inventory holding costs, administration expenses, etc.)
- OI4:(Overall productivity) - DHIS 2 has resulted in overall productivity improvement
- OI5:(Improved health outcomes/outputs) - DHIS 2 has resulted in improved health outcomes or outputs
- OI6:(Increased capacity) - DHIS 2 has resulted in an increased capacity to manage a growing volume of activity (e.g. transactions, population growth, etc.)
- OI7:(E-Government) - DHIS 2 has resulted in better positioning for e-Government.
- OI8:(Business process change) - DHIS 2 has resulted in improved organisational processes

Information Quality

- IQ1:(Importance) - Information available from DHIS 2 is important
- IQ2:(Relevance) - DHIS 2 provides output that seems to be exactly what is needed
- IQ3:(Availability) - Information needed from DHIS 2 is always available
- IQ4:(Usability) - Information from DHIS 2 is in a form that is readily usable
- IQ5:(Understandability) - Information from DHIS 2 is easy to understand
- IQ6:(Format) - Information from DHIS 2 appears readable, clear and well formatted

- IQ7:(Content Accuracy) - Though data from DHIS 2 may be accurate, outputs sometimes are not
- IQ8:(Conciseness) - Information from DHIS 2 is concise
- IQ9:(Timeliness) - Information from DHIS 2 is always timely
- IQ10:(Uniqueness) - Information from DHIS 2 is unavailable elsewhere

System Quality

- SQ1:(Data correction) - Data from DHIS 2 often needs correction
- SQ2:(Data currency) - Data from DHIS 2 is current enough
- SQ3:(Database contents) - DHIS 2 is missing key data
- SQ4:(Ease of use) - DHIS 2 is easy to use
- SQ5:(Ease of learning) - DHIS 2 is easy to learn
- SQ6:(Access) - It is often difficult to get access to information that is in the DHIS 2 system
- SQ7:(User requirements) - DHIS 2 meets my department/organisation requirements
- SQ8:(System features) - DHIS 2 includes necessary features and functions
- SQ9:(System accuracy) - DHIS 2 always does what it should
- SQ10:(Flexibility) - The DHIS 2 user interface can be easily adapted to one's personal approach
- SQ11:(Reliability) - The DHIS 2 system is always up-and-running as necessary
- SQ12:(Efficiency) - The DHIS 2 system responds quickly enough
- SQ13:(Sophistication) - DHIS 2 requires only the minimum number of fields and screens to achieve a task
- SQ14:(Integration) - All data within DHIS 2 is fully integrated and consistent
- SQ15:(Customisation) - DHIS 2 can be easily modified, corrected or improved.