DISSERTATION PROJECT

ASSESSMENT OF THE USEFULNESS AND ACCEPTANCE OF HEALTH MANAGEMENT INFORMATION SYSTEM BY HEALTH DATA MANAGERS IN HEALTH CENTERS AND HOSPITALS IN RWANDA

By

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DECLARATION

I, Fabien HAGENIMANA, declare that this dissertation contains my own work except where specifically acknowledged and it has not been presented to any other University for similar or any other degree award.

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DEDICATION

To all members of my family and friends,

To my colleague students in masters of health informatics and teammates.

ABSTRACT

Background: Information Technology (IT) holds boundless potential for enhancing healthcare quality and safety. Health Management Information Systems (HMIS) play a crucial role in facilitating effective healthcare delivery and management, particularly in Low- and Middle-Income Countries (LMICs). Despite the introduction of Rwanda's HMIS in 1998, no previous studies have evaluated its adoption from the perspective of end users. This research aims to assess the utility and acceptance of HMIS among Health Data Managers (HDMs) in Rwanda.

Methodology: This is a cross-sectional study combined both quantitative and qualitative design. The usefulness and acceptance of HMIS by health data managers has been assed using TAM. Questionnaires with quantitative questions in form of likert scale and complementary qualitative questions were administered into the HDMs in hospitals and health centers.

Results: Males account for 53% of the total respondents while females occupied 47%. Perceived usefulness (PU), perceived ease of use (PEU) and technology factors were significantly correlated with each other and system acceptance. The joint R Square for PU, PEU, INST, and TECH is .644. HDMs' PU of HMIS highlight its core functionalities which includes being quick, increase users' productivity, effectiveness, making the job easier, and its usefulness.

Conclusion: The significance of HMIS usefulness and acceptance among HDMs in Rwanda is evident, but opportunities for further improvement exist. HDMs acknowledge the valuable contributions of HMIS to their achievements. Factors such as Perceived Usefulness (PU), Perceived Ease of Use (PEU), and technology play crucial roles in the adoption of HMIS by HDMs. Continuous trainings, a user-friendly system, technical support, interoperability, and timely communication of updates were recommended by HDMs.

KEYWORDS DEFINITIONS

TECHNOLOGY: Technology can be described as the implementation of novel and improved methods to perform specific tasks or achieve particular objectives. According to Mascus, it involves the knowledge and data necessary to attain specific production outcomes through the combination of various inputs (13).

HEALTH INFORMATION SYSTEM: It encompasses electronic systems used by both patients and healthcare professionals to store, share, and analyze health information (14).

HIT: Health Information Technology (HIT) refers to the use of information processing that involves the integration of computer hardware and software to store, retrieve, share, and utilize healthcare information, data, and knowledge, aiding communication and decision-making (2). The data generated through technological advancements play a crucial role in informing health policymakers.

HIMS: It refers to the Health Management Information System, specifically customized for the District Health Information System Version 2 (DHIS2) (15). National Health Management Information Systems (HMIS) have been implemented in numerous low- and middle-income countries (LMICs) to routinely collect and manage facility-based data on health care service delivery (8).

EHR: Electronic Health Records (EHR) stand for electronic health records, which assist healthcare providers in maintaining and tracking patients' health data. EHRs offer numerous benefits, including the facilitation of health professionals sharing patients' health information with specialists who require it for their well-being (14). EHRs electronically create, collect, and store health data.

LIST OF ABREVIATIONS

TAM: technology acceptance model

CHWs: community health workers

HMIS: Health management and information system

UR: university of Rwanda

MOH: ministry of health

EHR: electronic health record

HIT: health information technology

HDM: Health data managers

PU: perceived usefulness

PEU: perceived ease of use

INST: institution factors

TECH: technology factors

UB: use behavior

IT: information technology

HIS: health information system

EMR: Electronic medical records

HF: Health facility

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CHAPTER ONE: INTRODUCTION AND BACKGROUND OF THE STUDY

1.1. Background

Ever since the integration of computers into human life, it has brought about significant changes, revolutionizing various activities (1). Health Information Technology (HIT) refers to the utilization of computer hardware and software for storing, retrieving, sharing, and utilizing healthcare information, data, and knowledge, aiding communication and decision-making (2). Developed nations have made notable progress in adopting diverse information technologies in healthcare, starting from electronic patient registration and enjoying a significant lead of about two decades over developing countries (3). Information technology presents boundless opportunities for enhancing healthcare quality and safety, leading to cost reductions and facilitating innovations in services (4). Developing nations can learn from the experiences of developed countries to expedite IT adoption, saving time and resources (3). To achieve systematic, accurate, secure, and up-to-date healthcare services meeting the expected standards, modern technologies, particularly information systems, are imperative in healthcare practices (5).

Over the past decade, significant progress has been made in digitizing data and reducing reliance on paper records, primarily due to the widespread adoption of Electronic Health Records (EHR) from 2010 to 2020 (6). The integration of technology in healthcare ensures standardized medical practices with secure and confidential client information. It also ensures that medical services align with current developments and general practice expectations (5). Health Information Systems (HISs) with four fundamental functions—data generation, compilation, analysis and synthesis, and communication—have been developed to integrate health information. These systems aim to meet consumer requirements, contribute to epidemiological research, enhance care quality, reduce expenses, facilitate information management, and provide a foundation for decision-making (7).

In numerous low and middle-income countries (LMICs), National Health Management Information Systems (HMIS) have been implemented to collect and manage facility-based data on health care service delivery as part of routine operations (8). HMIS plays a crucial role in ensuring efficient healthcare delivery and management in various countries, Rwanda being one of them. It is designed to offer precise, detailed, and real-time information from all levels of the health system, enabling disease surveillance, activity monitoring, resource allocation, and policy development (9). The Ministry of Health (MoH) in Rwanda is dedicated to enhancing healthcare service delivery

through the adoption of Information Communication and Technology (ICT) solutions. The implementation of electronic medical records, such as open-MRS and open clinic, along with the national health management and information system (HMIS), is a testament to their commitment to leveraging e-health for improved healthcare services (10). The implementation of an Electronic Medical Record (EMR) system in Rwanda was a strategic intervention aimed at fulfilling several objectives, including enhancing direct patient care and supporting decision-making by providing access to summary chart data and printed summaries. The utilization of automated alerts and reports was employed to ensure standardized care and facilitate efficient follow-up procedures (11).

The Rwanda Health Management Information System (HMIS) was established in 1998, and since 2012, it has aimed to enhance the quality of health data collected from community health workers (CHWs) and all Health Facilities (HFs) across the country (8). This system has proven instrumental in improving the quality and accessibility of health data, which is vital for informed decision-making in healthcare. The current health information systems in Rwandan healthcare facilitate efficient production of aggregate data for administrative, monitoring, evaluation, research, and reporting purposes. Moreover, the implementation of an automated data quality improvement system led to a substantial 92% reduction in known errors by empowering local data officers with tools and training to correct data inaccuracies (11). Despite the positive impact of integrating Information Technology (IT) into healthcare to support health data management, certain areas still exhibit low usefulness and acceptance, often facing resistance from users (12). The acceptance or rejection of Health Information Technology (HIT) remains an ongoing subject of investigation for researchers. Therefore, this study aims to evaluate the usefulness and acceptance of HMIS among Health Data Managers in Rwanda, focusing on health centers and hospitals

1.2. Problem statement

Despite the significance and widespread adoption of technology, certain challenges persist regarding its use and effectiveness (16). Integrating Information Technology in healthcare to support health data management has numerous positive effects; however, in some areas, its usefulness and acceptance remain low, encountering resistance from users (12). Continuously assessing the adoption of implemented technologies, such as HMIS, from the end-user perspective is crucial to understanding the actual system use and identifying associated challenges. Technology is ideally implemented for use and to enhance the quality of work. Nevertheless, sometimes, even with careful planning, staff training, and system implementation, acceptance of the technology becomes an issue. The effectiveness of any IT system can only be achieved when users have a clear understanding and actively use it (17). Behavioral and human factors play a significant role in determining system success and user acceptance. Predicting whether system users are willing to use the technology in place becomes essential (18).

While some studies have explored the quality and reliability of data from HMIS (19), none have specifically investigated the system acceptance and usefulness from the perspective of health data managers. This study aims to shed light on the acceptance and usefulness of HMIS by data managers working in health centers and hospitals in Rwanda. The Technology Acceptance Model (TAM) serves as a guiding theoretical framework for this research. TAM provides an explanation of the factors influencing technology acceptance and can be applied to various end-user computing technologies and user populations (20). This model is valuable in understanding users' behavioral intention to use technology (16).

1.3. Significance of the Study

The Rwanda HMIS was established in 1998 with the objective of enhancing the quality of routinely-collected health data from community health workers and all health facilities across the country (8). However, since its implementation, no studies have assessed its adoption in Rwanda. This study aims to provide insights into the local context of HMIS adoption by health data managers. The findings of this study can inform best practices in utilizing HMIS and provide valuable information to policymakers about the actual usage of HMIS. It presents beneficial insights to the Ministry of Health (MoH), particularly to the team responsible for the implementation and strengthening of HMIS in Rwanda.

1.4. Objectives of the Study

This study aimed to assess the usefulness and acceptance of Health Management Information System among Health Data Managers working in Health Centers and Hospitals in Rwanda. The objectives included determine the level of acceptance of health data managers in utilizing HMIS for health data management, explore their perceptions of HMIS usefulness since its implementation at health centers and hospitals, and identifying factors that positively influence the acceptance and utilization of HMIS in health data management. Additionally, the study concluded by highlighting aspects that should be considered for a successful implementation of the HMIS System in the current healthcare settings via health data managers suggestions.

1.4.1. General objective

To assess the usefulness and acceptance of HMIS by Health Data Managers in Health Centers and Hospitals in Rwanda

1.4.2. Specific objective

- To determine level of acceptance of health data managers to use HMIS for health data management
- To explore how health data managers perceive the usefulness of HMIS since its implementation at health centres and hospitals
- To determine factors which can positively influence the acceptance and use of HMIS in managing health data
- To suggest recommendations to ensure a continuous future use of HMIS at health centres and hospitals in Rwanda

1.5. Research Questions

- To what extent do health data managers accept to use HMIS for health data management?
- How do health data managers perceive the usefulness of HMIS since its implementation at health centres and hospitals?
- What factors can positively influence the acceptance and use of HMIS in managing health data?
- What do health data managers suggest to ensure a continuous future use of HMIS at health centres and hospitals in Rwanda?

CHAPTER TWO: LITERATURE REVIEW

2.1. Background of HIT

Health Information Technology (HIT) is the implementation of information processing that integrates both computer hardware and software for the storage, retrieval, sharing, and utilization of healthcare information, data, and knowledge to facilitate communication and decision-making (2). Health IT encompasses the complete infrastructure, organization, staff, and constituents involved in the collection, processing, storage, transmission, display, dissemination, and disposition of information within the healthcare industry (16).

Currently, technology has become an essential tool in various industries (22)(23)(19). Organizations strive to reduce costs, increase productivity, and rely on information technology to stand out in the global competition (24). The healthcare sector has undergone significant changes and contributed significantly to the economy in recent decades, primarily due to information technology (25). The introduction of new devices and technologies has provided more reliable patient information, leading to better healthcare delivery and improved patient care (25). Information technology plays a critical role in managing information and continues to grow in the healthcare domain (24). Health information management involves the collection and analysis of health data to provide necessary information for healthcare decisions, including patient care, institutional management, healthcare policies, planning, and research. This has led to a shift from medical records management to health information management, providing more opportunities but also posing challenges, particularly for modest institutions, such as expenses related to equipment purchase, maintenance, and storage (17).

As personal computers gained popularity in the late 1970s, healthcare staff started adopting electronic health record (EHR) systems, and by the 1980s, almost all medical facilities in the United States used both paper and computer-based systems (25). This provided an opportunity for software designers to create software that supports clinical functions for various health facility services, including pharmacy, clinical laboratory, patient registration, and billing (26).

Initially, the adoption of technology in healthcare was slow, and by the late 1980s, only partial benefits of Health Information Technology (HIT) were achieved. In response, the Institute of Medicine (IOM) established the Patient Record Project in 1989 to enhance the general acceptance of computer-based patient records (25). Over time, hospitals recognized the potential of using HIT,

and by 2015, 96% of hospitals and 87% of office-based physician practices in the United States were using electronic health records.

HMIS is customized from the District Health Information System Version 2 (DHIS2), an open-source platform developed in the mid-nineties in South Africa. Originally, DHIS2 started as a standalone application based on Microsoft Office and has since undergone significant technological advancements, becoming a major open-source web-based platform. Today, DHIS2 benefits many developing countries, with Health Information Systems Program (HISP) teams making major contributions in each represented country (27). The sustainability of DHIS2 relies on a community of users, developers, and implementers.

Health Information Technology (HIT) has the potential to enhance healthcare safety and efficiency, but the challenge lies in the lack of knowledge about successful implementation. According to the Department of Health and Human Services (HHS), only a few U.S. healthcare organizations have fully adopted HIT due to significant financial, technical, cultural, and legal barriers, including a lack of access to capital, data standards, and resistance from healthcare providers (25). The advent of the World Wide Web around 1990 had a considerable impact on the healthcare sector, resulting in reduced hardware costs and a proliferation of vendors in the internet community. Despite these developments, the popularity of electronic medical records (EMR) did not surge until the 2000s, with funding and sustainability increasing from 2010 until the present (18).

2.2. The role of HIT in healthcare

There are limitations associated with the use of paper-based records, such as inefficient communication between healthcare providers and difficulties in obtaining needed data. Developed nations have made substantial progress in adopting various types of Information Technology (IT) since the inception of electronic patient registration, putting them about two decades ahead of developing states (3). Utilizing paper-based methods for health data recording is costly, creates a heavy workload, and delays clinical decision-making. In contrast, technology interventions like Electronic Health Records (EHR) have demonstrated significant support in clinical practice by providing a smart tool for better health information management (21). Health data plays a vital role in ensuring effective service delivery, facilitating decision-making, and evaluating existing healthcare programs to maintain a standardized quality of healthcare (19). Developing nations can

learn from the experiences of developed countries, allowing them to save time and minimize resources required to increase IT utilization (3).

There is a substantial body of literature supporting the adoption of Health Information Technology (HIT), particularly the Electronic Health Record (EHR), as a valuable asset in healthcare (29). The implementation of HIT in healthcare has the potential to improve patient safety, organizational efficiency, patient satisfaction, and more (25). Technological advancements have made it possible to maintain longitudinal patient records, capturing medical information from various sources like physicians, labs, clinics, hospitals, and treatment sites. This comprehensive view of a patient's health history provides valuable information to enhance overall healthcare and outcomes (26).

HIT, with its four key functions of data generation, compilation, analysis, synthesis, communication, and use, brings significant value to the healthcare industry. It meets consumer requirements, contributes to epidemiological research, and facilitates data management for health promotion (7). The transformation and success of healthcare are greatly influenced by HIT, leading to decreased human errors, improved clinical outcomes, enhanced care coordination, and the ability to track data over time (2).

Information technology in healthcare settings, especially hospitals, enhances the quality of service delivery and safety while reducing costs and encouraging new service innovations (4) (5) (23). Healthcare information systems play a crucial role in maintaining an information space, improving the quality of medical records, reducing medical errors, increasing transparency of medical institutions, and enabling continuous analysis of economic aspects of healthcare. This leads to faster examination and treatment processes (30). With the implementation of HIT, patients, providers, and other stakeholders can expect increased efficiency, effectiveness, and safety in healthcare (19).

Jung So-Ra (20) highlighted some of the benefits of deploying HIT in healthcare:

- **Improved quality of data**: data obtained using information technology is less redundant and more reusable.
- **Efficiency Saving**: Information technology enables achieving the same level of performance with fewer resources.

- **Effect on cost**: Information technology improves productivity by optimizing resource utilization and reducing redundancies, leading to increased productivity. Additionally, the use of information technology reduces paper usage, as there is no need to spend time organizing and retyping the same medical data.

In a study focusing on best practices in Health Information Technology (HIT), (31) highlighted the current challenges faced by healthcare organizations, such as managing overwhelming amounts of data and dealing with disparate systems. The study recommends implementing best practices, such as identifying necessary resources (data, technology, and personnel), developing a data management plan, and adopting platforms that connect different silos. A systematic review conducted by Clemens Scott and colleagues (32) identified common barriers to the adoption of electronic health records (EHR). These barriers include cost, technical support, and interoperability, resistance to change, as well as the size and geographical location of facilities. Poorly functioning EHR systems can have adverse effects on invested efforts, time, and cost, leading to malfunctioning processes, errors, and increased expenses.

Another study by Sinju. D and colleagues (33) investigated the technical challenges faced by end-users in India regarding health information systems. Slow network, poor data integrity, difficulties in accessing data, lack of guidelines, and non-user-friendly interfaces were reported as major technical challenges. The study recommends involving end-users in Health Information System (HIS) implementation and consistently evaluating their satisfaction as crucial factors for better acceptability. In a study focusing on HMIS data verification in four districts of Rwanda (15), Nshimyiryo. A, and his colleagues examined the quality of HMIS data for maternal and newborn health by comparing consistency of HMIS reports with facility source documents. Most health facilities achieved acceptable verification factors for measured indicators. The study recommends continuous research on data quality and providing training to overcome existing gaps.

2.3. Important factors associated with HIT adoption and sustainability

Although Health Information Technology (HIT) improves the quality of services and reduces costs, it is crucial to assess its users continuously to ensure better quality, reliability, and maintenance (24). Research indicates that IT adoption rarely yields positive results if not accompanied by complementary factors or other investments, and both internal and external factors can potentially influence technology intervention and its effective utilization (35).

Researchers commonly report cost and incentives, technical concerns, technical support, and resistance to change as the major barriers hindering the adoption of electronic health records and making healthcare providers more reluctant to embrace them (19) (21).

Regular evaluation of technology's progress is of utmost importance, including identifying any unintended consequences of adoption and updating or redesigning as needed (34). The success of Health Information Technology (HIT) implementation relies heavily on the human element, with user acceptance and contribution being crucial factors (21). Studies have shown that smaller, rural hospitals are less likely to adopt HIT, and older users above 55 years are less receptive (32). Therefore, both technical and non-technical factors that may lead to technology rejection by end-users should be addressed (35). In a study conducted by Sinju d'costa in India to understand the attitudes and factors influencing end-users' acceptance of the current health system, participants reported slow network, poor data integrity, difficulty in accessing data, lack of guidelines for technology use, and a non-user-friendly interface as major concerns. The adoption of any health information technology is influenced by perceived ease of use and usefulness, facilitating factors, social impact, attitudes, and behavior of end-users (23) (35). Hence, user acceptance of technology is a strategic element and should be a core concern for health organizations and policymakers (35).

When developing an HIT solution, sustainability is essential, and certain components should be considered. These include better tools for evaluating the digital work environment in the field, generic formulations of requirements reflecting the actual context to be used during procurement, and proactive assessment (36). Poorly designed healthcare systems can negatively impact the work environment of healthcare staff and patient safety, often due to a gap between theoretical knowledge of design and its practical application in procuring and developing digital healthcare systems (36). The costs of proposed solutions and possible financial support must be considered in advance (22).

2.4. Rwanda health management and information system (HMIS)

National health management information systems (HMIS) have been implemented in numerous low and middle-income countries to collect and manage health data, providing valuable insights into the healthcare system for facilities and planners (15). It serves as a primary data source for national health planning and evaluation (19). In line with Rwanda's smart health initiative, the Ministry of Health (MoH) is dedicated to using Information Communication and Technology

(ICT) to enhance healthcare service delivery through electronic medical records (open-MRS and open clinic) and HMIS (10). The implementation of health information technology in Rwanda was aimed at addressing various needs, including improving the quality of services and decision-making by providing easy access to health data (11). The Rwanda HMIS was initially deployed in 1998 and later upgraded to a web-based system known as district health information system version 2 (DHIS2) (15). Over time, the data quality of HMIS has been consistently improving (23).

2.5. Current HIT status and way forward

The volume of healthcare data is growing rapidly every day, with the United States alone reporting over a billion healthcare encounters annually. This necessitates the development of new methods for managing and governing such vast amounts of data (6). Just like other sectors, the healthcare industry must embrace modern technology, especially in information systems, to ensure high standards in health information management (5). Health Information Technology (HIT) is transforming healthcare operations and is becoming increasingly prevalent, replacing paper-based systems in many healthcare institutions. This shift allows for more extensive and reusable health data across multiple instances (19) (37) (38). HIT has the potential to organize and analyze large amounts of health data, making it more accessible and enabling standardized healthcare service delivery while also reducing some costs (5) (23).

In developing countries like the United States, the adoption rate of electronic health records is higher compared to developing countries, which are still falling behind in this aspect (37). In Russia, there is a noticeable increase in health information systems being implemented in healthcare institutions to meet market demands and enhance human resources using new technologies (30). However, in some African countries such as Malawi and Ghana, the study conducted by Katurura MC (39) reveals that despite the advantages of Health Information Technology (HIT), like capturing, storing, and exchanging patient information across borders to enhance healthcare decisions, successful implementation has been hindered due to the lack of necessary infrastructures and resistance from certain healthcare providers.

On the other hand, some healthcare settings in Uganda have shown improvement with the adoption of IT. It has led to better legibility of clinical notes, improved monitoring of drugs and vaccines, enhanced management of chronic diseases, and facilitated statistical analysis when using WHO standard codes for diseases (24).

In his study on the barriers to health information systems and medical records implementation in Saudi Arabian hospitals, Mohamed Khalifa identified various factors hindering successful Health Information Technology (HIT) implementation (12). These barriers include human factors related to beliefs, behaviors, and attitudes; professional factors related to the nature of the job; technical factors associated with computers and IT; organizational factors tied to hospital management; financial factors linked to funding; and legal factors related to laws and legislations.

It is essential to recognize that the end-users of these systems are not designers or engineers. Hence, when developing new digital systems, established standards must be followed to ensure that the perspectives of the targeted users are considered, and the created systems possess the required functionality and usability as a long-term solution (25).

The healthcare industry has undergone significant changes, and the management of clinical data has evolved beyond merely reviewing medical history for informing individuals (31). Health information management plays a crucial role in modern healthcare, enabling healthcare organizations to enhance patient care, safety, and operational processes (26). It is evident that the future of healthcare will increasingly depend on Health Information Technology (HIT), as it ensures the secure exchange of health information among patients, providers, insurers, hospitals, government agencies, and other healthcare entities. Moreover, HIT is becoming increasingly relevant in making better, evidence-based decisions for meaningful patient care and improved public health (26).

The performance of poorly-functioning Health Information Technology (HIT) can have a negative impact on time, efforts, and costs, rather than streamlining processes, reducing errors, and cutting costs, which are the hallmarks of a well-functioning health system (32). Given the complexity of today's health systems, researchers and policymakers responsible for health technology must ensure the usability and acceptance of systems among the target population to garner significant support for their implementation (23). Numerous studies exist regarding the factors that influence the successful adoption of technology in healthcare, but it is essential to continuously reassess the reality of IT implementation in healthcare as it evolves over time (42).

When evaluating the acceptance of HIT, one main issue is to select suitable evaluation methods that yield the desired outcomes (25). Utilizing acceptance models, such as the technology

acceptance model (TAM), can help identify potential challenges faced by end-users that hinder the successful implementation of these systems (23). Evaluating health information technology is not a straightforward process since various end-user groups have different perceived needs and requirements concerning functionality and usability (27).

Most studies in the field of HIT adoption have delved into the elements that impact the uptake or acceptance of different health information systems. These factors encompass the system's user-friendliness, the accessibility of training and assistance, seamless integration with current workflows, as well as the perceived effects on job performance (12) (28). While others focused on their local context on health system adoption and recommended similar investigations in different areas (29). Scholarly investigations on HMIS have demonstrated that effectively implemented HMIS can result in enhanced precision and timeliness of data collection, analysis, and reporting. As a consequence, this can play a pivotal role in optimizing resource allocation, bolstering disease surveillance, and shaping effective policy formulation (30). In Rwanda, studies done on HMIS have mainly focused on HMIS data verification by reviewing the archives and contributions of HMIS in Rwanda health system (15) (30). And no study done on HMIS acceptance by end users.

2.6. HMIS Data collection process

According to Nshimyiryo A and colleagues (15), the process of HMIS data collection begins at the reporting facility, where clinical staff in each care service register patients and record the care provided to them in standardized registers and/or medical files. Each month, the facility data manager ensures the distribution of paper HMIS reporting forms to heads of services by the 25th day of the month. The head of service then collects relevant data for their specific service and submits a completed HMIS report for the previous month back to the facility data manager by the 3rd day of the following month. For timely reporting, the facility data manager should upload all facility data into DHIS 2 by the 5th day of every month. Data verification by the facility team and corrections in the system are only allowed between the 5th and 15th of each month. Requests for changes to the data in the system beyond the 15th of each month should be submitted to the central Ministry of Health (MoH), and access is only granted upon strong justification of the request.

2.7. Technology Acceptance Models (TAM)

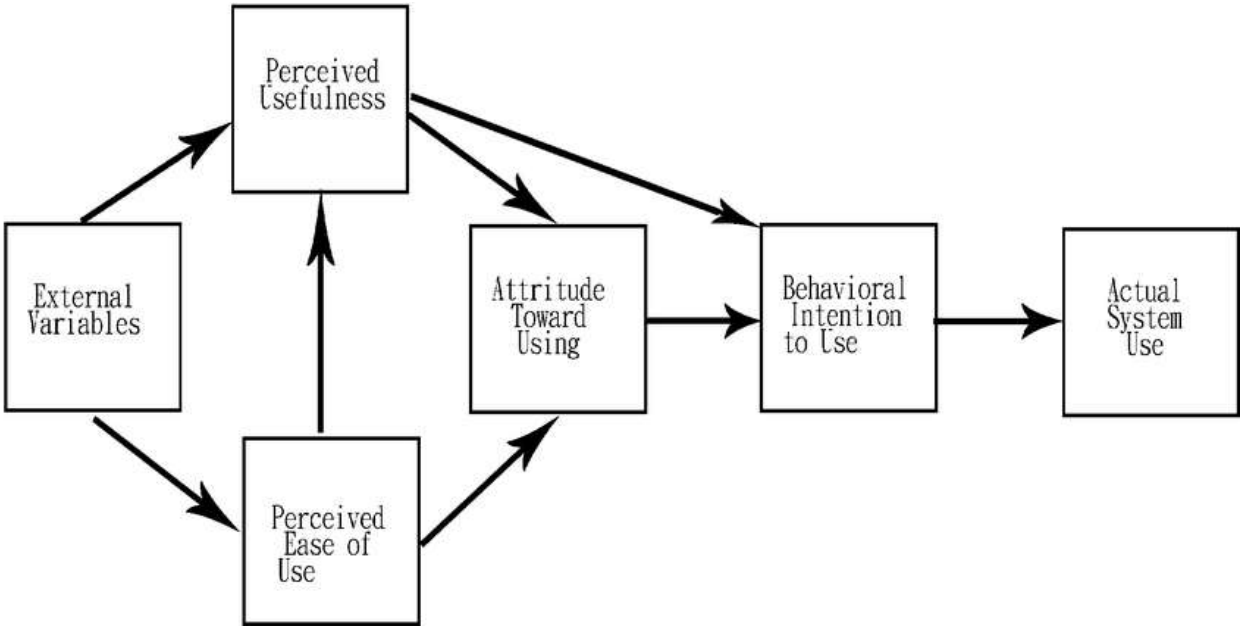


Figure 1. Basic TAM structure

The above Technology Acceptance Model (TAM) comprises six constructs (external variables, perceived usefulness, perceived ease of use, attitude toward using the system, behavioral intention to use the system, and actual system use), and it was originally introduced by Davis (1986, 1989) (31).

The history of studies concerning the adoption of information technology spans over 30 years, and during this period, various theoretical models have been developed and utilized to assess an individual's acceptance of new technology (24). The Technology Acceptance Model (TAM) was first proposed by Davis in 1989, with the purpose of understanding the reasons behind individuals' decisions to accept or reject a new technology (24)(44). TAM originated from the psychology theories of reasoned action (TRA) and theory of planned behavior (TPB) (45)(46). It is specifically applicable in the field of Information Technology because it focuses on two key variables: perceived usefulness and perceived ease of use, which significantly influence the adoption of new technologies (32).

AM has become a central model for understanding the factors that influence human behavior towards the potential acceptance or rejection of technology (45). The key factors in TAM that impact attitude are perceived usefulness (the user's belief that using the system will enhance their

performance) and ease of use (the user's perception of how effortless and easy it is to use the system) (46). TAM utilizes the relationships among beliefs, attitudes, intentions, and behaviors, with all external factors influencing intention and attitude indirectly through these two key factors.

The end-user's decision to adopt or reject technology is influenced by various factors, some of which are intrinsic, such as personality traits and cognitive styles, which TAM aims to discover (18). Understanding an individual's intentions and behavior is crucial since external factors beyond their control can also impact their behavior (33).

Davis' Technology Acceptance Model (TAM) is widely used as a basis for predicting the adoption of information technology, helping researchers understand the reasons behind the acceptance or rejection of a particular technology and providing strategies for explanation and prediction (46). TAM has been extensively tested in numerous studies over time to analyze why individuals either accept or reject information systems. The actual behavior of an individual is determined by their behavioral intention, which is influenced by their attitude and subjective norms, which in turn are shaped by their beliefs and other factors (17).

When designing and developing health systems, the focus is often on the technical aspects, which may result in less effectiveness in meeting the needs of organizations and individual users, and could even pose risks to patients. Therefore, TAM is utilized to assess and explain the acceptance and behaviors of technology users associated with the introduction of Health Information Technology (HIT) (44). Behavioral and human factors play a significant role in the success or failure of a system, as factors such as changes in human behavior and system usage can predict whether users will accept and use the system or not (34).

The adoption of healthcare information technology still faces resistance, particularly in developing nations (47). In response to this, a study was conducted to examine the attitude and behavior of health data managers towards the usefulness and acceptance of HMIS, using Davis's technology acceptance model (TAM) as a framework. Understanding the factors that drive end-users to accept and utilize information technologies in their workplaces is crucial. The study provides valuable insights for system developers and policymakers, helping them understand the challenges of adoption and develop effective strategies and practical guidance for the successful implementation of specific technologies (34).

CHAPTER THREE: STUDY METHODOLOGY

Typically, a research method aids the researcher in designing procedures that enable the gathering of pertinent data, aligning with the research problem and the specific field of study (1).

3.1. Research design

The research employed a mixed-method approach, incorporating both quantitative and qualitative methods to gather data on HMIS acceptance. Quantitative data was collected to assess health data managers' acceptance levels, their perceived ease of use, and the system's impact on their performance and efficiency during health data reporting. Additionally, recognizing the significance of capturing real-life experiences and recommendations from health data managers due to the system's existing implementation, qualitative information was collected to explore their perspectives through daily interactions with the HMIS.

3.2. Population and sample

Various sampling methods exist for sample determination. Probability sampling involves randomness as its core principle, allowing for an equal chance of selection among the population. On the other hand, non-probability sampling involves the researcher selecting participants using strategies like strata, convenience, or snowball sampling instead of random selection (35) (1).

In this research, the target population consisted of health data managers working in hospitals and health centers across Rwanda who utilize the HMIS system for reporting healthcare data. The sampling methods were chosen in accordance with the research objectives.

This study employed Slovin's formula to ensure a representative sample from the population. Using the known population size (N=542) and an acceptable error margin (e=0.05), the formula resulted in an appropriate sample size (n). Therefore, n= N/ (1+Ne2) =230 data managers representing various health facilities. They were conveniently selected from hospitals and their catchment health centers.

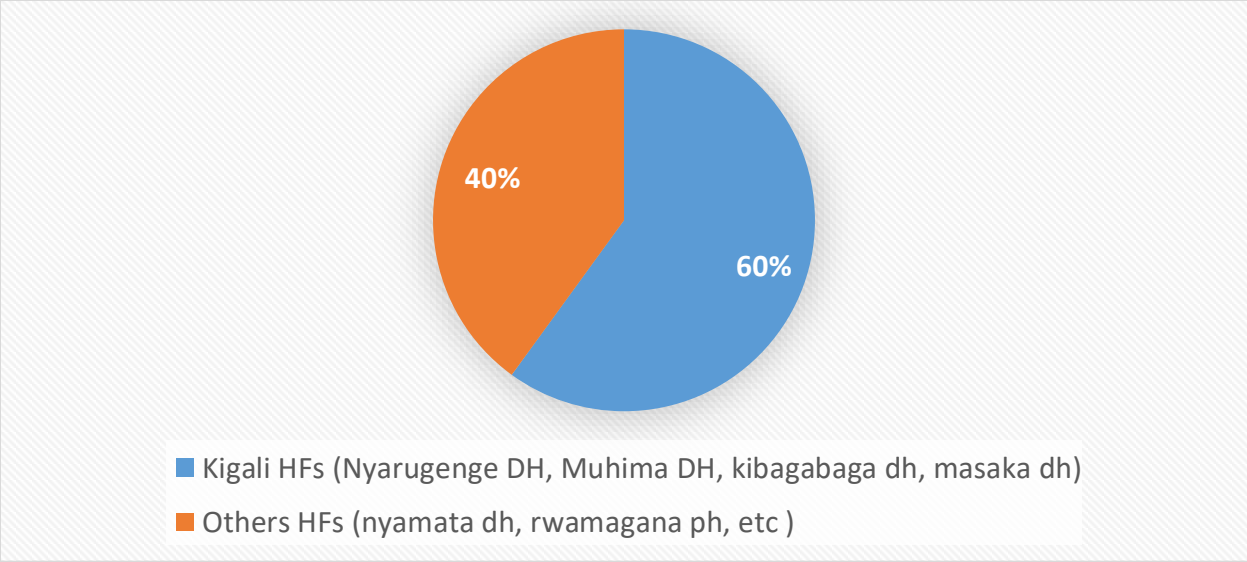


Figure 2. Sample size distribution

The Figure 2, show the distribution of the study sample in health facilities (HFs). These health data managers are distributed in Kigali city and outside Kigali. Kigali account for 60% while the rest account for 40%.

3.2. Inclusion criteria

This study included all health data managers from hospitals and health centers in Rwanda who uses HMIS and agreed to participate in the study.

3.3. Exclusion criteria

All health data managers from hospitals and health centers who don't use HMIS or refused to participate in this study.

3.4. Data Collection:

Several challenges arise when collecting data, including limitations related to the researcher's capabilities, time constraints, budget considerations, and the selection of appropriate methods that align with the research questions, sample, and data sources (1). In this study, primary data was gathered using a questionnaire. Questionnaires are designed to obtain information from participants by having them respond to questions prepared by the researcher, capturing facts, beliefs, and opinions (1). The study utilized a pre-set questionnaire, which took approximately 8-15 minutes to complete, to assess the overall level of HMIS usefulness and acceptance among

health data managers. Participants were asked about their experiences with reporting using the HMIS system, as well as their thoughts on the steps that should be taken by top management in charge of HMIS implementation and the Ministry of Health to ensure its long-term success.

3.3.1. Data Collection Plan

Field sampling strategy: The research used convenient sampling and data collection to optimize the available resources. The convenience sampling practice falls into the non-probability sampling strategy; it is inexpensive and saves time in the data collection (1). The study used both hard and e-questionnaires options to collect the needed data.

Authorization: Authorization was first requested at hospitals requesting data collection approval at those hospitals with health centers in their catchment areas. And data collection followed the approval.

Field data collection: before starting data collection process, the informed consent were first obtained from DM by presenting the approval letter from his/her facility and clearly explaining the purpose of the study. The consent was followed by the administration of the questionnaire.

Field data management: physical questionnaire was collected back to the researcher once DM was done answering to the questions. While e-questionnaires were shared to the DMs via a link, and submitted back when they are done.

Data collection schedule and work time: to optimize data collection and the availability of DMs, data collection was scheduled during working days and other agreed extra-time according to the availability of DMs. Online questionnaire was a second alternative to achieve study goals.

3.4. Data analysis: Microsoft excel was used to organize data and then quantitative data were analyzed using **SPSS**, and MAXQDA for qualitative data.

3.5. Ethical Consideration

The research must be undertaken with a scientific integrity and confidentiality obeying the laws of the country and the codes of research ethics (1). As this research study involves human beings, ethical issues must be considered. Thus, it was vital to protect participants' interests by ensuring that participation was voluntary as per the consent form standards. Before engaging participants

in the research, they were informed about the purpose of the study on an introductory consent form and their role as respondents was clarified.

3.6. Study limitation

This study was limited to health data managers who have been using the HMIS for at least six months or more. Both health centers and hospitals were considered. Also, the urban and rural areas were taken into consideration with the assumption that the level of internet penetration is different from these regions. As health data managers are staff overloaded with huge tasks, it was not easy to find them for answering to the survey questionnaire.

CHAPTER FOUR: FINDINGS AND ANALYSIS

This chapter present the findings of the study from the use of questionnaires and participant observations about usefulness and acceptance of HMIS in Rwanda. The data analysis is presented. The chapter ends with conclusion and discussion for further research in the same field.

4.1. Data analysis

Before diving into data analysis, we analyzed construct validity and reliability of the research variable measurements.

4.1.1. Constructs validity

It is important to ensure the validity of study model applied through regression analysis to understand the relationship between constructs and their validity (1). According to the research model developed, conditional variables such as PU, PEU, Use behavior (UB) and other factors such as institutional (INST) and technology factors were used to identify independent determinants of health data managers' behavioral intention and HMIS acceptance. The construct validity for this study was proved by measuring convergent and discriminate evidences. The discriminate validity was measured to ensure that there was an internal consistence of the survey instrument.

Table 1. Constructs validity

TAM constructs	Number of Items	Factor Loadings
Perceived Usefulness (PU)	6	.631
Perceived Ease of Use (PEU)	6	.773
Institutional Factors (INST)	8	.926
Technology Factors (TECH)	4	.543
Use Behavior (UB)	6	.817

Generally, the threshold and acceptable count for discriminate validity is when the constructs of the model have an average variance greater than 50% (0.5); which means 50% of the measurements was achieved by items in particular construct (1). In the above table 1, all of the constructs used scored above 60% of loading factors which demonstrate effective validation of the model. In order to increase the validity of measured constructs even higher, the researcher completed the survey questionnaire by conducting interviews with study respondents. All the constructs used for this study were significantly correlated and supported as all the value observed using convergent validity were greater than zero.

4.2.2. Reliability analysis

Reliability of the study constructs and items can be shown by cronbach's Alpha analysis using SPSS package (1). As reported in table 2, it appears that all the constructs expresses highly significant level of reliability which is greater than acceptable threshold of .70.

Table 2. Constructs reliability analysis

TAM constructs	Cronbach's Alpha	Number of Items
Perceived Usefulness (PU)	.839	6
Perceived Ease of Use (PEU)	.981	6
Institutional Factors (INST)	.964	8
Technology Factors (TECH)	.889	4
Use Behavior (UB)	.800	6

4.2.3. Descriptive analysis

The study was carried out in the selected health centers and hospitals of Rwanda from January 2023 to May 2023. The author worked hands in hands with health facilities administration and the team leaders of health data managers in Rwanda to investigate usefulness and acceptance of HMIS by health data managers. The population of this study was made up of health data managers from health facilities in Rwanda who use HMIS on daily basis for health data reporting. The descriptive data from the study is presented in figures.

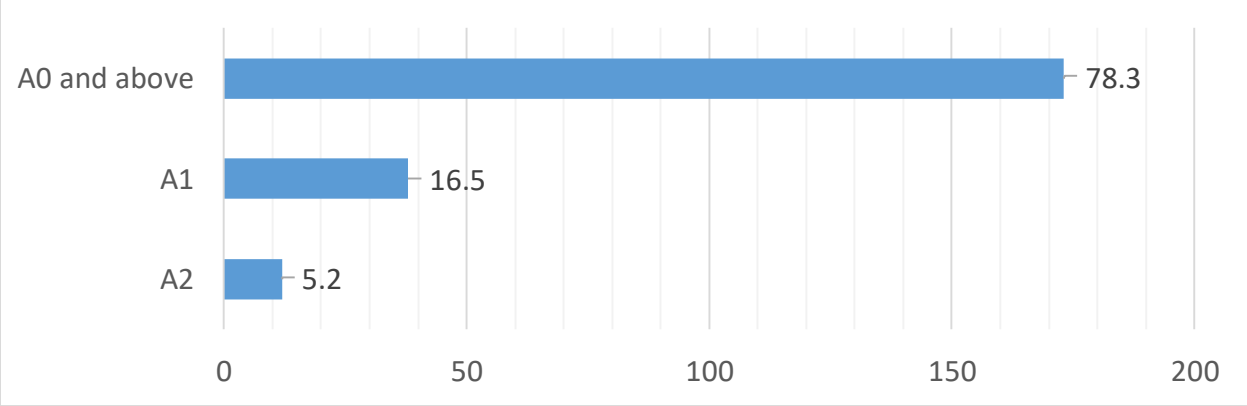


Figure 3. Educational level of respondents

Reading figure 3, 94.8% of the respondents have hold advanced diploma, bachelors' degree and above.

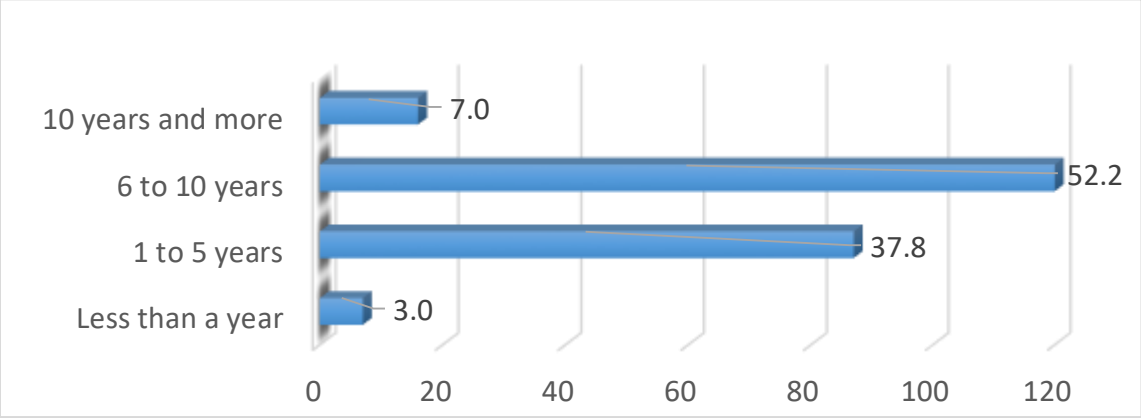


Figure 4. Experience of respondents as health data managers

Reading figure 4, 97% of the respondents have been working in health facilities as data managers in the period ranging from one year to 10 years and more. This proves their experience in using

HMIS for health data reporting. 97% of the respondents have been working in health facilities as data managers in the period ranging from one year to 10 years and more.

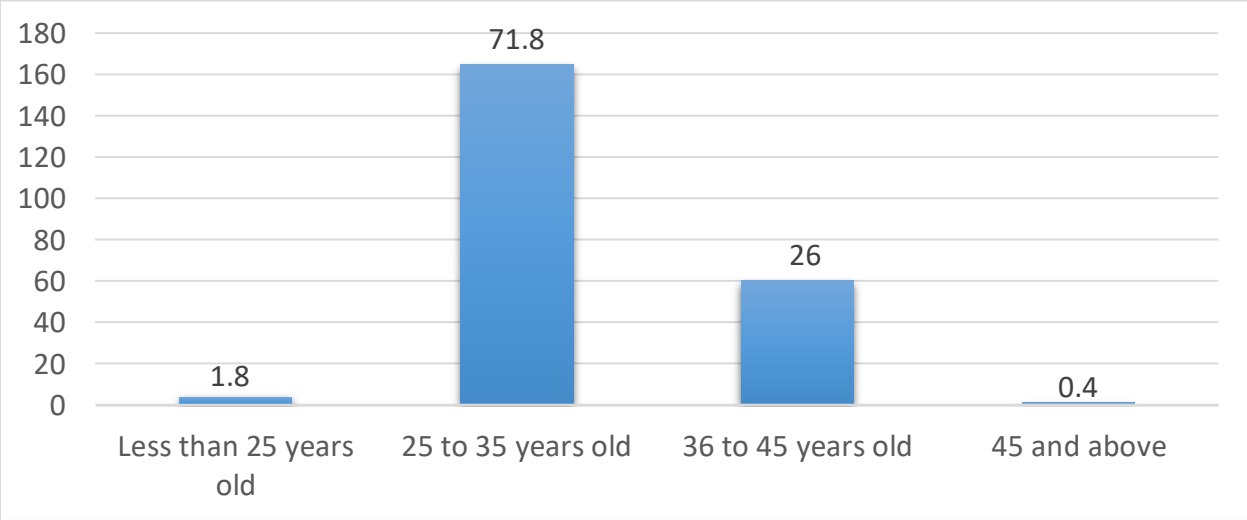


Figure 5. Respondents' oldness

Figure 5 presents respondents' oldness statistics. Study shows that 97.8% of the respondents are between twenty five and forty five years old during study period.

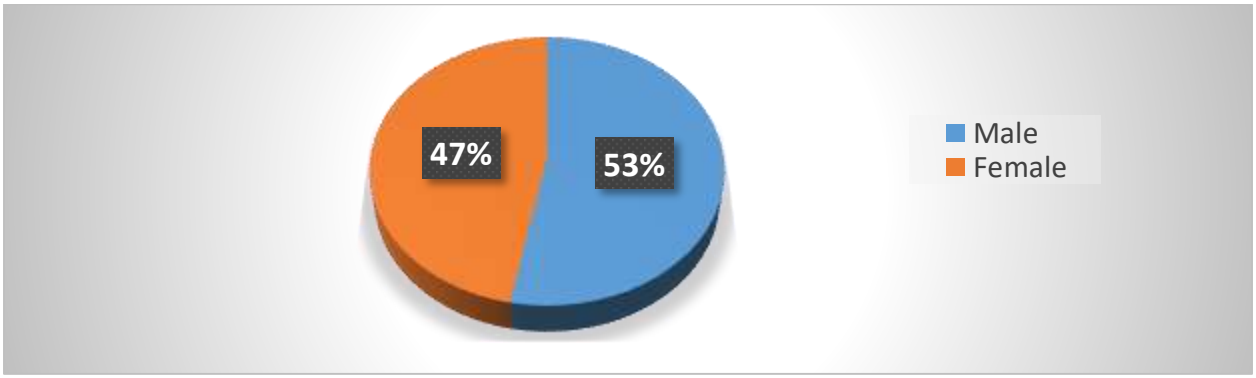


Figure 6. Gender of respondents

Figure 6 presents respondents' gender statistics. Males account for 53% of the total respondents, while females occupied 47%.

4.1.4. Correlational analysis

The research hypotheses were tested to understand how health data managers expect usefulness and acceptance of HMIS as data management tool used in health facilities. Hence, the spearman's

correlation analysis was used to measure the relationship among the TAM model constructs used for this research. The data obtained support a significant relationship between perceived usefulness (PU) and Perceived ease of use (PEU) at significance the level of 0.01 as the original model propose strong correlation between the two (34). Among the other constructs used in this study, perceived usefulness and perceived ease of use were both significantly correlated with technology factors at the level of 0.01. Perceived usefulness and perceived ease of use were also significantly correlated with use behavior or HMIS acceptance at the level of 0.01. There is no correlation between institutional factors with technology factors and use behavior. Hence, his means that the stronger relationship between technology and use behavior or acceptance can be taken by HISP Rwanda and ministry of health as an opportunity for the long term success of HMIS.

Table 3. Correlations analysis results

	PU	PEU	INST	TECH	UI
Perceived Usefulness	1.000				
	.				
Perceived Ease of use	.554**	1.000			
	.000	.			
Institutional factors	.082	.007	1.000		
	.216	.912	.		
Technology factors	.275**	.367**	.049	1.000	
	.000	.000	.462	.	
Use behavior (UI)	.628**	.534**	.081	.621**	1.000
	.000	.000	.222	.000	.

**. Correlation is significant at the 0.01 level (2-tailed).

4.1.5. Regression analysis

Regression analysis is a process of examining the relationship between variables. This statistical measure is usually used in research to inspect the functional relationship among two or more dependent and independent variables of the study to predict the level of existence of one variable depending on the state of other constructs (1). A regression can be bivariate if analysis looks at

relationship between two paired data sets or multivariate in case the estimation involves a single regression model with more than one aftereffect variable.

In this study, all four hypotheses are related to the Use behavior or HMIS acceptance (PU->UB, PEU->UB, INST->UB, and TECH->UB).

Multiple regression analysis was used to test four proposed hypothesis. The outcome of the regression analysis (Appendix) shows an important data that are summarized here. In short, regression analysis generate four kinds of data.

The first type of data is beta unstandardized coefficient (B); which are the estimates results from analysis of independent variables standardized to the variance of one. This process is done when a researcher want to estimate the degree of effect of an independent variable on dependent one when performing multiple regression analysis. The second generated data is Beta, which is standardized Beta coefficient and shows level of alternative independent variables. The third outcome is ANNOVA table which shows p- value or significant level of value predictors attribute to the dependent variable. P- Value is usually set at .05 and when the outcome is less than .05, then it has a significant effect on the dependent variable.

The last outcome is R Square or adjusted R Square which is displayed in percentage of independent variables. Using the data from regression analysis, the four study hypotheses were tested. The first regression analysis measured the relationship between four predictor variables (PU, PEU, INST, and TECH) and one dependent variable UB (acceptance). The results obtained indicate that the B coefficients for PU, PEU, INST, and TECH to health data managers' UB or acceptance were .320, .292,.041, and .397 with the P- value of .000,.000,.311 and .000 respectively. This means that Perceived usefulness, perceived ease of use and technology factors were statistically significant to have an impact on HMIS acceptance by health data managers while institutional factors were not. The joint R Square for PU, PEU, INST, and TECH is .644, which means that they explain about 64.4% of variability in UB or HMIS acceptance.

CHAPTER 5: DISCUSSION

This study tried to explore how variables such as perceived usefulness, perceived ease of use, technology, institutional factors, and technology factors affect the acceptance and usage of HMIS by health data managers. And our findings are consistent with several previous studies. All the constructs used in this study were valid and reliable. According to scientific literatures, the validity of study instruments is achieved when it is greater than .60 and it is reliable when it is above .70 threshold (1)(32)(34). The loading factors of our study constructs was > 60% with greater than .70 of its reliability results.

Other studies in the domain of health information technology suggest that the adoption of health information system by end users has a dramatic effect on the improvement of healthcare services (32), and the findings of this study can be used by Ministry of Health, Health Management Information System implementers, and their partners to consider critical factors influencing utilization and success of Health Management Information System implementers as a key infrastructure for the improvement of Rwanda healthcare system.

5.1. Reflecting On Study Questions

The main goal of this study was to understand the usefulness and acceptance of Health Management Information System implementers by Health Data Managers in Health Centers and Hospitals in Rwanda. Therefore, during study period and interaction with health data managers as a daily users of HMIS study goals were achieved. The study adopted Technology acceptance model (TAM) and its constructs to investigate usefulness and acceptance of HMIS by health data managers. The research goal was attained by answering the following research questions by using the corrected information:

5.1.1. To what extent do health data managers accept to use Health Management Information System implementers for health data management?

The study went on to determine the level of acceptance and use of HMIS by health data managers. According to the Appendix, the B coefficients statistics indicates that the health data managers' perceived usefulness (.320), perceived ease of use (.292), and technology factors (.397) on using HMIS positively influences their acceptance towards using HIMS while institutional factors is not significantly correlated with health data managers acceptance of using HMIS. Therefore, the

degree of acceptance is at 64.4% (R2 = .644), as the variability explained by the Perceived usefulness, perceived ease of use, institutional factors and technology factors.

5.1.2. How do health data managers perceive the usefulness of Health Management Information System implementers since its implementation at health centres and hospitals?

This research question has been answered focusing on qualitative data. The data were corrected mainly from the following questions:

One health data managers from the respondents mentioned the following:

"…. *I use HMIS system on daily basis. It is very useful. It saves me much time, for example when I need aggregated data. I can quickly get needed report in limited time; which can take me much time when not using HMIS"*

Another health data managers from the respondents mentioned the following:

"…. I appreciate *HMIS contribution on my work. It makes my job easier by producing complete reports with quality health data"*

Another health data managers from the respondents mentioned the following:

"….*Actually, Data managers are staffs overloaded by excessive data and reporting demands. So, using HMIS in health data reporting enhance my job performance"*

Another health data managers from the respondents mentioned the following:

"…. *HMIS is very useful system. It is easier, quick, and increase my overall productivity"*

Another health data managers from the respondents mentioned the following:

"…. *HMIS is the best system to use. It provides accurate, real-time and high quality reports"*

Another health data managers from the respondents mentioned the following:

"…. *HMIS is really applicable at my workplace and can be accessible via any connected devices like telephone"*

In summary, health data managers' answers to the perceived usefulness of HMIS highlight its core functionalities which includes being quick, increase users' productivity, effectiveness, making the job easier, and its usefulness.

5.1.3. What factors can positively influence the acceptance and use of Health Management Information System implementers in managing health data?

The results from spearman's correlation analysis prove that health data managers' perceived usefulness (.628), and perceived ease of use (.534) and technology factors of HMIS (.621) were critical factor for adoption of HMIS system by health data managers. Although TAM model doesn't suggest a direct relationship between institutional factors and use of the system (.081), the study done on SciPro system adoption by university of Rwanda supervisors, show a significant correlation between institutional factors such as facilitating conditions and system adoption (1). In their study, Hosein Barzekar and colleagues found management and administrative support to encourage nurses at Khorramabad training hospital to use HIS which leads to an increased level of perceived easiness and usefulness and its acceptance (32); and highlight trainings and presence of technical support as an important factors for user satisfaction and system adoption. Training was also highlighted as an important factor in the adoption of any HIS by the end-users in the study done by Hamed Nadri and his colleagues (34). As a conclusion, to enhance system use and acceptance, HMIS usefulness and ease of use as well as technology factors such as user-friendliness, reliability, accessibility and interoperability of HMIS need to be ensured.

5.1.4. What are health data managers' suggestions to ensure a continuous future use of Health Management Information System implementers at health centers and hospitals in Rwanda?

This research question has been answered focusing on qualitative data. The data were corrected mainly from the following questions: Based on your experience, what could you recommend the Ministry of Health or your healthcare institution to improve the acceptance and use of HMIS across Rwandan Health Sector?

One health data managers from the respondents mentioned the following:

"….*HMIS system is useful and solve many problems. Many quality trainings for data managers are needed to ensure quality of reports as well as adoption of HMIS"*

Another health data managers from the respondents mentioned the following:

"….*HMIS system is useful and it is simple to use, but its technology need to made more simpler and user-friendly"*

Another health data managers from the respondents mentioned the following:

"….*Many systems are used in healthcare system, and it would be very helpful if HMIS communicate with those systems in place"*

Another health data managers from the respondents mentioned the following:

"….*we appreciate HMIS technical support provided when needed. And we need that to be sustainable"*

Another health data managers from the respondents mentioned the following:

"….*there are many changes and updates that happen within HMIS. So, we need timely communication and training on every updates concerning data managers"*

In summary, data managers recommends continuous trainings on hath management information system, making system more user-friendly, increase user support when needed, and timely communication of updates.

CHAPTER 6: CONCLUSION AND RECOMMENDATION

In conclusion, the study highlights the considerable usefulness and acceptance of the Health Management Information System (HMIS) by health data managers in Rwanda. However, there is always room for improvement and progress. Health data managers acknowledge the significant role of HMIS in their achievements. Factors such as Perceived Usefulness, Perceived Ease of Use, and technological aspects are crucial in influencing the adoption of the HMIS. This information is valuable for HMIS providers and policymakers.

Health data managers express their willingness to use a system that is both useful and easy to navigate. Therefore, during the design and development of the system, special attention should be given to maximizing system functionalities and technology. To ensure successful health technology adoption and improved healthcare outcomes, developers should prioritize health technology solutions that are user-friendly, perceived as beneficial, and meet end-users' expectations.

For the sustainable implementation of the Health Management Information System, health data managers recommend continuous training, a more user-friendly system, technical support, interoperability, and timely communication of updates. Addressing these recommendations can contribute to the long-term success and effectiveness of the HMIS.

REFERENCES

1. Byungura JC. E-learning management system for thesis process support from a supervisor perspective. 2015;(May).
2. Articles R. The impact of health information technology on patient safety. 2017;38(12):1173–80.
3. Tomasi E, Facchini LA, Fatima M De, Maia S. Health information technology in primary health care in developing countries : a literature review. 2004;006700(03).
4. Øvretveit J, Scott TIM, Rundall TG, Shortell SM. Improving quality through effective implementation of information technology in healthcare. 2007;1–8.
5. Olofin B, Ejim JN, Olofin O, Onyeabor GO. Deploying Health Information Systems in Nigeria ' s Health Institutions : Prospects an d Challenges. 2020;(May).
6. D'Amore J. Electronic Health Record Data Governance and Data Quality in the Real World. 2022;1–5.
7. Shahmoradi L, Habibi-koolaee M. Integration of Health Information Systems to Promote Health. 2016;45(8):1096–7.
8. Sharma A, Rana SK, Prinja S, Kumar R. Quality of health management information system for maternal & child health care in Haryana state, India. PLoS One. 2016;11(2):1–11.
9. Adane A, Adege TM, Ahmed MM, Anteneh HA. Routine health management information system data in Ethiopia : consistency , trends , and challenges. Glob Health Action [Internet]. 2021;14(1). Available from: https://doi.org/10.1080/16549716.2020.1868961
10. Baptist J. The impact of information technology (IT) on patient laboratory data management : a case of Rwanda ' s national phone and internet-based reporting system (TRAC net PCR laboratory module) for children born on HIV + patients. 2012;
11. Amoroso CL, Akimana B, Wise B, Fraser HSF. Using electronic medical records for HIV care in rural Rwanda. In: Studies in Health Technology and Informatics. IOS Press; 2010. p. 337–41.

12. Khalifa M. Barriers to health information systems and electronic medical records implementation a field study of Saudi Arabian hospitals. In: Procedia Computer Science. Elsevier B.V.; 2013. p. 335–42.

13. Wahab SA. Defining the Concepts of Technology and Technology Transfer : A Literature Defining the Concepts of Technology and Technology Transfer : A Literature Analysis. 2012;(June 2017).

14. Health IT : Advancing America ' s Health Care.

15. Nshimyiryo A, Kirk CM, Sauer SM, Ntawuyirusha E, Muhire A, Sayinzoga F, et al. Health management information system (HMIS) data verification: A case study in four districts in Rwanda. PLoS One [Internet]. 2020;15(7 July):1–14. Available from: http://dx.doi.org/10.1371/journal.pone.0235823

16. Buntin MB, Burke MF, Hoaglin MC, Blumenthal D. The benefits of health information technology: A review of the recent literature shows predominantly positive results. Health Aff. 2011;30(3):464–71.

17. Blogs OT. The History of Health Information Management - From Then to Now - OpenText Blogs. 2017;1–7. Available from: https://blogs.opentext.com/history-heath-information-management-now/

18. Virginia. Health Information Technology For Nursing Curriculum Northern Virginia Community College 2014. 2014;

19. Kruse CS, Kothman K, Anerobi K, Abanaka L. Adoption factors of the electronic health record: A systematic review. JMIR Med Informatics. 2016;4(2):1–13.

20. Jung S. LSU Digital Commons The perceived benefits of healthcare information technology adoption : construct and survey development THE PERCEIVED BENEFITS OF HEALTHCARE INFORMATION TECHNOLOGY ADOPTION : CONSTRUCT AND SURVEY DEVELOPMENT. 2006;

21. Kruse CS, Kristof C, Jones B, Mitchell E, Martinez A. Barriers to Electronic Health Record Adoption: a Systematic Literature Review. J Med Syst [Internet]. 2016;40(12). Available from: http://dx.doi.org/10.1007/s10916-016-0628-9

22. Vaganova E, Ishchuk T, Zemtsov A, Zhdanov D. Health information systems: Background and trends of development worldwide and in Russia. Heal 2017 - 10th Int Conf Heal Informatics, Proceedings; Part 10th Int Jt Conf Biomed Eng Syst Technol BIOSTEC 2017. 2017;5(Biostec):424–8.

23. Nisingizwe MP, Iyer HS, Gashayija M, Hirschhorn LR, Amoroso C, Wilson R, et al. Toward utilization of data for program management and evaluation: Quality assessment of five years of health management information system data in Rwanda. Glob Health Action. 2014;7(1).

24. Hong SH, Smith P, Stewart B, Welsh M, Lee KH, Shin JI, et al. Medicine in a forgotten corner of Africa : how EMR can benefit the developing world – The FIMRC and EMR4DW experience. 2021;4139–48.

25. Persson J, Rydenf C. Why Are Digital Health Care Systems Still Poorly Designed , and Why Is Health Care Practice Not Asking for More ? Three Paths Toward a Sustainable Digital Work Environment Corresponding Author : 2021;23:1–11.

26. Polverini PJ. Personalized oral health care: From concept design to clinical practice. Pers Oral Heal Care From Concept Des to Clin Pract. 2016;(January 2015):1–158.

27. Kaipio J, Kuusisto A, Hyppönen H, Heponiemi T, Lääveri T. International Journal of Medical Informatics Physicians ' and nurses ' experiences on EHR usability : Comparison between the professional groups by employment sector and system brand. Int J Med Inform [Internet]. 2020;134(August 2019):104018. Available from: https://doi.org/10.1016/j.ijmedinf.2019.104018

28. Ali O, Erfannia L. Evaluating the factors that influence cloud technology adoption — comparative case analysis of health and non-health sectors : A systematic review. 2020;

29. Sinhaed RKD. Usability Assessment of Hospital Information System Integrated Electronic Medical Record. 2018;17(3):1–6.

30. Use ID, Russpatrick S, Li M, Bruland A, Rodvelt MO, Muhire A, et al. Improving Data Use and Participatory Action and Design To Support Data Use : the Case of Dhis2 in Rwanda. Proc 1st Virtual Conf Implic Inf Digit Technol Dev 2021. 2021;220–9.

31. Kemp A, Palmer E, Strelan P. technologies for use with technology acceptance models. 2019;50(5):2394–413.

32. Barzekar H, Ebrahimzadeh F, Luo J, Karami M, Robati Z, Goodarzi P. Adoption of hospital information system among nurses: A technology acceptance model approach. Acta Inform Medica. 2019;27(5):305–10.

33. Park ES, Park MS. Factors of the technology acceptance model for construction IT. Appl Sci. 2020;10(22):1–15.

34. Nadri H, Rahimi B, Afshar HL, Samadbeik M, Garavand A. Factors affecting acceptance of hospital information systems based on extended technology acceptance model: A case study in three paraclinical departments. Appl Clin Inform. 2018;9(2):238–47.

35. Creswell JW, David Creswell J. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches.

LIST OF APENDICES

Appendix 1: Ethical clearance

UNIVERSITY of RWANDA

COLLEGE OF MEDICINE AND HEALTH SCIENCES

DIRECTORATE OF RESEARCH & INNOVATION

CMHS INSTITUTIONAL REVIEW BOARD (IRB)

Kigali, 14/11/2022
Ref: CMHS/IRB/487/2022

HAGENIMANA Fabien
Health Informatics Program,
Center of Excellence in Biomedical Engineering and E-Health (CEBE)
CMHS, UR

Dear HAGENIMANA Fabien,

RE: ETHICAL CLEARANCE

Reference is made to your application for ethical clearance for the study entitled ***"Evaluation of the usefulness and acceptance of HMIS by health data managers in health centers and hospitals in Rwanda".***

Having reviewed your application and been satisfied with your protocol, your study is hereby granted ethical clearance. The ethical clearance is valid for one year starting from the date it is issued and shall be renewed on request. You will be required to submit the progress report and any major changes made in the proposal during the implementation stage. In addition, at the end, the IRB shall need to be given the final report of your study.

We wish you success in this important study.

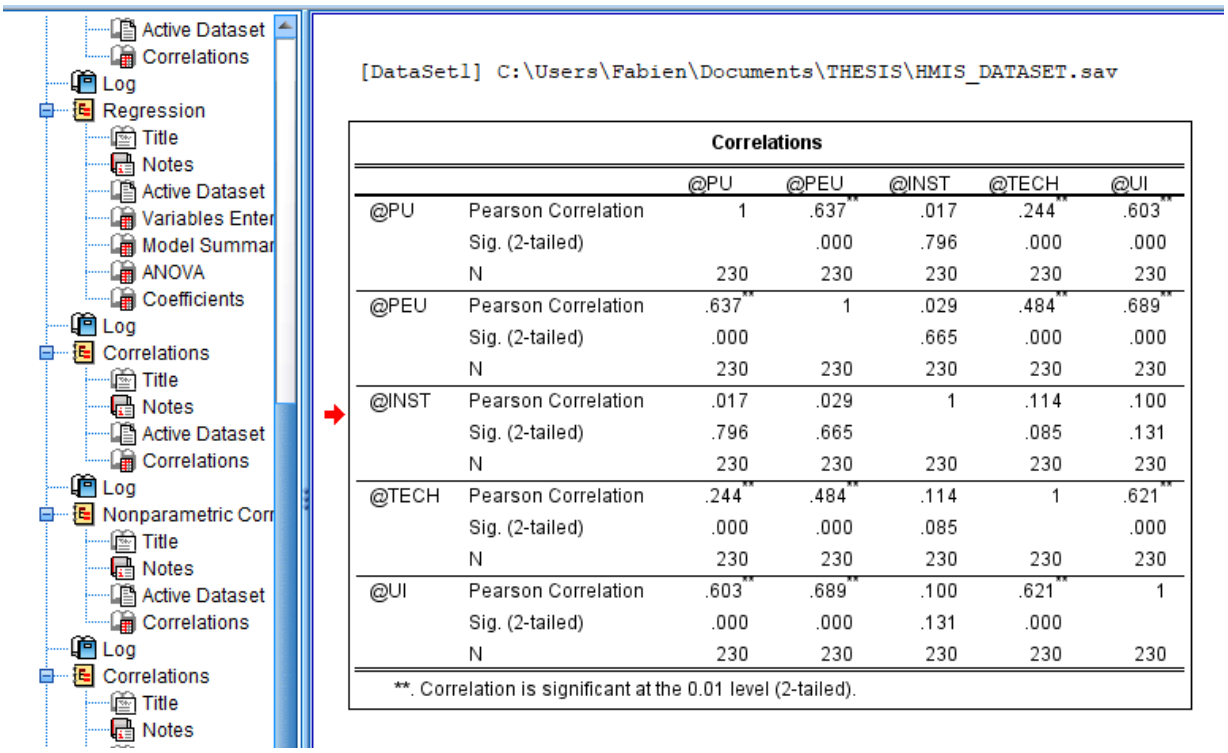
Assoc. Prof. Stefan Jansen (PhD)
Acting Chairperson Institutional Review Board,
College of Medicine and Health Sciences, UR

Cc:

- Principal College of Medicine and Health Sciences, UR
- University Director of Research and Postgraduate studies, UR

Email: researchcenter@ur.ac.rw P.O Box 3286 Kigali, Rwanda www.ur.ac.rw

Appendix 2: Correlation analysis

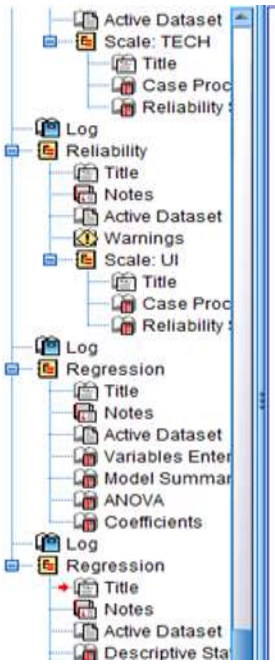


Correlations

		@PU	@PEU	@INST	@TECH	@UI
@PU	Pearson Correlation	1	.637**	.017	.244**	.603**
	Sig. (2-tailed)		.000	.796	.000	.000
	N	230	230	230	230	230
@PEU	Pearson Correlation	.637**	1	.029	.484**	.689**
	Sig. (2-tailed)	.000		.665	.000	.000
	N	230	230	230	230	230
@INST	Pearson Correlation	.017	.029	1	.114	.100
	Sig. (2-tailed)	.796	.665		.085	.131
	N	230	230	230	230	230
@TECH	Pearson Correlation	.244**	.484**	.114	1	.621**
	Sig. (2-tailed)	.000	.000	.085		.000
	N	230	230	230	230	230
@UI	Pearson Correlation	.603**	.689**	.100	.621**	1
	Sig. (2-tailed)	.000	.000	.131	.000	
	N	230	230	230	230	230

**. Correlation is significant at the 0.01 level (2-tailed).

Appendix 3: validity, reliability test and regression



Factor Analysis

[DataSet1] C:\Users\Fabien\Documents\THESIS\HMIS_DATASET.sav

Communalities

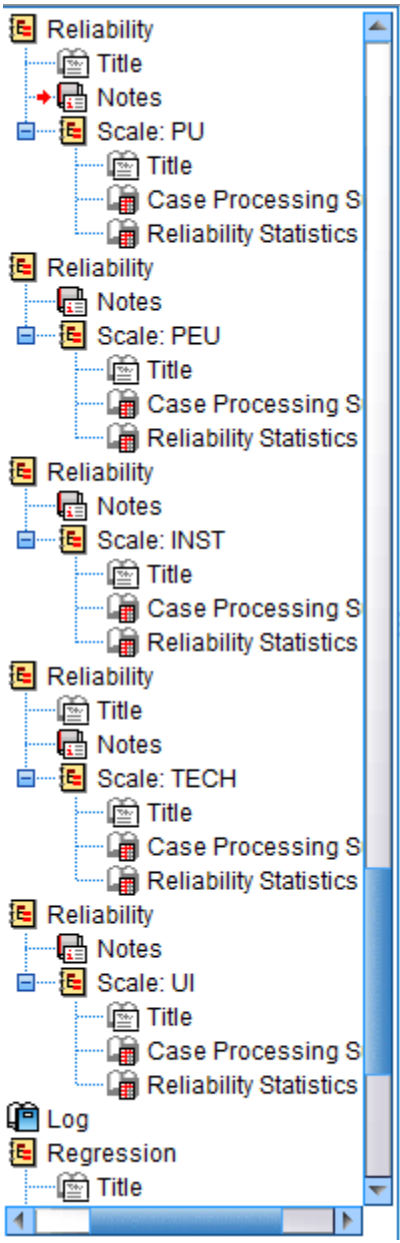
	Initial	Extraction
usefulness	1.000	.631
easeofuse	1.000	.773
institution	1.000	.926
technology	1.000	.543
individual@UI	1.000	.817

Extraction Method: Principal Component Analysis.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.671	53.428	53.428	2.671	53.428	53.428
2	1.019	20.371	73.799	1.019	20.371	73.799
3	.749	14.978	88.777			
4	.314	6.275	95.052			
5	.247	4.948	100.000			

Extraction Method: Principal Component Analysis.



Scale: PU

Case Processing Summary

		N	%
Cases	Valid	230	100.0
	Excluded[a]	0	.0
	Total	230	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.839	6

Scale: PEU

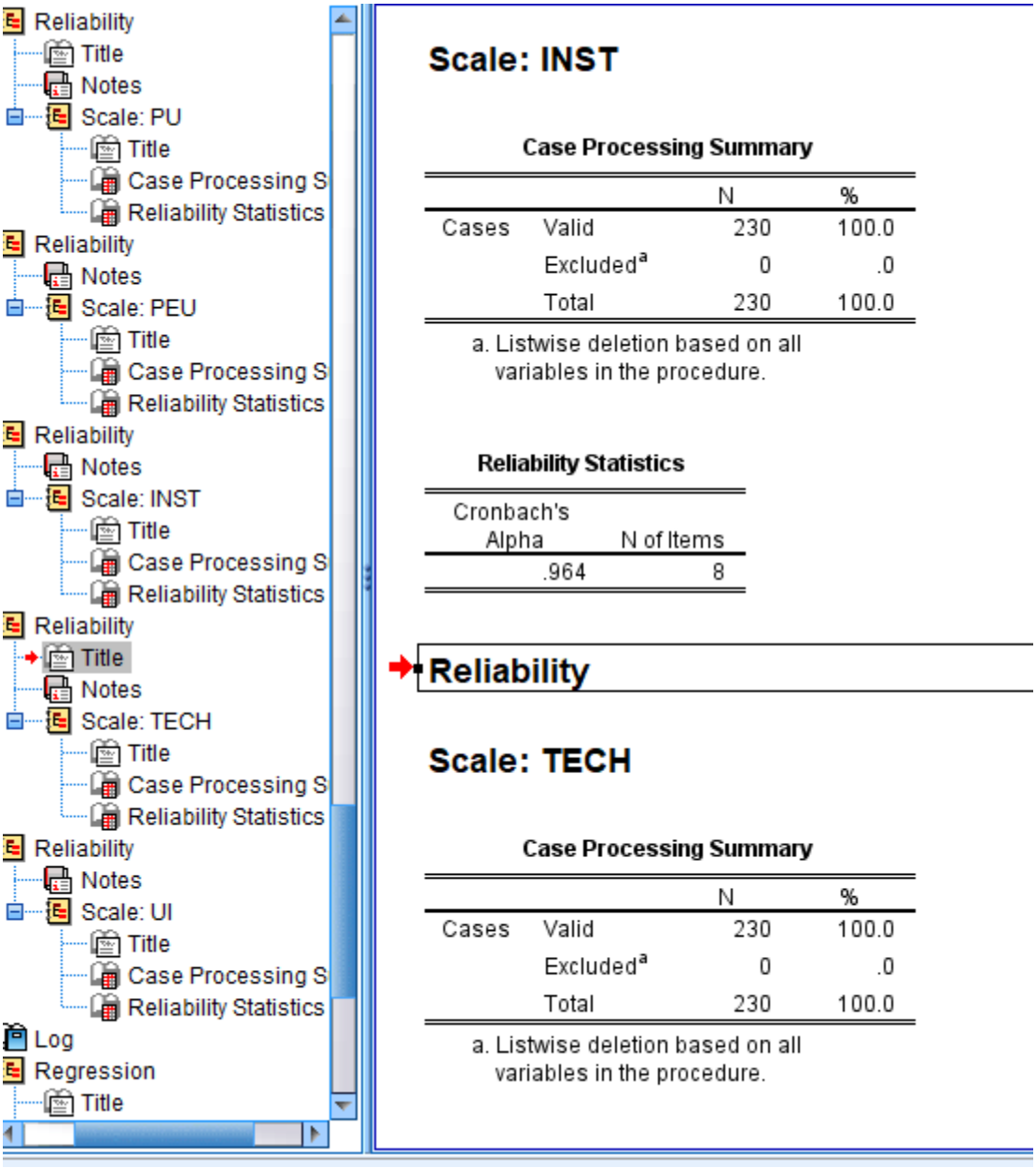
Case Processing Summary

		N	%
Cases	Valid	230	100.0
	Excluded[a]	0	.0
	Total	230	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.981	6


Reliability
Title
Notes
Scale: PU
Title
Case Processing S
Reliability Statistics
Reliability
Notes
Scale: PEU
Title
Case Processing S
Reliability Statistics
Reliability
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Scale: INST
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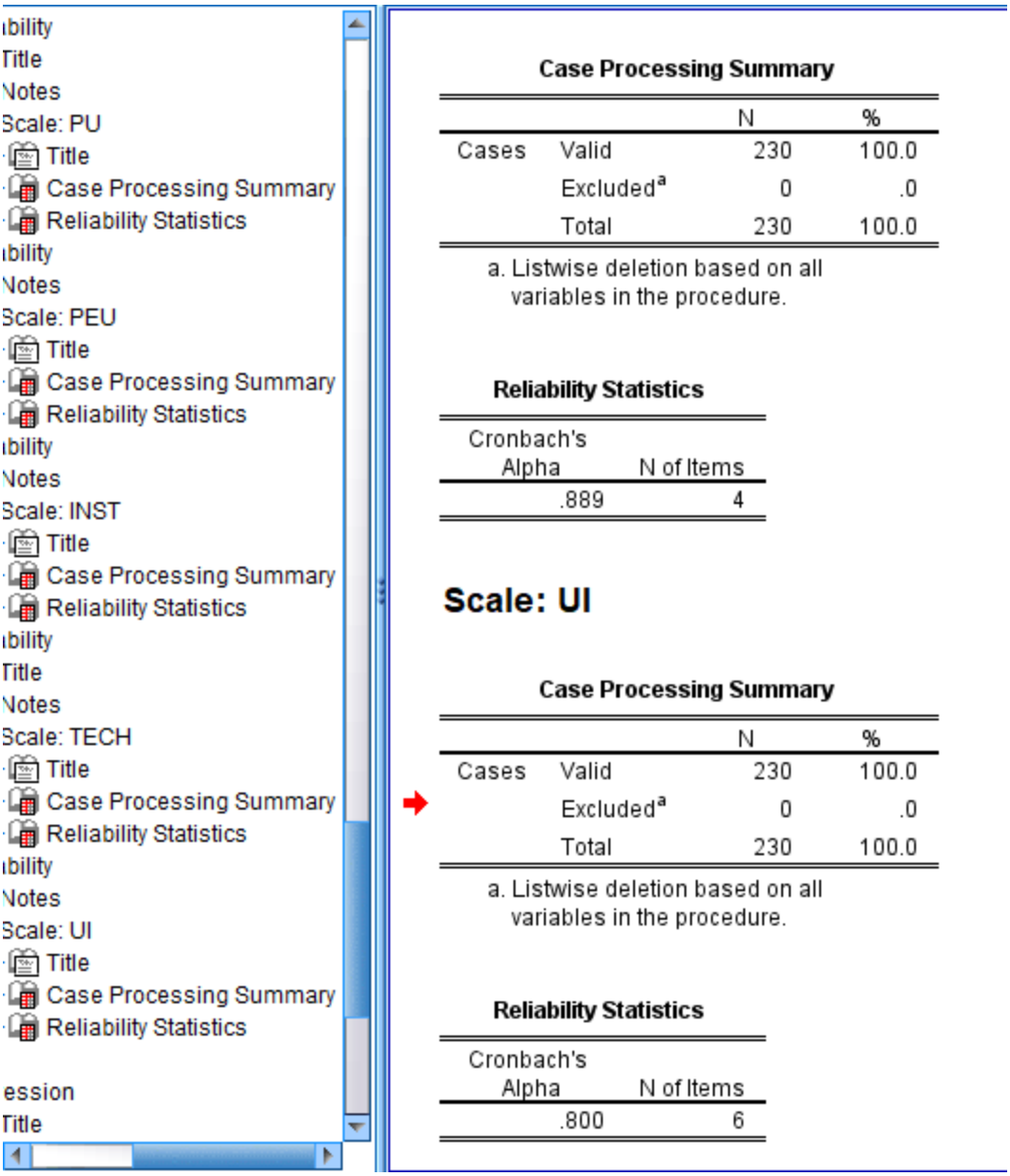
Title
Notes
Scale: TECH
Title
Case Processing S
Reliability Statistics
Reliability
Notes
Scale: UI
Title
Case Processing S
Reliability Statistics
Log
Regression
Title
Scale: INST
Case Processing Summary
N %
Cases Valid 230 100.0
Excluded[a] 0 .0
Total 230 100.0
a. Listwise deletion based on all variables in the procedure.
Reliability Statistics
Cronbach's Alpha N of Items
.964 8
Reliability
Scale: TECH
Case Processing Summary
N %
Cases Valid 230 100.0
Excluded[a] 0 .0
Total 230 100.0
a. Listwise deletion based on all variables in the procedure.


ıbility
Title
Notes
Scale: PU
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Case Processing Summary
Reliability Statistics
ıbility
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Case Processing Summary
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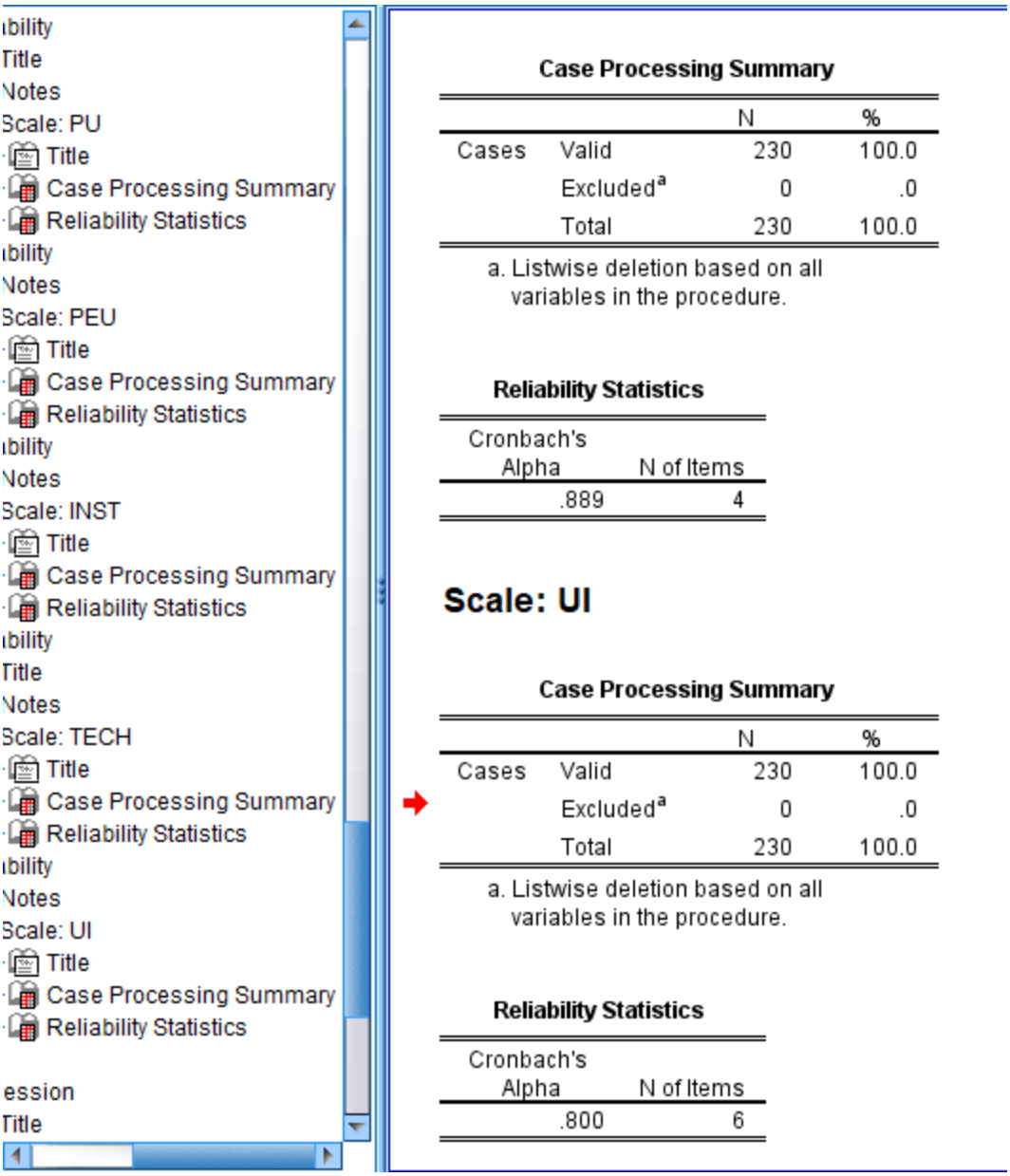
ession
Title
Case Processing Summary
Cases Valid 230 100.0
Excluded[a] 0 .0
Total 230 100.0
a. Listwise deletion based on all variables in the procedure.
Reliability Statistics
Cronbach's Alpha .889 N of Items 4
Scale: UI
Case Processing Summary
Cases Valid 230 100.0
Excluded[a] 0 .0
Total 230 100.0
a. Listwise deletion based on all variables in the procedure.
Reliability Statistics
Cronbach's Alpha .800 N of Items 6


ıbility
Title
Notes
Scale: PU
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Case Processing Summary
Reliability Statistics
ıbility
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Scale: PEU
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Case Processing Summary
Reliability Statistics
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Scale: INST
Title
Case Processing Summary
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Title
Notes
Scale: TECH
Title
Case Processing Summary
Reliability Statistics
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Scale: UI
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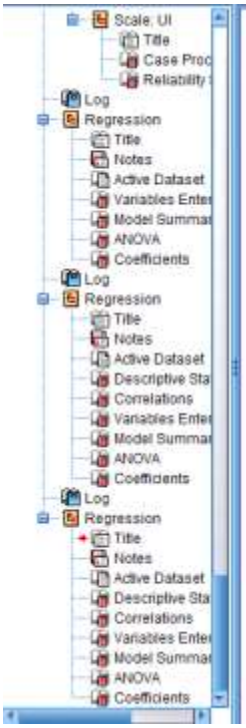
Case Processing Summary
Reliability Statistics
ession
Title
Case Processing Summary
Cases Valid 230 100.0
Excluded[a] 0 .0
Total 230 100.0
a. Listwise deletion based on all variables in the procedure.
Reliability Statistics
Cronbach's Alpha .889 N of Items 4
Scale: UI
Case Processing Summary
Cases Valid 230 100.0
Excluded[a] 0 .0
Total 230 100.0
a. Listwise deletion based on all variables in the procedure.
Reliability Statistics
Cronbach's Alpha .800 N of Items 6



easeofuse[b]

a. Dependent Variable: UB

b. All requested variables entered.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.803[a]	.644	.638	.40222	.644	101.936	4	225	.000

a. Predictors: (Constant), technology, institution, usefulness, easeofuse

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	65.965	4	16.491	101.936	.000[b]
	Residual	36.400	225	.162		
	Total	102.365	229			

a. Dependent Variable: UB

b. Predictors: (Constant), technology, institution, usefulness, easeofuse

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	9.951	1.286		7.739	.000	7.417	12.485
	usefulness	.250	.040	.320	6.169	.000	.170	.329
	easeofuse	.036	.007	.292	5.080	.000	.022	.050
	institution	.009	.009	.041	1.016	.311	-.009	.027
	technology	.433	.050	.397	8.649	.000	.335	.532