THE MAASTRICHT SCHOOL OF MANAGEMENT
P.O.BOX 1203, 6201 BE MAASTRICHT
THE NETHERLANDS

THE IMPACT OF INFORMATION TECHNOLOGY (IT) ON PATIENT LABORATORY DATA MANAGEMENT: A CASE OF RWANDA'S NATIONAL PHONE AND INTERNET-BASED REPORTING SYSTEM (TRACnet PCR LABORATORY MODULE) FOR CHILDREN BORN ON HIV+ PATIENTS

THIS PAPER WAS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTERS IN BUSINESS ADMINISTRATION (MBA) AT THE MAASTRICHT SCHOOL OF MANAGEMENTP.O.BOX 1203, 6201 BE MAASTRICHTTHE NETHERLANDS 2012

BY
John Baptist Mugisha

SUPERVISED BY
Ing. David Dingli MBA, M.Phil

2012

DEDICATION

To Kagame, Cynthia and Gisa, I love you all.

To my father NGARAMBE Leopold and my Mother MUKANDUTIYE Cecile

To my Brothers and Sisters

DECLARATION

I, declare that the work on the topic **the impact of information technology (IT) on patient laboratory data management: a case study of Rwanda's national phone and internet-based reporting system (TRACnet PCR laboratory module) for children born on HIV+ patients** is mine and that all the sources used in the paper have been acknowledged.

Signed:……..

ACKNOWLEDGEMENTS

First and foremost, I thank almighty God for the grace and help during my quest for education.

I would particularly like to thank **Dr David Dingli**, my supervisor in accomplishment of this study. We did spend a lot of effort and time discussing a range of issues, providing good guidance to successfully achieve my objectives.

Special thanks are due to **CYIBUKAYIRE Cynthia** for your support, love, enthusiasm, patience and encouragement during this period. Without you, this could not have been done.

Finally to all members of my family for all things they did since I was born up to know. May God bless you all.

John Baptist MUGISHA
2012

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LIST OF ABBREVIATIONS AND ACRONYMES

ARV	Antiretroviral
AIDS	Acquired Immune Deficiency Syndrome or Immunodeficiency Syndrome
ANC	Antenatal Clinic
AMPATH	Academic Model for Prevention and Treatment of HIV/AIDS
AMRS AMPATH	Medical Record System
ART	Anti-Retroviral Therapy
CD4	Cluster of differentiation 4
CDC	Centers for Disease Prevention and Control
CNLS	Commission Nationale de Lette contre le Sida National AIDS Commission
DBS	Dried Blood Spot
DHS	Demographic Health Survey
DNA	Desoxynucleic Acid
D&M	DeLone and McLean Model of Information Systems Success
DSS	Decision support systems
EAPHLN	East African Public Health Laboratory Networking Project
EHRS	Electronic Health Records
E-Health	The use of information technology in the delivery of health care.
EID	Early Infant Diagnosis
FIFO	First in First Out
GIS	Geographic Information System
GoR	Government of Rwanda
HAART	Highly Active Anti-Retroviral Therapy
HC	Health Centre
HF	Health Facility
HINARI	Health Internetwork Access to Research Initiative
HIV	Human Immunodeficiency Virus
ICT	Information and Communication Technology
INC	Incorporated
IS	Information System
IRS	Information Reporting Systems
ISP	Internet Service Providers
IT	Information Technology
ITPOSMO	Information Technology Processes Objectives Staff Management
MBA	Masters in Business Administration
MIS	Management Information System
MTCT	Mother-to-Child Transmission
NICI	National Information and Communication Infrastructure
MoH	Ministry of Health
NRL	National Reference Laboratory
PCR	Polymerase Chain Reaction
PEPFAR	United States President's Emergency Plan for Aids Relief
PMTCT	Prevention of Mother-to-Child Transmission
RHIS	Rwanda Health Information System
RDHS	Rwanda Demographic Health Survey

SCMS	Supply Chain Management System
Sd-NVP	Single dose Nevirapine
SOP	Standard Operating Procedure
SMPP	Short Massage Peer to Peer protocol
SMS	Short Message Service
TB	Tuberculosis
TELEMEDICINE	Transfer of medical information through interactive audiovisual Media for the purpose of consulting or remote conduct of medical Examinations.
TPS	Transaction Processing System
TRACnet	A web and phone-based electronic monitoring and Reporting System for HIV/AIDS programs in Rwanda.
TRACPlus	Center for Treatment and Research on AIDS, Malaria, Tuberculosis And Other Epidemics
UI	User Interface
US	United States
VCT	Voluntary Counselling and Testing
Voxiva	US-based company specialized in health Information Technology Solution
WHO	World Health Organization

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ABSTRACT

The Ministry of Health (MoH) through e-health is committed to the use of Information Communication and Technology (ICT) to improve the healthcare service delivery. It is through this initiative that in March 2010, the National Reference Laboratory (NRL), Center for Treatment and Research on Acquired Immune Deficiency Syndrome (AIDS), malaria, Tuberculosis (TB) and other epidemics (TRACPlus) and Voxiva Inc. launched TRACnet Polymerase Chain Reaction (PCR) laboratory module, a phone and internet based reporting system to disseminate patient laboratory test results through Short Messages System (SMS). Using TRACnet PCR laboratory module, healthcare providers receive the PCR results timely and are able to follow up with infants born on HIV positive parents in remote sites. The study *impact of Information Technology (IT) on patient laboratory data management: a case study of Rwanda's national phone and internet-based reporting system TRACnet PCR laboratory module) for children born on HIV positive parents* was part of researcher's thesis in fulfillment of the requirement for the Degree of Masters in Business Administration (MBA). It was also intended to provide an insight on the systems achievements since its launch March 2010 to March 2011 as well as to facilitate NRL to determine whether the system should be used to disseminate other laboratory test results besides PCR.

The TRACnet PCR study main objectives were to; examine the impact of IT on patients laboratory data management, to assess the promptness and confidentiality of the systems results , evaluate the challenges the system encounters in its two way delivery of patient laboratory test results , conduct an analysis on whether the system can be used to transmit other laboratory test results besides PCR and finally to suggest possible recommendations on how the system can be improved in case there are inefficiencies.

The results derived from the study revealed that seventy four (74%) of the respondents at NRL report the PCR results using TRACnet PCR module while ninety two (92%) of the respondents at Health Center (HC) receive the PCR results through SMS. The study findings revealed that the results received through SMS are prompt, accurate and confidential and it is through the use of this system that the management of PCR results has improved by reducing results Turnaround Time (TAT) from moths to seconds. The study found that from March 2010 to March 2011, one thousand six hundred and fourteen (1614) numbers of PCR were received in NRL while nine hundred forty two (942) results were disseminated to HC using the system.

Although the system has improved the results TAT, it is also facing some challenges which include;

- Improper feeling of patient sample repulsion form
- Frequent internet failure and low band width
- NRL data clerks involvement in other laboratory activities leading to accumulation of unsent results and constant PCR reagent stock out

It is through the researcher's findings that recommendations have been drawn to stakeholders using the system namely (MoH, NRL, HC and Voxiva) to improve on the current systems inefficiencies caused by the challenges earlier mentioned.

CHAPTER 1: INTRODUCTION

1.1 Background of the problem

The National Information and Communication Infrastructure (NICI) 2006-2010 committed the Government of Rwanda to an integrated ICT -led socio-economic policy and plan. In line with this plan, MoH is committed to deployment of ICT in order to contribute to this social development. In view of this policy and plan, the MoH was mandated to facilitate the implementation of the use of IT in the delivery of health care (e-Health) systems which are geared towards the improvement of healthcare service delivery. The e-health objective is to improve patient healthcare outcomes and patient safety by equipping primary healthcare providers with better equipment, tools and information for clinical decision support, and by allowing a gradual transition to technology assisted practice.

In 2004, MoH institutions TRAC Plus and NRL that is in charge of every medical laboratory activities, from routine to specialized testing for diagnostic control and surveillance of epidemic disease and Voxiva Inc. a United States(US)-based company specialized in health IT solutions established a web and phone-based electronic monitoring and reporting system for Human Immunodeficiency Virus (HIV)/AIDS programs in Rwanda. The system is commonly known as TRACnet and hosts four modules namely; program indicators (aggregate antiretroviral therapy program data), patient (individual-level information from HIV-infected patients), laboratory (linked to patient module) and inventory (for ART drugs and consumable management).

March 2010, NRL, TRACplus and VOXIVA Inc. launched TRACnet Polymerase Chain Reaction (PCR) laboratory module. By implementing the laboratory module, PCR results are transmitted to Health Centers (HC) in timely manner via Short Message Service (SMS) and internet.

1.2 Motivation/Justification for the study on impact of IT on patient laboratory data management

The study on TRACnet PCR laboratory module will provide an insight on the achievements gained since its launch March 2010 to March 2011. The study is part of researcher's thesis in fulfillment of the requirement for the Degree of MBA. Also, this study would allow NRL to determine if the TRACnet PCR laboratory module should include other laboratory tests besides PCR.

Previous studies conducted focused on the TRACnet system performance and adoption by the end-users at all levels. A study conducted by Tulane University (Jones J, 2005) looked at data completeness and accuracy within the TRACnet database. Findings from this study suggested that the quality of data is questionable and required great attention in order to improve its use by system end-users at the HC as well as at the national levels.

A second study was conducted by Georgetown University in 2007 and focused at the absorption of this new technology by the health workers. The study looked at enabling factors and barriers to the integration of TRACnet into end-users daily work across the health system using the ITPOSMO[1] framework. Key findings from this assessment stressed the limitations related to the lack of accessible feed-back to data producers Health Facilities (HF) due to the lack of internet coverage to allow all end users to view their data on the web-interface. In addition, data utilization at all levels was highlighted as a major concern.

Based on studies findings, efforts have been made to address issues related to data quality. Computations on the database have been corrected. A data completeness dashboard has been incorporated that automatically displays the numbers of HF that have reported late or have not reported HIV/AIDS program data every month. This strategy helped to improving reporting process for the program indicators module.

However, since the launch of TRACnet PCR laboratory module March 2010, no study has ever been conducted to evaluate the systems functionality and its adoption by end users.

[1] Information Technology Processes Objectives Staff Management and Others

There is therefore a need for an in-depth analysis of the PCR laboratory data in the TRACnet PCR laboratory module and how PCR results are transmitted to HC. There is also a need to review the TRACnet PCR laboratory module with regard to the NRL current needs and to determine if some or all laboratory test results could be disseminated using TRACnet PCR module.

1.3 Statement of the problem

"Although there has been a rapid scale up of the national Prevention of Mother-to-Child Transmission (PMTCT) and pediatric HIV care and treatment programs, access to Early Infant Diagnosis (EID) and treatment of HIV remains a critical gap towards the attainment of national and universal targets"[2], key challenges include inadequate coverage and efficiency of the national EID programs.

This was further highlighted during the EID (May13-15, 2010) meeting that was held in Arusha, Tanzania by recognizing that as countries work to implement and scale up EID services, they are faced with multiple challenges that include collection of samples of HIV testing, timely transport of samples to the lab and return of PCR test results to the HC, collection and management of EID data among many[3].

During (November 2009) Rwanda EID symposium organized by Commission Nationale de Lette contre le Sida/ National AIDS Commission (CNLS), MoH, NRL, TRAC plus and partners, all parties pledged to improve coverage of EID/PCR services in conducting concrete actions in four specific areas which included; planning, training of providers, EID/PCR laboratory sample transportation and use of IT to disseminate-reporting of laboratory results.

In March 2010 the NRL, TRACplus and VOXIVA Inc. launched TRACnet PCR laboratory module with the primary objective of disseminating laboratory test results to HC using SMS for early infant children that were born on HIV positive parents. The model is under TRACnet functional modules illustrated in figure 4.

[2] *Report of symposium on EID (2010), Page 1*

[3] *Early Infant Diagnosis: Improving PMTCT and pediatric HIV programs meeting report(2010), page 3*

Sending the PCR laboratory results by SMS is a promising new technology in Rwanda due to improved quality of laboratory results in terms of reduced results Turnaround Time (TAT).

However one year after the implementation of TRACnet PCR laboratory module, NRL has been receiving complaints from system end users such as; SMS being sent to wrong telephone numbers, some delay in sending PCR laboratory results still exist contrary to maximum seven days set results TAT. In addition, there is also the lack of system feedback functionality to alert the laboratory personnel of system's inefficiencies when it comes to the number of delivered PCR results or failure to transmit some of results in regard to PCR test samples referred to NRL, hence hindering proper decision making in PMTCT program management.

Deliberations and recommendations from Rwanda 2010 EID symposium suggest that an evaluation on TRACnet PCR laboratory module system should be conducted in 2011[4] and should mainly focus on the following aspects;

- To have an alternative ways of communication of sending back the results;
- To have an assessment on sites in order to have the real functionality of SMS result delivery;
- Result registration in the patient file;
- Result communication to the mother;
- Early initiation of treatment for HIV + infants and
- Enhancing system technology/ functionality with an SMS printer.

This study is based on these recommendations and the main objective is to collect data/information that will enable the researcher to obtain an informed judgement about how TRACnet system has impacted patient laboratory data management and examine how better it has improved the EID program.

[4] *Report of symposium on EID (2010) Page, 9*

1.4 Research objectives

The main objectives of this study are the following:

- To examine the impact of IT on patient laboratory data management;
- To assess the promptness and confidentiality of PCR laboratory results as TRACnet's PCR laboratory module provides;
- To evaluate the challenges that TRACnet PCR system encounters in its two-way delivery of Patient Laboratory test results;
- To conduct an analysis on whether TRACnet PCR system can be used to transmit other laboratory test results other than those of HIV/AIDS and
- To suggest possible recommendations on how TRACnet PCR system can be improved so as to sufficiently address the problem of the system inefficiencies.

1.5 Research Questions

The study on TRACnet PCR laboratory module will develop a comprehensive profile of the system and system environment. Therefore, both direct and indirect stakeholders of the system will be consulted to ensure that the proposed study questions are technically viable and responsive to the needs of the various stakeholders. The research questions include major and minor questions.

1.5.1 Major Research Question

To what extent is the TRACnet PCR laboratory module providing stakeholders with quality laboratory test results that can optimally support the national laboratory network quality of PCR laboratory test result? Tied to this question is the accurate number and proportion of PCR laboratory results disseminated by NRL to HC using TRACnet PCR laboratory module.

1.5.2 Minor Research Questions

- What is the impact of IT on patient's laboratory data management?
- To what extent are the results provided by TRACnet PCR laboratory system prompt, accurate and confidential?
- What are the challenges that TRACnet PCR system encounter in its two-way delivery of patient laboratory test results.

- Can TRACnet PCR system enable the transmission of other laboratory test results other than those of HIV/AIDS, Tuberculosis (TB), Malaria Measles to mention but a few?
- What are the possible recommendations that would be suggested to TRACnet PCR system developers and administrators to improve the dissemination and delivery of patient laboratory test results?

1.6 Research variables-independent & dependent variables

1.6.1 Independent variables- IT

Under the IT, the following will be looked into;

1.6.1.1 System Adoptability:

- SMS: The number of sites that receive PCR results using (SMS, Internet and Telephone);
- Internet ;
- Telephone system;
- Data management skills: (Education level/on job trainings of data managers in that field);
- Proper records of telephone SMS (SMS backup using results log books and the number of dedicated telephones for this activity both at the HC/NRL);
- Computer System: Security, access to TRCnet PCR module system and
- Results backup and storage at NRL.

1.6.1.2 System Performance

- Data quality;
- Functionality and
- Confidentiality.

1.6.1.3 Incorporation of other laboratory test results

- Viral Load
- Cluster of Differentiation4 (CD4)
- PCR

1.6.2 Dependent Variables-Patient laboratory data management

- Confidentiality;
- Quality of laboratory PCR results at the HC/NRL;
- Timely manner: Results TAT to the HC;
- Security measures: Number of breaches into the system;
- Data use: Proper recording of PCR results in patient files/laboratory log books.

1.7 Context and Theoretical Framework of the Study

Africa is plagued with severe pandemics, such as HIV and malaria. To be contained, these diseases require strong public actions. The monitoring of population health and treatment is hence critical to ensure a timely response and to avoid the wider spread of the diseases. However this monitoring is particularly difficult in countries where information does not circulate easily. As roads and communications infrastructure remain inadequate, many African countries are hampered in their struggle against malaria and HIV. When patients live far from the laboratories where diagnosis can be made precisely and from main warehouse where drugs are stored, the treatment chain can be broken, immediately affecting those who suffer.

The TRACnet PCR laboratory module system, developed by Voxiva Inc, is a web-based application that is accessible both through computers and mobile phones. The system allows laboratories to send HIV/AIDS patient information from mobile phones with SMS text messaging to a central database using phone with a downloadable application. Using TRACnet PCR laboratory module system facilitates health practitioners and the laboratories to obtain the laboratory test results especially for the HIV patients who happen to be far away from rural areas where infrastructures such as electricity and mobile network coverage are minimal. Besides the laboratory results that are disseminated in a timely manner, the HC's uses the system to inquire information related to laboratory commodities and consumables through alerts on their respective mobile phones, TRACnet PCR laboratory module also facilitates better communication from laboratory to laboratory as well as from individual laboratories to NRL in Kigali.

The TRACnet PCR laboratory module requires a computer and internet connection for it to server its purpose. The system uses a dashboard on which the user captures the information related to HIV/AIDS programs in the country which includes the indicators and numbers of people infected and the status of those on drugs. With the quality of data captured by the system, the MoH institutions whose mandate involves the fight against the HIV/AIDS spread are able to measure the trend of their effectiveness in terms of rate at which the pandemic is reducing or increasing over a number of years. This dashboard also serves as information gateway to the MoH development partners when they want to know all HC in the country that offer HIV/AIDS services in particular those experiencing stock out of anti-retroviral drugs and this is made possible because of installed geographic information system (GIS) mapping feature. The MoH long term strategy is to use the system in monitoring and evaluation of outbreak of killer disease such as measles, polio, meningitis, malaria and other outbreaks.

Although the use of mobile and internet based system facilitates the sharing of health and laboratory data in timely manner, some limitations do exist on mobile phone technology. The details required by clinicians on the patient's status do not match the number of characters required when using SMS.

The other challenge with the use of mobile technology is the network coverage which does not cover the entire country. In such situation, the mobile telephone end users have got to have inconsistent network which in end frustrates them and the patients to which their health status is being reported on.

However much the challenges exist, the TRACnet PCR laboratory module impact in the health sector has been recognized due to its use of mobile phone existing infrastructure to send SMS that ordinary Rwandans use in their daily communicated activities.

Despite the already mentioned challenges, the use of TRACnet PCR laboratory module system has facilitated the NRL to transmit the patient results timely and this led to increased laboratory efficiency, accountability, and better health outcomes in treating infectious diseases.

The theory/module to underpin this study is the DeLone and McLean (D&M) model of IS success. The D&M model suggests that system and information quality are essential components of measuring IS success. Others include, service quality, system use, user satisfaction and net benefits. By using these variables, the researcher was able to measure users and managers satisfaction or dissatisfaction with the TRACnet PCR laboratory module performance for the study period March 2011-March 2012. Also measured was the impact or influence of TRACnet PCR module's information products to the system end user in conducting their work which ultimately and collectively impacted on NRL, TRAC Plus and MoH institutions to mention but a few.

This research therefore sought to prove whether TRACnet PCR laboratory module system is efficient and is really addressing the problem of lack of communication and data management infrastructures that the Rwandan health sector deserves to have. The variables that were measured included the PCR system adoptability, system performance, incorporation of other laboratory test results and patient laboratory data management.

1.8 Research methodology

Research methodology means the approach by which the study is accomplished and refers to the full result of the process at a quick look. Generally this research used several ways of collecting and analyzing data. It includes some chronological steps that are necessary to complete the study successfully.

The selected methods are based on the objectives of the research, scope, budget constraints and personnel. The adopted methodology for the current research is presented in sequential as follows: Structured questionnaire, systems end-users interview and comparison of PCR results disseminated by TRACnet PCR module with NRL PCR samples and results log books. Chapter four (4) provides the detailed study methodology.

1.9 Assumptions and Limitations

As with any cross-sectional study, findings from this study reflect a snapshot of the TRACnet PCR laboratory module and also demonstrate trends in data quality improvement over time.

However, the study did not check the quality of all data collected in TRACnet system. Moreover an unforeseen selection bias might have affected the data sampled for quality checks.

2.0 Interested Parties

The study on TRACnet PCR laboratory module will involve the following stakeholders; Staff of NRL, MoH through TRAC Plus, CNLS, Voxiva Inc, and various staff at each level of national laboratory network.

The NRL is the primary owner of TRACnet PCR laboratory module and uses it to send timely PCR test results to health workers in laboratory network who refer the PCR test samples to the NRL. The NRL administration has strong interest in TRACnet PCR laboratory module study. The findings of this study will help the NRL understand TRACnet PCR laboratory module system's performance and highlight the areas that need improvement.

TRAC Plus is interested in the study findings and recommendations to use them to provide guidance in line with MoH mid- and long-term vision that fits into Rwanda's health information system strategy.

The CNLS is the coordinating body at the central level for HIV/AIDS program and is the main user of TRACnet data in general and PCR laboratory module data in particular at the national level. CNLS needs a well-performing data collection and analysis tool which will facilitate MoH to make timely, evidence-based decisions. The study also will provide insights on the effective and efficient transmission of PCR laboratory test results and better improvement of PCR laboratory module.

Voxiva Inc, being the developer of the TRACnet PCR laboratory module, is looking forward to hear on its performance and is also interested in learning about suggested system improvements. TRACnet PRC laboratory module sustainability in entire laboratory network will depend on how it has impacted on patients' acquisition of laboratory results. Through this study, Voxiva Inc. will better understand end-users' perceptions and attitudes towards the system to subsequently consider upgrading the module to include other laboratory tests.

2.1 Presentation Of The Study

This study is divided into 6 chapters which are the following;

Chapter 1 is the introduction and shows the background of the study, the reason why this topic was chosen, the theoretical framework that explains the researcher's analysis and the study design.

Chapter 2 Explains TRACnet PCR laboratory module systems overview within the Rwanda laboratory network. It describes its functionality and impact on reducing patient results TAT. This chapter also shows the impact of similar systems in various countries.

Chapter 3 Is a review of relevant literature and highlights a brief review of previous studies on the problem and significant writings on the impact of IT on information management.

Chapter 4 presents the theoretical framework research methodology used to conduct the survey.

Chapter 5 analyses data and presents data collected from the field.

Chapter 6 provides the conclusion, recommendations from the findings as well as the feature research.

CHAPTER 2: RWANDA TRACnet SYSTEM OVERVIEW

2.1. Rwanda TRACnet System

In (2004), TRACnet, a web and phone-based electronic monitoring and reporting system for HIV/AIDS programs, was implemented in Rwanda by Voxiva Inc, a US-based IT company specialized in health IT solutions. The TRACnet system has been implemented under both the leadership of NRL as well as TRAC Plus.

Through a strong public-private partnership involving a local private phone, internet provider and Mobile Telephone Network (MTN), the TRACnet system used the existing mobile phone infrastructure to support deployment of the HIV/AIDS IS. Other stakeholders that substantially contributed to the system development included the then Rwanda Information and Technology Authority (RITA), Rwanda Drug, Consumables and Equipment Central Procurement Agency (CAMERWA) and Tulane University.

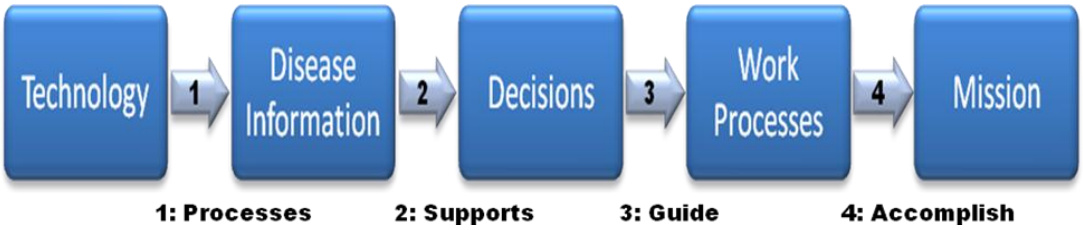
2.2 Description of TRACnet system

TRACnet uses a combination of telephone and Internet web-browsers for data entry and reporting. Health workers from their sites access the TRACnet system database on the Kigali-based server either through a toll free number or the web-interface. Backup servers are located outside the country. TRACnet system's data security includes the use of protected access based on the users' role and permission level. The role-based system provides different levels of database access to administrators, analysts and site-level users depending on their positions within the HIV/AIDS program and the Rwanda health information system (RHIS).

2.2.1 TRACnet Logical architectural design framework

The TRACnet system uses the ICT to process the laboratory data and this data is converted and received by HC personnel in form of SMS. This information is used by health care providers in public health sector for decision making. The whole process is summarized in four levels p*rocess, support, guide and accomplish* as shown in figure1 bellow.

Figure 1: TRACnet Logical architectural design



Source: (April 2011, East Africa Public Health Laboratory Networking (EAPHLN) project ICT workshop report)

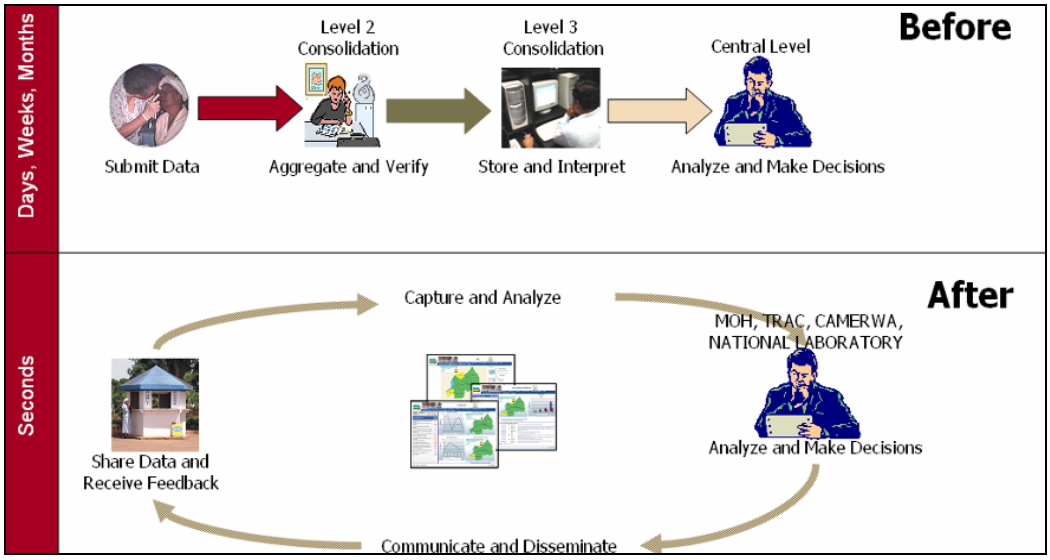
2.2.2 Schematic diagrams of how TRACnet System Works to improve PCR results TAT

The development of TRACnet PCR Laboratory system came as a result of using a poorly managed paper based system which also did not conform to the established laboratory patient results TAT.

With the introduction of electronic system, one thing one notes is the time difference. Whereas the paper based system took days, weeks and months to deliver results, TRACnet system takes seconds.

Figure 2 shows the comparison between the old systems (paper based) used prior to the introduction of TRACnet and sending the PCR laboratory results by SMS. The Latter system has improved quality of laboratory results in terms of reduced TAT.

Figure 2: Comparison between paper based and TRACnet PCR laboratory module in terms of reduced TAT.



Source: (April 2011, EAPHLN ICT workshop report)

2.2.3: TRACnet Technology User Interfaces (UI)

TRACnet system uses multi-channel interfaces to access, capture, and visualization to communicate HIV patient information. Users play various roles such as creating and amending basic forms, lists and notify the user on reagents or drugs stock out. The aggregated data, graphs, and reports are all tasks that can be performed through the TRACnet UI.

The system uses three communications networks. The public internet, the Public Switched Telephone Network (PSTN) 8 telephone lines through two separate Primary Rate Interfaces (PRI) and SMS through Short Message Peer to Peer Protocol (SMPP) and users view, analyze and map the data in real-time. They also communicate; send alerts and information back to the field in a timely and systematic way. Figure 3 shows how TRACnet allows users to collect real-time information from the field via web, phone, mobile application and paper.

Figure 3: The User Interfaces used by TRACnet PCR laboratory module

Source: (April 2011 EAPHLN ICT workshop report)

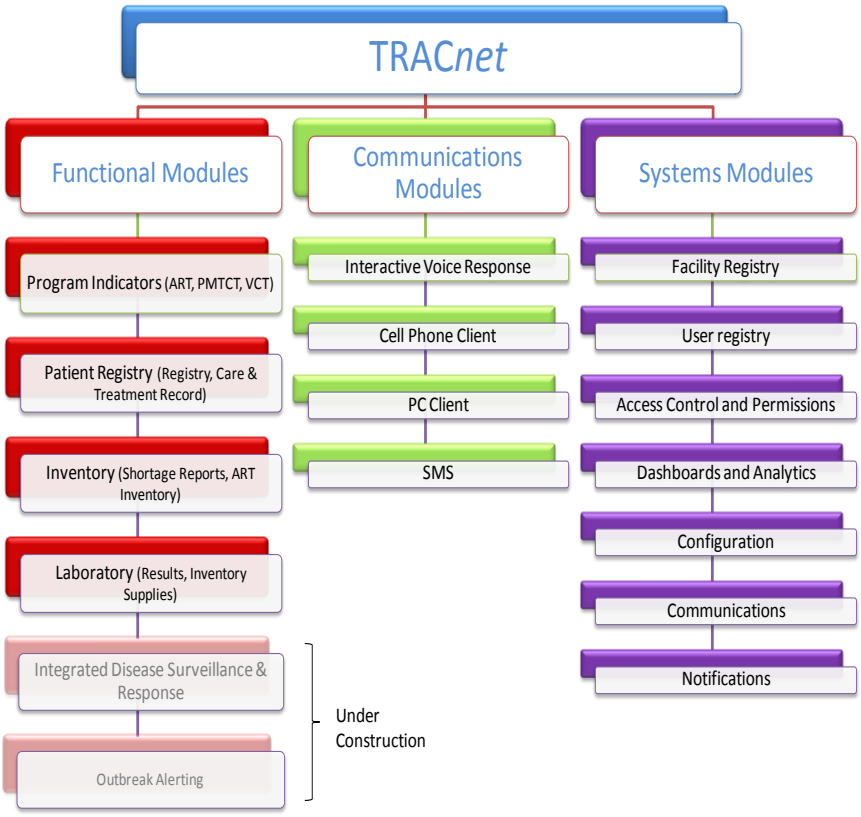
2.2.4 TRACnet Main Modules

TRACnet hosts three main modules namely; functional module, communication module and system module. Figure 4 shows schematic diagram of the arrangement of main modules and their corresponding sub modules and the PCR laboratory module is the fourth under functional modules.

As soon as data is in the system, supervisors at multiple levels view and analyze data in real-time via web-based dashboards and this includes; reviewing and approving reports, track new reports, map and analyze data, track and manage people.

The reviewed and analyzed data in TRACnet allow national decision-makers to quickly analyze and respond to timely-sensitive information; enabling improved planning and response to critical needs down to the facility level; and tracking key program indicators to identify trends and view program impact over time. The system is built on technology designed and deployed to take full advantage of the growing numbers of HC in Rwanda that have computers, internet and the broad availability of mobile phones at virtually every HC.

Figure 4: The structural framework of TRACnet system



Source: (April 2011 EAPHLN ICT workshop report)

Besides disseminating laboratory PCR results, TRACnet PCR laboratory module facilitates communication and monitoring of HIV/AIDS programs through mobile telephone to provide data to remote site where these programs operate in a timely manner. These data facilitate the healthcare providers in their catchment area to communicate to the central level program managers on the progress and challenges faced by their Antiretroviral Therapy (ART) patients. The cadres at the TRACPlus, MoH, CNLS and other stakeholders at central level access them by logging to the TRACnet website. However, access to EID and treatment of HIV/AIDS remains a critical gap towards the attainment of national and universal targets and key challenges include inadequate coverage and inefficiency of the national EID programs.

The (November 2009) EID symposium organized by CNLS, MoH, NRL, TRAC plus and partners pledged to improve coverage of EID/PCR services in through the use of IT to reporting of EID laboratory results among others. A PCR laboratory module was added to the TRACnet system

(March 2010) and this module is used to disseminate PCR test results in form of SMS to HC's that refer their PCR laboratory test samples to NRL.

Prior to the introduction of TRACnet PCR laboratory module, the paper based system was used and it took months to deliver PCR results to HC. The baseline workflow of results transmission was as follows; HIV+ mother would visit the HC with her new born for immunization and medical checkup. The health provider then ordered a PCR test and he/she fills the DBS form. This would be followed by the lab technician or nurse taking the baby's blood sample. The nurse/lab technician delivers the sample to NRL the only laboratory in Rwanda where the PCR test is conducted. NRL the receptionist provides the laboratory code and the nurse writes down in her/his laboratory register. The NRL laboratory technician runs tests and records result in on the DBS form. The NRL receptionist enters all data fields of PCR to an excel sheet and finally the health facility nurse picks the results up and takes them back to the HC. Table 1 bellow summarizes the whole process.

Table 1: National Reference Laboratory -Rwanda long TAT (Avg > 120 days)

Health center: Take sample	Nurse/ lab tech brings samples to NRL	NRL: Process specimen	NRL: Receptionist enter results in Excel spreadsheet	Nurse receives the results	Results communication to the mother(action)
1-day	1-30 days	3-7 days (max.14d)	1-10 days	1-3 months	2-4 months

Source: (Rwanda 6th Annual pediatric conference (2010)

From table 1, it is evident that average number of days from sample collection to sample reception at NRL is 13 days Versus 33 days as witnessed in baseline assessment, average number of days from sample reception at NRL to result availability is 7 days and the average number of days from results availability at NRL to result reception to HC is 6 days versus 1-3 months in baseline assessment. In total 26 days versus 2-4 months.

2.3 The EID Trend

As a follow up of Atlanta (May 13 2008) EID meeting, another conference was organized in May 2010 in Tanzania to review the United States Presidents Emergency Plan For Aids Relief (PEPFAR)-supported EID programs. As results of these meetings, two EID program laboratory informal surveys were conducted in November 2008 and 2009 respectively in twenty four countries. Figure 2 shows a list of countries in which the survey was conducted.

In the survey report (2010) presented by Centers for Disease Control and prevention (CDC) it was clear that despite countries best intentions to dramatically increase in the number of HIV/AIDS PCR tests conducted between 2007 and 2008, scale up of EID has been progressing slowly. Nearly all countries surveyed included EID implementation as part of their national HIV policy although the report indicated that only about a third of the counties had actually implemented EID activities at 80% or more of their PEPFAR supported sites. Eleven out of 15 countries had plans for national scale up of pediatric HIV treatment, whereas only eight had plans for scale up of their EID programs. CDC's findings of the slow pace of EID scale up were corroborated in World Health Organization (WHO) 2009 report dubbed towards universal access stated that only 15% of HIV exposed infants received HIV testing for EID in the first two months of life.

Throughout the 3 day meeting, countries cited a number of challenges to scaling up EID services such as; laboratory long TAT, data collection, management and analysis, service accessibility and lack of laboratory capacity to mention but a few.

Table 2: List of countries in which informal survey on the scale up of EID program

Angola	Ethiopia	Malawi	Tanzania
Botswana	Guyana	Mozambique	Thailand
Cambodia	Haiti	Namibia	Uganda
Cameroon	Jamaica	Nigeria	Vietnam
Cote d'Ivoire	Kenya	Rwanda	Zambia
DRC	Lesotho	Swaziland	Zimbabwe

Source: (EID (May 2010) presentation on country polices and level of program Implementation, slide 4 by Francois-Xavier Bagnoud (FXB) center at the university of Medicine and Dentistry of New Jersey).

For countries to address challenges of long TAT, the use of SMS and other novel technologies to improve the TAT have been adopted. A list of countries using these technologies is found in table3. The use of the technologies enhances communication to and from DNA PCR testing labs (between the labs and clinics or the labs and central level).

Table 3: A list of countries currently using SMS and other novel technologies for improving.

Countries using SMS technology for reporting of lab results	Type of technology	Date of implementation	Stage of implementation
Cameroon	SMS connects lab machines to printer in health facility		
Ethiopia	SMS connects lab machines to printer in health facility	February-September 2009	Pilot: SMS printers in four sites
Kenya	SMS connects lab machines to printer in health facility		
Mozambique	Expedited Results System (ERS) connects internet to severs to GPRS wireless network to printer in health facility	August 2009	Pilot: Carried out August – October 2009. National rollout began in November 2009
Nigeria	SMS connects lab machines to printer in health facility		
Panama	SMS connects lab machines to printer at health facility		
Rwanda	TRACnet, web-based system that uses SMS to send results to EID focal people at health facility as well as reports to district and national PMTCT programs	March 2010	Implemented nationally: all sites collecting DBS samples have results returned via SMS.
South Africa	Bhyve Technologies' mediLABS solution		Pilot: over 600 3G enabled laptops in clinics and hospitals; 40 doctors in Johannesburg participating with mobile phone pilot
Tanzania	SMS connects lab machines to printers in health facility	March 2010	Pilot involving seven sites and one laboratory
Uganda	SMS connects lab machines to printer in health facility	October 2009	Pilot at ten sites
Zambia	SMS system sends results from lab to cell phone or printers in health facility; also use smart cards for all patients (only in Lusaka)	February 2010	Pilot: SMS printers were installed in five EID facilities

Source: (EID: Improving PMTCT and pediatric HIV programs, Arusha, Tanzania final meeting report August 2010.)

From table 3 above, Rwanda is the only country which has implemented nationally web based lab system for results return (TRACnet). It also utilizes the SMS technology for broadcasting educational messages, announcements of trainings and updates and disseminating automated monthly reports and charts. All sites that collected PCR samples received the results by SMS. The use of technologies has facilitated rapid communication and dissemination of DNA PCR results between the labs and clinics or the labs and central level in addition to enabling faster TAT of EID

results. However, table 4 shows dramatic reductions in TAT achieved through the use of mobile technology and SMS printers to strengthen laboratory systems in Nigeria.

Table 4: Nigeria Decrease in EID Result TAT

Hospital Name	**Known TAT Prior to SMS Printers**	**Known TAT During SMS Pilot**
Murtala Mohammed Specialist Hospital	31.1 Days (n = 85)	16.3 Days (n = 27)
Federal Medical Centre Azare	56.2 Days (n = 24)	15.8 Days (n = 11)
Hasiya Bayero Pediatric Hospital	N/A	10.6 Days (n = 14)
Ahmadiyyah Muslim Hospital	35.9 Days (n = 45)	12.7 Days (n = 10)
Total	**32.5 Days** **(n = 154)**	**14.2 Days** **(n = 62)**

Source: (EID conference (May 2010)

The lessons learnt from the two experiences were; the challenges to EID scale up along with solutions proposed by countries to address these challenges which include; Stigma and poor community involvement, multiple EID guidelines that do not adhere to standard clinical and laboratory algorithm, lack of follow up of infants and their mothers or lost, poor linkages to comprehensive care, laboratory TAT capacity to mention but a few. To improve laboratory TAT capacity SMS and other novel technologies have been introduced. Some countries such as Rwanda, Zambia and South Africa are using web based technologies that can expedite storage of epidemiological data for later analysis. While the use of SMS and similar technologies does help to reduce TAT for EID results from laboratory to facility, it was noted that this is not a comprehensive solution for reducing the total time taken from obtaining PCR sample to receipt of results by caregiver. More efficiency is required in pre-analytical stages to ensure that health facility dispatch samples regularly, the samples transportation is rapid, sample processing is quickly done by laboratories and results are dispatched in a timely manner.

CHAPTER 3: Literature Review

3.0 Introduction

This Chapter reviews the module that is guiding my study, before developing a conceptual framework and presents literature related to the respective study objectives.

The following was considered:

- *The DeLone and McLean (D&M) Model of Information Systems Success*

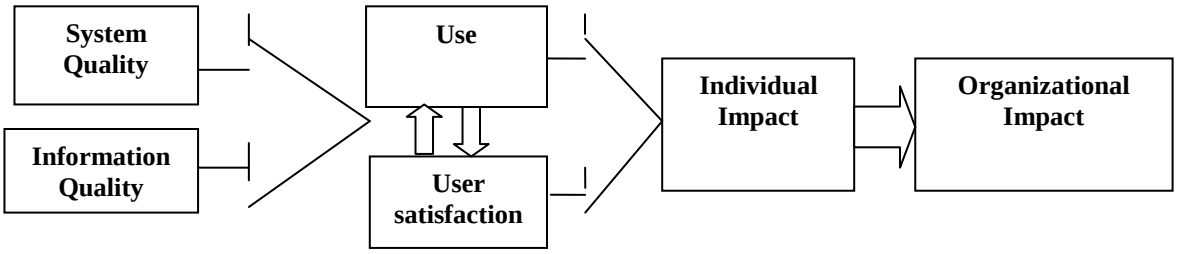
Following is the brief description of the module mentioned above.

3.1 The DeLone and McLean Model of Information Systems Success

The measurement of information system success or efficiency is acute to every one's understandings of the value and efficacy of IS management and IS investment. In 1992, D&M published a paper in which they attempted to bring some awareness and structure to the dependent variable IS success in IS research and developed a model known as D&M IS success model.

According to D&M's model of information system success (1992), the model acts as a framework for conceptualizing and operationalizing IS success. They urge that the semantic level is the success of information in conveying the intended meaning while the effectiveness level is the effect of information on the receiver.

Figure 5: The D&M IS Success Model



Source: (Proceedings of the 35th Hawaii International Conference on System Sciences – 2002)

The main purpose of the D&M information systems research was to synthesize previous research involving Managing Information System (MIS) for a clear ground of wisdom and to guide researches that might be conducted in future for the same aspect. According to Shannon and Weaver (1949) and Mason (1978), their communication research and the information influence

theory respectively in addition to empirical MIS research studies from 1981-1987, a comprehensive, multidimensional model of IS success was postulated. D&M's model combined both process and casual explanations of IS success.

D&M urges that considering a process model, an IS is developed with a range of different categories of systems and information quality. The end users and their managers then through the use of the categories mentioned above acquire satisfaction or are dissatisfied by the systems performance and the quality of information it produces. D&M concludes that it is through frequent use of the system that its information results creates impact or influences every systems user in performing their work and it is through these individuals impact that collectively becomes organizational impact as well.

A casual or variance on the other hand assesses various dimensions that lead to its success in order to determine whether any relationship might exist among them. They urge that the systems high quality will results into higher user satisfaction and use and all end results will be the positive impacts to the individual users produce hence improvement in organizational performance and productivity.

The D&M's model consists of six interrelated dimensions of success: *System quality, Information quality, System use, user satisfaction, Individual impacts, and Organizational impacts.* The interrelationship which is embedded in these dimensions plays a major fundamental role when it comes to determine the IS success in empirical studies through; measuring, analyzing and reporting.

3.2 Model Validation

Rai, A., Lang et al (2002) conducted two research studies to practically test and validate D&M IS model.

Seddon et al (1994) surveyed 104 users of university accounting system that had just been implemented and their findings indicated that there was a significant relationship between system quality with user satisfaction and individual impact, information quality with user satisfaction and individual impact and user satisfaction and individual impact.

According to Grover et al. (1996), that system quality and information quality are original effective theories behind system success while D&M considers them important factors of success.

It is through this argument that Grover supplemented and extended D&M model of IS by six effective classes. These included; Infusion, Market measures, Economic measures, Usage measures, perceptual measures and productivity measures.

The above classes can be collated with D&M IS success model in the following manner bellow;

Infusion measures is correlated with organizational impacts, economic measures to organizational impacts, usage measures to system use, perceptual measures to user satisfaction and productivity measures to individual impact. The six classes which is not covered in the D&M IS Success Model is market measures.

3.3 D&M's Model Extension

The Grover et al. (1996) IS effectiveness framework developed to validate the D&M IS Success Model suggested to include market or industry impacts and this was included in D&M updated model of IS success.

Pitt et al. (1995, p. 173) observed that commonly used measures of IS effectiveness focus on the products. He however emphasizes that the services derived from the function of IS should be also looked into. This will eliminate the IS researchers underestimation of the IS effectiveness. Kettinger et al (1995) finds it paramount to include service quality as part of measures of IS success.

Pitt, Watson & Kavan (1995), successfully applied and tested the SERVQUAL instruments marketing by observing its tangible, reliability responsiveness assurance and empathy dimensions to measure its service quality. It is through their empirical research on this instrument that they recommended service quality be added to the success model.

Kappelman (1999) through his empirical research challenged SERVQUAL metric practical performance. It is through this research that the instruments reliability, discriminant validity, convergent validity and predictive validity of measures were found with errors.

While there is an agreement with the concerns expressed about this particular metric, the researcher remained optimistic that if service quality could be properly measured, it would

ultimately be considered important component of IS success besides system quality and information quality.

One important point that must be taken into consideration is that all six quality dimensions that are used to measure the success of IS have got different weighs which depends on the extent of researcher's analysis. For example, one might use information quality or system quality as the most important quality component used to measure the success of a single system where as measuring the overall vesting in ERP may or may not lead to improved information quality an aspect of IS success.

3.4 D & M's Model System Critiques

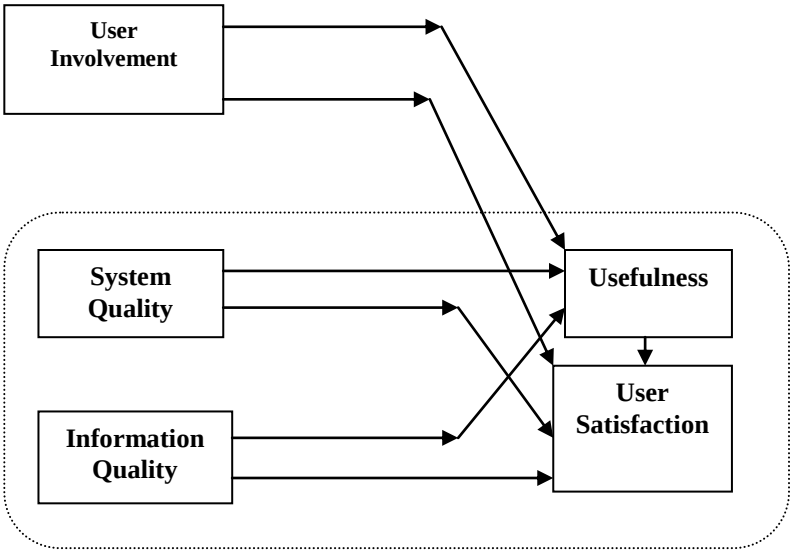
Many researchers conducted studies and produced papers that have tested and validated the D&M IS Success. However, others researchers have found it difficult to apply the model in some specific research which were performed guided by this particular model.

(*Jiang & Klein (1999),Whyte et al. (1997), Seddon et al. (1998), Both Mohr (1982) Newman et al (1992)).* This resulted into attempts to challenge or extend the model itself. Their findings have contributed to better understanding of success and its dimension. D&M (1992, p. 88) however, agree with their critiques findings. This is clearly seen in their response to critiques findings, they had written that their model required further development and validation before it could be considered a basis for selection of appropriate IS measure. Jian &Klein (1999) empirical study, the findings indicated that the IS users will prefer to use different success measures and this will also depend on the system that is being validated.

Seddon et al. (1998) make an important contribution by proposing a two-dimensional matrix for classifying IS effectiveness measures based on the type of system studied and on the stakeholder in whose interest the information system is being evaluated. In this regard, the researcher completely agrees. As Seddon adds, interconnectivity between the six variables set by D&M. indeed, some systems might need a stronger or weaker variable that might stop the linear D&M model, with Seddon, it more reflect the complex systems where various stakeholders have to be involved.

In their paper a respecification and extension of D&M Model of IS success, Seddon et al (1997) agree that D&M comprehensive review of different information system success resulted in measuring two important contributions which added value to the IS success and provided a scheme for classifying the multitude of IS success measures into six categories. Motivated by D&M desire and willingness to further develop and validate their model, the researchers Seddon and Kiew (1994) added a new variable called user involvement which is illustrated in figure 6 bellow.

Figure 6: The D&M's model with a new variable user involvement.



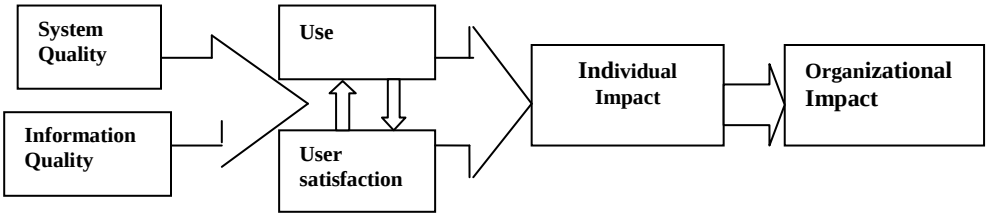
Source: (Source: Information System Research vol.8, No.3, September 1997)

According to Seddon, figure 6 represent an IS success model which recognizes success as a process that must include both temporal and casual influences in determining IS success. The six IS success categories presented in D&M are rearranged to suggest an interdependent success construct while maintain the serial, temporal dimensions of information flow and impact.

Fraser and salter (1995) replicated Seddon and Kiew's (1994) study and obtained similar results. Based on the highly significant path coefficients in the both studies, their research found that for individual users of particular applications, there is a considerable recognition for D&M's model.

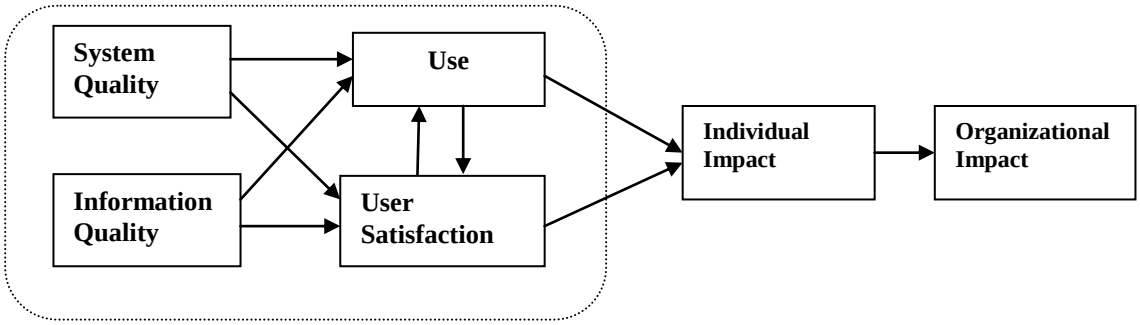
Seddon however urges that D&M's combination of both process and casual explanations of IS success leads to many potentially confusing meanings that ultimately weaken its value. They discuss figure 5 and figure 6 in 7& 8 below.

Figure 7: D&M's Model of IS Success



Source: (Source: information system Research vol.8, No.3, September 1997)

Figure 8: Path Model that seems to be implied by D&M's (Seddon and Kiew 1994)

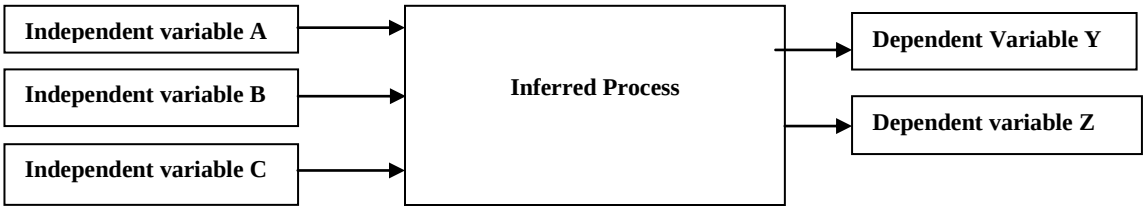


Source: (Source: Information System research vol.8, No.3, September 1997)

3.5 Comparison of Variance and Process Models

To address the confusion and the weakness caused by the combination of process and variance models in D&M's of IS success, the two models were separated and given their respective definitions. It was observed that variance in any one of the independent variables of any system is essential and it is sufficiently enough to cause variance in the dependent variables of similar system. This concept is illustrated in figure 9 bellow.

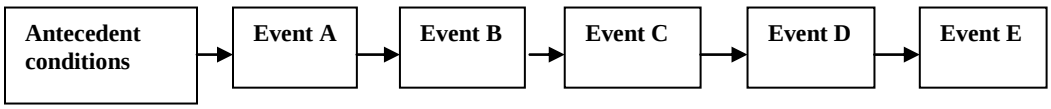
Figure 9: The variance model



Source: (Information System research vol.8, No.3, September 1997)

On the other hand, with a process model one discovers how certain combinations of events in a particular sequence lead to certain outcomes. An example of a process modeling research in IS is the paper by Sab-herwal and Robey (1993). The researcher analyzed a sequence of events which included; assignment of personnel, submission of proposal and approval, in 53 IS implementation projects and used cluster analysis to identify six distinct types of implementation process. The figure 10 bellow shows a process model with a series of events.

Figure 10: The process model



Source: (Information system research vol.8, No.3, September 1997)

Both Mohr (1982) and Newman and Robey (1992, p.251) urge that the boxes and arrows in a variance and a process model do represent different concepts therefore and it is wrong to combine the two in one model. They further go ahead to explain that the arrangement of boxes or the boxes in a process model seem to represent an event which did happen or did not happen while the arrows shows a sequence not interconnection.

Many of the boxes and arrows in D&M's model of IS success have both variance and process models. D&M say their model combines both process and casual (variance) explanations of IS success and while validating D&M, Seddon added a new variable to suggest an interdependence success construct while maintaining D&M's serial (process) and temporal dimensions. After testing part of D&M' model use, Seddon and Kiew (1994), Fraser and salter (1995) obtained similar results. They conclude that for users of an individual application, there is substantial agreement with D&M but combining process and casual in their model for the whole IS success leads to many potential confusing meanings. This is where they come up with a comparison between variance and process models both found in D&D's model. After this comparison and identifying the confusion, Seddon came up with a re-designed and extended D&M version that addressed the confusion generated by multiple alternative meanings for boxes and arrows which represent the variance and the process.

In an effort to overcome the mentioned difficulties caused by combining both process and variance in D&M's model of IS success, Seddon came up with a modified and extended version of D&M's model. This modified or respecified model as he named it retained most of the features of D&M model but the confusion caused by multiple meanings from boxes and arrows was eliminated. It was achieved through dividing D&M's into two variance sub models that catered for both use and success and ultimately eliminated the process model perception.

Seddon in his further arguments stresses that the confusion and difficulties found in D&M's as a result of combining process and variance models could be verified by concentrating only on the use box in Figure 7. He observed that it is possible to identify three possible meanings for use such as; IS use as a variable that proxies for the benefits from use, IS use as the dependent variable in a

variance model of future IS use and IS use as an event in a process leading to individual or organizational impact.

IS use as a variable that proxies for the benefits from use. Seddon highlights that when IS use is uppermost in the readers mind, use is understood as a variable that stands for the benefits from use.
Lucas (1975) complements Seddon on benefits from use success interpretation of use by observing that the system which are not put into are regarded as failures and also frequently heavily used systems are successes.

Szajna (1993) further challenges this assumption by highlighting that the critical factor for IS success measurement is net benefits and which he recommends to flow from use. He concludes that the net benefits such as higher work performance in the same time or taking less time to achieve as much work as the same quality as was prior to acquisition of the new system should be delivered to the system end user.

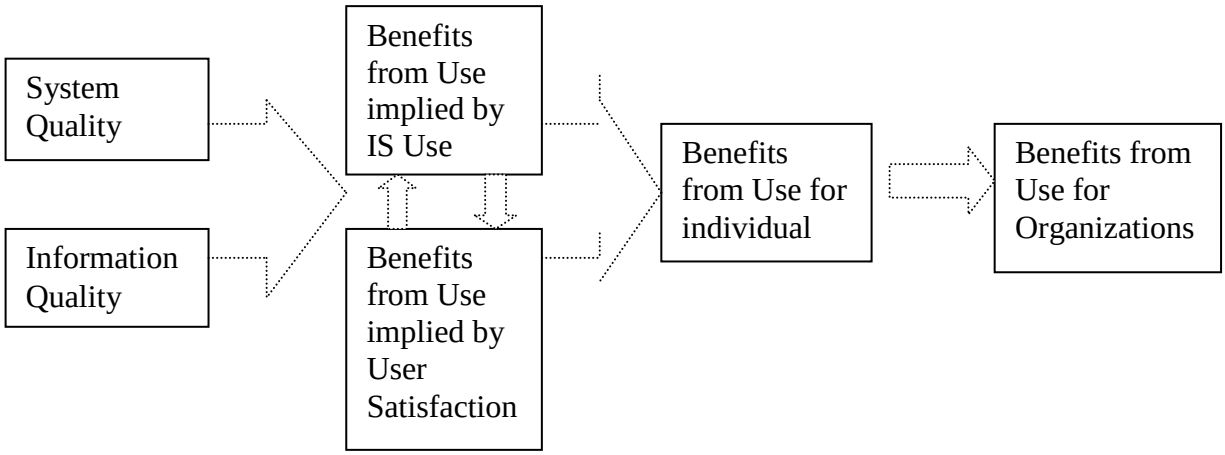
The perception of IS use as the dependent variable in a variance model of future IS use. Saddon asserts that if any person read this concept, the first interpretation from the arrows leads to three dimension of system quality, information quality and user satisfaction as seen in figure 7. Seddon urges that D&M's model is therefore not a valid interpretation of use since its primary objective was to interrelate categories of IS success measure.

IS Use as an event in a process leading to individual or organizational impact. Seddon goes ahead and highlights the third possible interpretation for IS use in which he says that the user satisfaction, individual t and organizational impact are all the results of a process that starts with IS use. It is from this observation Saddon assumes that the arrows in D&M model lead from use to user satisfaction, individual and then organizational impact.

Seddon concludes by stressing that the important point to note here is that use should not be regarded as a measure of IS success rather user satisfaction, individual impact and organizational impacts if at all observed to determine if the system is successful.

To emphasize what the variables in D&M's measure, Figure 7 was redrawn in Figure 11 bellow with the words benefits from use placed in front of each of the four right classes of variables. D&M's relationship between these variables was also drawn as dotted lines. Figure 11 bellow illustrates the re-drawn D&M's model to indicate what the variables measure.

Figure 11: The meaning of the categories in D&M's (1992) Model of IS Success.



Source: (Information System Research VOL.8, No.3, September 1997)

From figure 11 above, Seddon concludes that the system quality and satisfaction one gains from using it leads to one's desire of wanting to frequently use the system. Hence the more the system is used the greater the individual impact and organizational impact. The re-drawn model in figure 11 above is a bit less interesting than D&M's in such a way that the IS use as the dependent variable in a variance model of future IS use and IS use as an event in a process leading to individual or organizational impact meanings one reads into D&M's eliminated.

Seddon's overall conclusion on this was that D&M's IS success model is a combination of three models and these are; a variance model of IS success, a variance model of IS use as a behavior and a process model of IS success.

With the three proposed combination of D&M's model, Saddon asserts that the independent and dependent variables of a variance model in this particular case are probably system quality and information quality and the dependent variables are IS use a variable that proxies for the benefits from use and user satisfaction respectively. A variance model of IS Use as a behavior (IS Use as the dependent variable in a variance model of future IS use. The third and the last model in the combination is a process model of IS success, where IS use is seen as an event in a process leading to individual or organizational impact.

3.6 A re-specified Version of D&M's (1992) Model of IS Success

To eliminate the confusion caused by multiple alternative meanings of D&M's model of IS success caused by boxes and arrows, Saddon redrew D&M model in figure 12. In this model, the process interpretation of D&M's model was eliminated and the remaining part was divided into two variance models as seen in figure 5. First is a partial behavior model of IS use that is shown in the rounded box at the top left of the figure. He made the second to be variance model of IS success and is shown in the large rectangular box at the bottom of the re-specified figure. He finally linked the two variance models through the path drown from the significances of IS use, through IS success model and back from user satisfaction in the IS success model to the revised expectations on the net benefits of the future use in the partial behavior model.

Taylor and Todd (1995a, figure5, p.163) complements with Seddon on the behavior variance model which is found at the top left of the re-specified model. They assert that if all other factors such as norm and perceived behavior control are alike, the higher expectations of the net benefits of future IS use will automatically lead to higher levels of IS use.

Seddon therefore emphasizes that it is in this regard that expectations of net future benefits appears in the rectified model of IS success and use not the three variables in D&M's model, as the casual variables that drives IS use. The consequences of IS use are represented by the individual, organizational and societal consequences of IS use and these describes the outcomes which are attributed to IS use not its success measures. The arrow from IS use to consequences represents the suggestion that more IS use implies more consequences. He therefore observes that there is unclear meaning of arrows which point to impact boxes in D&M's and this ambiguity which is found in

process model interpretation is linked to IS use being necessary but not adequate to cause any effects whereas the variance model interpretation is necessary and sufficient to cause more impacts The large rectangle labeled IS success model is the logical equivalent of figure 11 and the six dimensional success measures of system quality, information quality, user satisfaction, individual impacts and organization impacts found in D&M's do appear. In a re-designed model, use acts as a measure which is found at the bottom of other benefits from use column three (3) as volitional IS use with two new variables of perceived usefulness and net benefits to society added.

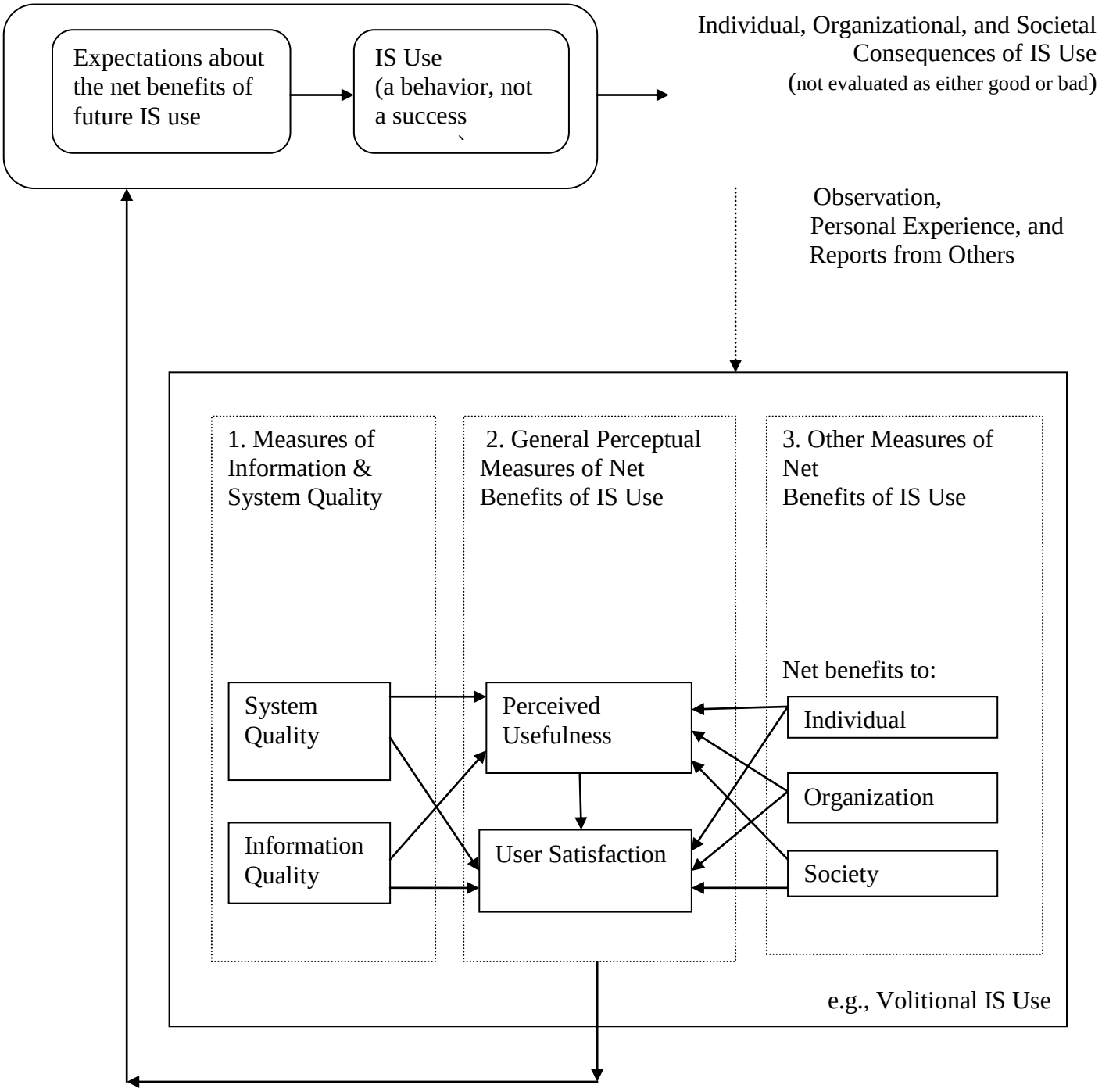
Column one (1) talks about the measures of information and system quality and the variables defined are identical to D&M's and in terms of relationship they are all interdependent. Thus this is consistent with D&M's model. Column two (2) talks about the general perceptual measures perceived usefulness and user satisfaction of the net benefits from IS use and as indicated in figure 12. The four remaining classes of variables on the side of D&M's model are only classifications of the measures of benefits from IS use and it is through these measures that the usefulness of and IT application the systems end user is realized.

In his definition of perceived usefulness of an IT application, Davis (1989) asserts that it is the degree to which the user of an IT application believes that through the use of that particular system the performance of his job is enhanced. Therefore the perceived usefulness of an IT application as per the Saddons re-specified model of IS success and use is the degree to which a person believes that through its use the system enhanced his or her job performance, as well as the organizational to which he belongs.

Lastly the relationship to describe in rectified model of IS success and use is the path drown from IS success through expectations in the behavior model. If all other factors are held constant, it is assumed that higher benefits which were derived from the systems previous use ultimately lead to users higher expectations about future benefits. Since user satisfaction was chosen in rectified model of IS success and use to signify the variable with almost similar meaning to net benefits so was the idea behind arrow representing this feedback path drawn from user satisfaction to expectations.

Seddon concludes that D&M's IS success model which comprehensively reviewed the empirical literature represents an important step towards the consolidation of knowledge of IS success measures. It through his empirical research and after working with their model led him to conclude that inclusion variance and process interpretations led to confusing meanings which at the end diminish its value.

Figure 12: Respecified Version of DeLone and McLean's (1992) Model of IS Success



IS Success Model

Source: (Information system research vol.8, No.3, September 1997)

3.7 Other Success Frameworks

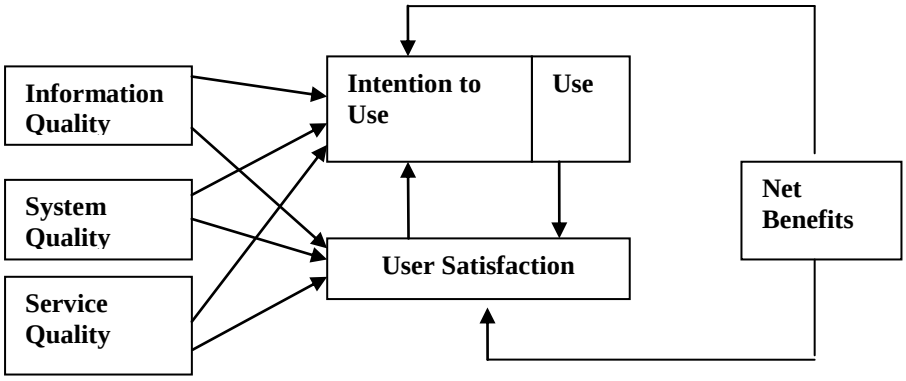
Although there have been attempts to criticize or modify the D&M IS Success Model, some researchers developed and proposed alternate frameworks for measuring IS effectiveness with little attempt to reconcile their frameworks with D&M IS Success model. Grover, Jeong & Segars (1996) created six effectiveness categories that include; infusion measures, market measures, economic measures, usage measures, perceptual measures, and productivity measures.

Smithson and Hirschheim (1998) proposed a framework that consists of three zones of measures namely; efficiency, effectiveness, and understanding.

3.8 The Updated D&M IS Success Model

Based on research contributions, and changes in the role and management of information systems, D&M came up with an updated model. Their updated model had one unifying factor that was quality and it had three major dimensions of information quality, systems quality and service quality. The D&M updated model is illustrated in figure 13 below.

Figure 13: Updated D&M IS Success Model



Source: (DeLone & McLean, 1992)

Various researches have been conducted based on the success of D&M IS success model. Among these is Molla, et al (2001). They suggested that D&M IS success model be used to measure and validate the success of other IS. It was through this study that they proposed the adoption of D&M to measure the challenges the new e-commerce world was facing.

According to Shannon, C.E., and Weaver, W. (1949, the D&M is built on communication theory. They further urge that although the internet is considered a powerful communication and commerce medium, it is also a communication and IS that is used for measurement framework in e-commerce world. One of the observations made in e-commerce IS is that the primary system end users are the customers or the suppliers involved in the business and are totally different from systems internal users. In e-commerce world the, the system facilitates customers and suppliers decision making in the execution of business transactions. The customers and suppliers electronic decisions will ultimately impact e-commerce's individual's users, the organizations in which they work as well as their nations economics. It is through this interrelationship that makes the researcher to conclude that communications and commerce process may fit into the D&M IS Success Model. The six dimensions of D&M model of IS success fits in e-commerce business transaction in the following manner;

The e-commerce system quality; Internet facilitates to measure the e-commerce desired characteristics. These include; the systems usability, its availability, the level of adaptability and response time through upload and download time. All these are systems qualities which their usefulness are valued by end-users of an e-commerce system.

Information quality; this dimension looks at e-commerce's contents in which the prospected buyers or suppliers involved in e-commerce will base on to efficiently and effectively use the system. The systems contents in this particular case the web should be personalized, complete, relevant to business aspect, easy to understand and secured. The information quality will prompt the customers to initiate transactions decision making via internet and their intention to return to the business site on regular basis.

Service quality; the e-commerce service quality will encourage the buyers and suppliers involved in business transactions to frequently use the system. However, the overall support provided by the service provider remains critical, irrespective of whether it comes from IS department or a new unit created after organizational restructuring.

Usage; This dimension **of** measuring the e-commerce looks at how frequently the end users visit the website, their ability to navigate within the web, retrieval of information related to e-commerce throughout the whole process of business transaction.

User satisfaction; this is an important factor and means to measure customers or systems users opinion on the system in use for this particular case the e-commerce. The customers opinion should be centered on their experience cycle from the systems information retrieval, purchase, easy of payment, provision of payment receipt and service as well.

Net benefits; the net benefits are the most important and critical success measures of e-commerce. It is through this dimension that the e-commerce customer's positive and negative impacts are realized. Besides the customers, the employs, organizations, markets, industries, economies and the whole society will also feel the systems impact as well.

E-commerce net befits success measures play an important role and through this dimension one is able to feel the impact of other five dimensions. However, this measure cannot be analyzed and understood without the measures of systems quality and information quality. In addition, to measure the impact of e-commerce IS through the design and layout of the website to the customers purchase cannot be realized without thorough evaluation of its customer's usability and the relevance of decisions which are made based on the information provided to the prospective customers.

The benefits of D&M revised module to the impact of IT on patient laboratory data management a case of Rwanda's national phone and internet based reporting system PCR laboratory module for children born on HIV+ patients research is system quality to which three major dimensions of information quality, systems quality, and service quality evolves. TRACnet PCR laboratory module will disseminate quality laboratory results in form of SMS which is complete, relevant, and easy to understand. The D&M revised model helped the researcher measure the TRACnet PCR laboratory model's system performance, system adoptability, incorporation of other laboratory test results and patient laboratory results with reference to D&M's models six variables (information quality, system quality, service quality, use, intention to use, user satisfaction and net benefits) . The overall support in disseminating laboratory PCR test results using TRACnet PCR laboratory module, through obeying TAT benefited the researchers study.

3.9 The role of ICT to Enhance Health Service Sector

Katikireddi SV (2004) and HINARI, assert that the use of internet and current telecommunications technologies brought massive benefits to institutions that offer health-care services in sub-Saharan Africa and the Health Internetwork Access to Research Initiative (HINARI) is considered among the most successful ones. Launched by WHO in January 2002 in collaboration with the BMJ publishing group, HINARI through online access improved researchers access to scientific information in the developing world.

Frederick B., and N. Walsh (2007), argues that ministries of health in developing countries in collaboration with a organizations have partnered with local institutions establish Electronic Health Records (EHRs) at the HC level both in rural and urban areas. EHRs have improved the reliability of data collection and processing which ultimately enhanced the decision-making process across the healthcare system.

The WHO views the use of ICTs in health systems as not merely about technology but also a means to reach a series of desired outcomes across the entire health system. ICTs in health sector act as tools and means that facilitate communication, processing and transmission of information by electronic means for the purpose of improving delivery of health services to the population[5].

Schulte JS (2001*55: 28–29*) asserts that that experiments which have been performed with IT to improve diagnosis at the sometime focusing on ways to reduce the cost of medicare the findings indicate that almost all primary care could be provided by physician extenders with much assistance of computer-driven diagnostic tools and support systems.

[5] *Dzenowagis J. Connecting for health: global vision, local Insight. Available at: http://www.who.int/kms/resources/wsis_report/en/index.html.*
Accessed October 2, 2007

According to the online doctor is in, economist, 22 March 2001, telemedicine is recommended as one of the ways through which ICT is advancing the health care status with the primary obligation of delivering the best medical consultations and treatment to patients irrespective of their location.

According to Sorensen et la. (2007), telemedicine and e-Health systems have been recommended as tools for monitoring and evaluation. The two systems have been used to support HIV/AIDS treatment and management in South Africa, One of the challenges of access to treatment through anti-retroviral medication has been the difficulty of receiving accurate and up-to-date information at the planning level. Therefore ICT has been used in a number of pilot studies to address this bottleneck through providing an infrastructure for telemedicine and e-health applications.

Reddy NK, Graves M. (2000: 35–49) provides an example of Indian healthcare project in the state of Rajasthan. This project is shared between the Government of India, Apple Computers and CMC. In Embalam, a two-street village of 22km located west of Pondicherry, 130 out of 210 families struggle below the poverty line. However the village elders allowed the M.S. Swami Nathan foundation access to one side of the temple to facilitate the housing of two solar-powered computers that are used to provide the villagers with data which range from the price of rice to weather conditions and medical information as well.

According to Siik et la. (2005) ,the establishment of an electronic medical record system for ambulatory care of HIV-infected patients in Kenya in 2001 indicates that the system has been used to manage and improve the quality and efficiency of care for patients with HIV/AIDS in sub-Saharan Africa. AMRS played a significant role in patient care at all AMPATH sites. It standardized patient data collection and made data retrieval much faster than the traditional paper-based record as well as evidence based decision-making for patient encounters and for the health system.

The use of ICT have brought a lot of benefits to the health-care sector institutions in sub-Saharan through improved access to scientific information by establishment of EHRs at clinic level, both in rural and urban areas. This led to improved reliability of collected and processed data and enhanced the decision-making across the healthcare system. This is complemented by electronic

medical record system for HIV-infected patients that have improved quality and efficiency of care for HIV/AIDS patients in sub-Saharan Africa.

Using ICT's in health sector has been a resource that facilitated communication, processing and transmission of information by electronic means to different parts irrespective of their distance. The example given is telemedicine used to provide medical advice and treatment to patients. Besides telemedicine, e-health systems have been adopted for monitoring and evaluation to support HIV/AIDS treatment and management in Africa.

CHAPTER 4: THEORETICAL FRAMEWORK AND RESEARCH DESIGN

4.0 Introduction

This chapter presents the theoretical framework and methodology that was followed in conducting this study. There are different methodologies that are used to identify the solution to the problem being searched on and these include; use of structured questionnaires, conducting end user interviews, comparison of various data sources to mention but a few. Research methodology covers research design, population and sample size, data collection, data analysis techniques, validity and reliability of the research findings.

In this chapter, the methodology used to conduct this research will be discussed such as the type and method of research, planning of the study, sampling techniques and data analysis.

4.1 Problem definition (Case study of Rwanda's National Phone- and Internet-Based Reporting System (TRACnet) for HIV+ Patients)

The NRL is using a phone and internet based reporting system to transmit PCR laboratory results to HC in a timely manner via SMS and internet. Sending the PCR laboratory results by SMS is a promising new technology in Rwanda due to improved quality of laboratory results in terms of reduced results TAT.

Table 5: Total PCR samples referred to NRL from all over Rwanda and the results disseminated using the TRACnet PCR laboratory module

	Mar	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Total**
#Samples received	1,345	1,291	1,439	1,266	1,406	1,265	1345	1190	1030	1273	961	926	634	**15,371**
#Results sent	531	612	705	313	1705	1054	1573	740	828	1358	439	13	166	**10,037**

Source: (*NRL 2010-2011 laboratory PCR specimen and sample reception log book (samples received) and NRL TRACnet PCR laboratory module (number of PCR result disseminated)*

Accurate and timely data play an important role in health care provision as well as health program management. The TRACnet PCR laboratory module system aims at providing such information to MoH, the NRL and various institutions under MoH involved in similar activities and to other stakeholders involved in the HIV/AIDS program implementation. Findings from Tulane University's (Jones J, et al., 2006) assessment of the TRACnet system suggested that data collected through the TRACnet system was poor quality and required special attention. The evaluation recommended a thorough review of data quality. This assessment was conducted before the design of PCR laboratory module and since its launch no study has ever been conducted on PCR laboratory module. My study will assess the PCR module checking for data completeness, integrity, accuracy and validity. The completeness of the information collected is ascertained through the required number of PCR test results posted on the TRACnet PCR laboratory module system for the period of one year since its launch. Data integrity and accuracy will be checked in the TRACnet PCR laboratory module against data sources from the health facilities (e.g., patient sample requisition forms, registers, e-registers, quarterly and annual laboratory reports).

However, one year after the system implementation, NRL continue to receive complaints from system end users such as;

- The lack of system feedback functionality to alert the laboratory personnel of system's inefficiencies when it comes to number of delivered PCR results or failure to transmit some of results in regard to PCR test samples referred to NRL, hence hindering proper decision making in PMTCT program management;
- Some delay in sending PCR laboratory results still exist contrary to Maximum set results TAT of seven days (7) and
- SMS sometimes are sent to wrong telephone numbers that are not intended to receive them.

This leads to the main problem statement: Although there has been a rapid scale up of the national PMTCT and pediatric HIV care and treatment programs, access to EID and treatment of HIV remains a critical gap towards the attainment of national and universal targets, key challenges include inadequate coverage and efficiency of the national EID programs.

4.2 Research Objectives

The main objectives of this study are the following:

- To examine the impact of IT on patient laboratory data management;
- To assess the promptness and confidentiality of PCR laboratory results as TRACnet's PCR laboratory module provides;
- To evaluate the challenges that TRACnet PCR system encounters in its two-way delivery of Patient Laboratory test results;
- To conduct an analysis on whether TRACnet PCR system can be used to transmit other laboratory test results other than those of HIV/AIDS and
- To suggest possible recommendations on how TRACnet PCR system can be improved so as to sufficiently address the problem of the system inefficiencies.

4.3 Theoretical Framework

The study will make use of the D&M's revised Model of Information Systems Success.

4.3.1 Dependent variables

- Confidentiality;
- Quality of laboratory PCR results at the HC/NRL;
- Timely manner: Results TAT to the HC;
- Security measures: Number of breaches into the system and
- Data Use: Proper recording of PCR results in patient files/laboratory log books

The dependent variables listed above are linked to net benefits part of D&M's model of information success.

4.3.2 Independent variables

4.3.2.1 System Adoptability:

- SMS: The number of sites that receive PCR results using (SMS, Internet and Telephone);
- Internet;
- Telephone system;

- Data management skills: (Education level/on job trainings of data managers in that field);
- Proper records of telephone SMS (SMS backup using laboratory results log books and the number of dedicated telephones for this activity both at the HC/NRL);
- Computer System: Security, access to TRCnet PCR module system and
- Results backup and storage at NRL

The system adaptability is linked to system and information quality part of D&M's IS success module. The reason being that their quality is key to measuring IS success.

4.3.2.2 System Performance

- Data Quality;
- Functionality and
- Confidentiality

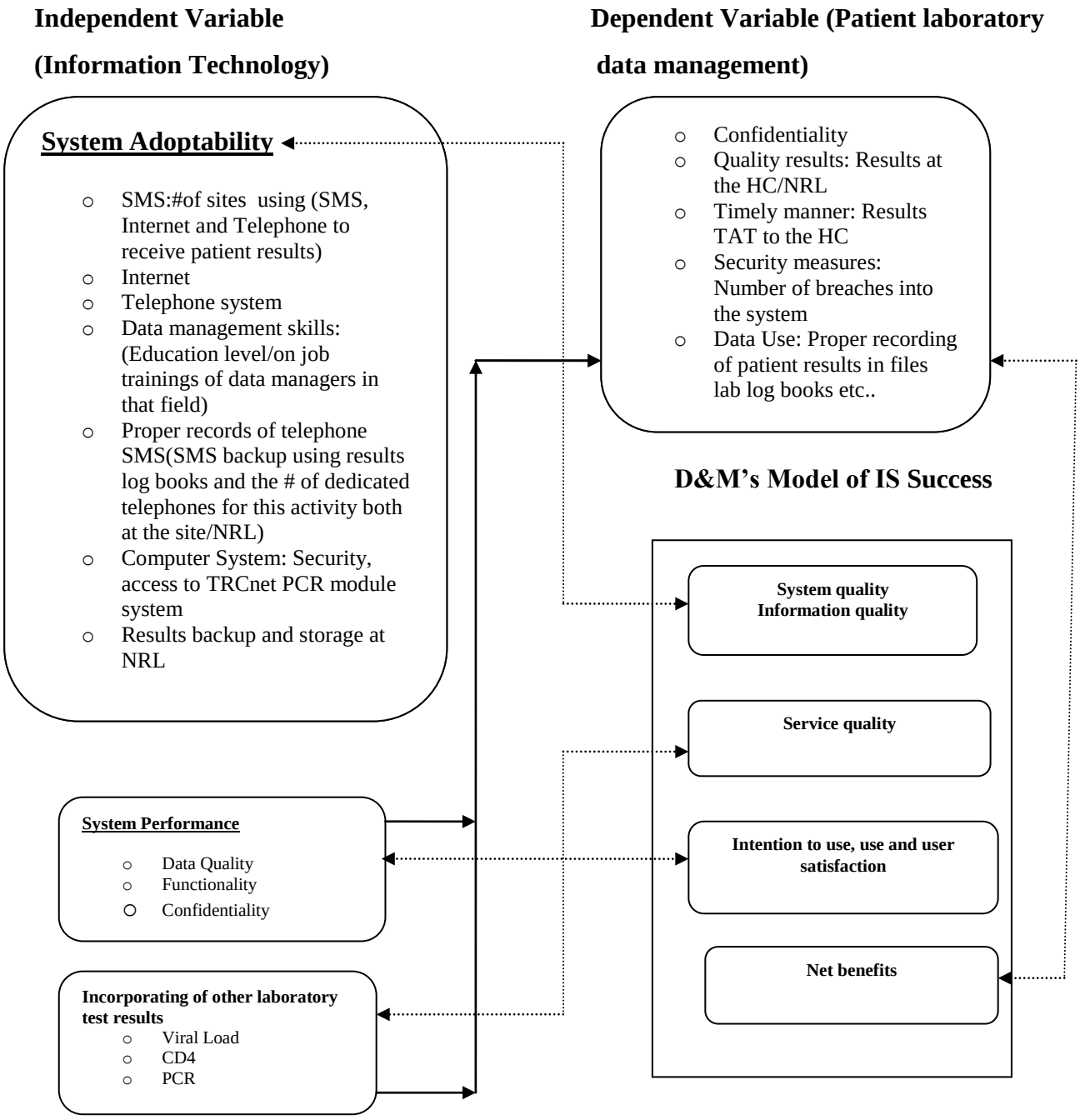
The system performance is linked to intention to use, use and user satisfaction that all a result of system, information and service quality of the system.

4.3.2.3 Incorporating other laboratory test results

- Viral Load
- CD4
- PCR

The above variable is linked to service quality part of D&M's IS success model.

Figure 14: Conceptual Framework elaborating the link between the researcher's framework and the D&M IS success model.



Key:

Rectangular box with doted-line arrows D&M IS success model

Rounded boxes with solid-line arrows Researchers conceptual frame work

4.3 The Relevance of D & M Model to the Researcher's Conceptual Framework Model

Although it is really obvious that the measure of any IS success entirely depends on the system that is being evaluated; Jiang & Klein (1999), there are constant and standard dimensions required for measuring the IS success. According to Jiang various IS have got different measures that justify their success. For instance the updated D & M model of IS success is measured on the basis of six dimensions namely: system quality, information quality, service quality, system use, user satisfaction, individual impact and organizational impact.

However, some IS successes are measured in such a way that may not necessarily follow this trend. For example Rwanda phone and web based IS (TRACnet PCR laboratory module) IS success is measured along the following four (4) main dimensions which include: system adoptability, system performance, incorporation of other laboratory test results as well as patient data management. Realistically, the above two views have a lot in common when measuring IS success because they all include system quality as a major ingredient in the success of IS.

For months Rwanda TRACnet laboratory module has encountered a lot of complaints emanating from both the beneficiaries' and the system user sides, claiming that there has been a partial failure of the system where it was evident that some SMs were sent to wrong telephone numbers, prevalence of delays in sending PCR laboratory results and lack of system feedback functionality to alert laboratory personnel of the system's inefficiencies in results' delivery or failure which in the long-run /in the due course/ finally give poor results.
The D & M model of IS success is therefore, relevant to the researcher's conceptual framework for a number of reasons which include the following:

First of all, D & M IS success model reiterates that information quality and system quality are key to measuring IS success. This practically correlates with system's adoptability part of the researcher's conceptual framework which covers specific issues such as: the number of sites using SMS;

- Internet and telephone to receive patients' results;
- Data management skills, proper records of telephone SMS;

- Computer system and PCR results backup and storage.

The above issues translate into two D & M's IS success measures which emphasize "system quality" as a central IS success component.

Secondly, D & M's work reaffirms that service quality is another important actually an irreplaceable input in measuring the IS success. Service quality best corresponds with the researcher's appeal to incorporate other Laboratory test results when using the TRACnet PCR laboratory module system.

Thirdly, D & M IS success model came up with an understanding that information quality, system quality and service quality lead to intention to use, use, and user satisfaction which are close associates of data quality, functionality and confidentiality that are a byproduct of the researcher's conceptual framework system performance.

Forth, and the last the nature of service, system and information quality impacts greatly the system use, the intention to use and systems user satisfaction which ultimately lead to systems net benefits. The net benefits witnessed in D & M's IS success model out rightly relate to confidentiality, PCR quality results, reduced TAT, data use and data use all of which are net benefits derived from system adoptability, system performance and incorporating other laboratory test results.

Therefore, this research found out that the above complaints are genuine in a sense that they all rotate around the "quality" of the IS in use and recommended that if this can be rectified the PCR laboratory module objective would be achieved. The TRACnet PCR laboratory model is connected to D&M in way that using the TRACnet system, the process remains the same but the quality of the data changes as well as its impact to the organization.

4.5 Research Assumptions

- As with any cross-sectional study, findings from this study reflect a snapshot of the TRACnet PCR laboratory module and will not reflect the trends in data quality improvement over time and;
- The information obtained from HC, NRL, TRACPlus, Voxiva, and PMTCT program respondents as well as various reports is accurate.

4.6 Research limitations

- The study will not be able to check the quality of all data collected in TRACnet system. Moreover an unforeseen selection bias may affect the data sampled for quality checks;
- The case study findings are limited to period of the study. The study on TRACnet PCR laboratory module is intended to cover a period of twelve months (12) from March 2010 to March 2011 and therefore the findings will relate to this period. Any changes that have occurred after that period won't be part of this study;
- The study is predominantly qualitative in nature and;
- The time allocated for the study is not enough given the fact that the researcher is studying while working. The study necessitated working hard through overtime in order to meet the study set time.

4.7 Research Questions

Research questions usually arise when the system end users have mixed reaction towards the systems performance versus original intended use.

4.7.1 Major Research Question

To what extent is the TRACnet PCR laboratory module providing stakeholders with quality laboratory test results that can optimally support the national laboratory network quality of lab test result? Tied to this question is the accurate number and proportion of PCR laboratory results disseminated by NRL to HC using TRACnet PCR module

4.7.2 Minor Research Questions

- What is the impact of IT on Patients Laboratory Data management?
- To what extent are the results provided by TRACnet PCR laboratory system prompt, accurate and confidential?
- What are the challenges that TRACnet PCR system encounter in its two-way delivery of Patient Laboratory test results?
- Can TRACnet PCR system enable the transmission of other laboratory test results other than those of HIV/AIDS, Tuberculosis and Diabetes? And;
- What are the possible recommendations one would suggest to TRACnet PCR system developers and administrators to improve the dissemination and delivery of Patient laboratory test results?

These questions require examination of the following areas: Disseminated Laboratory test results quality, test result storage and use, user acceptability, PCR module management, and TRACnet technology, including scalability, sustainability, capacity building, and technology transfer to the laboratory personnel.

4.8 Research Methodology

Methodology is a way in which attempts to investigate and obtain knowledge about the social world. Burrell et al (1979). The study aims at following an applied research approach by utilizing the DeLone and McLean Model of Information Systems success which links to RQ's through models and theories to the study objectives illustrating the variables to be measured.

4.8.1 Methodology

- Identify HCs that receive DBS data by SMS and internet.
- Elaborate a questionnaire for both NRL and HC.
- Analyze the DBS data in TRACnet system
- Analyze the data corrected at HCs

4.9 Procedures and methods

The study on TRACnet PCR laboratory module is a cross-sectional survey and will include three data collection methods as outlined below:

4.9.1 Data Correction Instruments and Sources

4.9.2 Data correction approach

Three methodologies of data collection exist for case studies Y (2003), he suggests the use of multiple sources of data, create a case study database and maintaining a chain of evidence. In order to achieve the study objectives, the researcher intends to use multiple data sources.

4.9.3 Data correction tools

- **A structured questionnaire** was used to enable the researcher to collect the completed responses in a short period of time. The questionnaire included a combination of closed and open questions. The closed questions will present a series of answers where the respondents are to select one e.g. How many PCR samples does your HC refer to NRL every month? Open ended questions on the other hand are used to explore individual ideas / feelings / thoughts – elaboration on a concept etc.
- **End User interview** as a separate data collection tool with health program managers, Data managers, and health care providers will be conducted in English to assess the attributes of the current TRACnet PCR laboratory module at HC which offer the PMTCT program. The questionnaire will be directed towards end-users at NRL and health centers. Aspects such as system functionality, test results confidentiality, systems security and test results quality of the TRACnet PCR laboratory module and it's' management will be assessed.
- **Comparison of results** within TRACnet PCR laboratory module system and NRL laboratory logbooks by comparing the results of specimen at both places, the researcher was able to measure the quality of the data entered and data disseminated by the system.

A random sample was conducted on DBS samples referred to NRL on monthly basis. The sampling frame will include the monthly DBS test results disseminated using TRACnet PCR laboratory module from 1/03/2010 to 1/03/2011, A total of **9971** test results have been transmitted

to **417** health facilities. In order to have statistical significance at least **200** DBS samples referred to NRL from 15 health facility need to be analyzed.

$$n = \frac{Z^2 P(1-P)N}{d^2(N-1) + Z^2 P(1-P)}$$

Where: Z = 1.96; d = desired precision is 5 %; P= Proportion of accurate DBS results sent using TRACnet PCR module (50%); N= is the size of the population (15.371).

Given the internet access and phone coverage limitation, 15 health facilities were selected proportionately to DBS samples collected from five (5) provinces. Three (3) HC were chosen from each province and each selected HC was given a unique number.

4.10 Assumptions &Limitations

As with any cross-sectional study, findings from this study reflect a snapshot of the TRACnet PCR laboratory module and did not reflect the trends in data quality improvement over time.

The study will not be able to check the quality of all data collected in TRACnet PCR laboratory module system. Moreover an unforeseen selection bias may affect the data sampled for quality checks.

- **A data quality audit** will be carried out on total number of DBS test samples received at NRL using monthly reports to compare DBS test results within the TRACnet PCR laboratory module database with the primary data collection sources at the HC which will include patient registers, sample requisition form, DBS filter papers. The reports will be subjected to a random sample to assure unbiased representation of the findings. Therefore, test results from selected health facilities' tally sheets and registers for a defined period of time will be compared with what is reported into the TRACnet PCR laboratory module database.
- **Document review** will be conducted on current and historical project documents (Request for Proposal, proposal, quarterly and annual reports), previous assessments and annual national pediatric conferences on children infected and affected by HIV and AIDS concept papers and reports.

Table 6: The operationalization of the research variables

Dimension Minor research question	Dependent Variable	Independent Variable	Operationalization of the variable
1. What causes delays in sending EID laboratory results contrary to Maximum set results TAT?	**System Adoptability** -SMS: #of sites using (SMS, Internet and Telephone to receive patient results)	**Timely manner:** Results TAT to the HC	-Operational effectiveness of the system -Educational level, training of the system users (data managers) -Other factors such as reagent stock out.
2. Do health facilities receive results corresponding to the samples referred to NRL?	**System Performance** -Data Quality	**Quality results:** Results at the HC/NRL	System functionality, proper recording of patient results -Quality of DBS samples referred to NRL by HC
3. What is the cause of sending EID laboratory results to wrong telephone numbers?	**System Adoptability** -Data management skills: (Education level/on job trainings of data managers in that field) -Proper records of telephone SMS(SMS backup using results log books and the # of dedicated telephones for this activity both at the site/NRL)	**Data Use**: Proper recording of patient results in files lab log books	-Knowledge, skills and experience of system users, lack of dedicated telephone and personnel to that activity -Laboratory technicians staff turnover in Rwanda laboratory network.
4. Why are some EID laboratory results not transmitted by TRACnet EID laboratory module system to HC?	**System Performance** Functionality		-Tasks performed by system users at NRL -Policy on sending PCR results (first came first to be disseminated).
5. Patient results are received in form of SMS. How are they stored and backed up for future reference?	**System Adoptability** Results backup and storage at NRL	**Data Use**: Proper recording of patient results in files lab log books.	

4.11 Research Type

The research was to be conducted by using case study method to maximize the outcome within in the time allocated for the study. Yin (1994), defines a case study as an empirical inquiry that investigates a contemporary phenomenon within its real life context especially when the boundaries between phenomenon and context are not clearly evident. It focused on a particular aspect of the problem to the study which in this particular was the impact of information technology on patient laboratory data management case of: Rwanda's National Phone- and Internet-based reporting system TRACnet PCR laboratory module for children born on HIV+ patients. The researcher intends to use this type because of the nature of the study objectives and due to limited time scope of the study.

4.12 Research Classification and Reasoning

The study is guided by predominantly qualitative approach because it highlights the significance of looking at variables in their natural setting. According to Jacob (1988), comprehensive data is collected through open ended questions that provide direct quotations and the interviewer hence becomes a central and integral part of the investigation This differs from quantitative research which tries to collect data by impartial methods with the intention to obtain information about relations, comparisons and predictions with an attempt to remove the investigator from the investigation (Smith, 1983).

By using both qualitative and quantitative data, the researcher will be able to have a good overview of TRACnet system impact as per de D&M IS model. The data quality will be measured quantitatively by comparing results at NRL and at sites while user satisfaction will be measured with a standardized questionnaire.

4.13 Research Design and Strategy

The design of the research will be applied research since it is using the case study method that is based on modules and theories and applied to a single case study research strategy.

The data will be obtained from both primary and secondary sources. The primary data will be collected using a questionnaire. This data collection tool will be used to collect data from HC, NRL, TRACPlus, Voxiva staff involved in using TRACNet laboratory PCR module as well as PMTCT program. The secondary data will be collected from various sources already existing and these include;

- DBS quarterly and annual reports;
- NRL/HC laboratory sample and results logbooks;
- Annual national pediatric conference meeting reports;
- Statistical analysis of PCR results in TRACNet PCR laboratory module so far sent to HC and;
- National laboratory sample transportation assessments reports.

CHAPTER 5

DATA ANALYSIS, FINDINGS AND DISCUSSION

5.1 Introduction

Chapter five presents the analysis of data collected from the field and its main focus is data interpretation. The tables and diagrams were used for better understanding of the results. Further discussions on major findings were conducted as well.

5.2 Data Collection

The data collection process was extensive and in line with case study methodology. Various data sources and data collection instruments were used. This included both qualitative as well as quantitative data. A summary of data and instruments used to collect it is presented in table 7. Also it presents a list of all people and institutions contacted. NRL being the only referral laboratory that conducts the PCR tests, it was possible to contact the identified HC that refer their samples in order to obtain the following information:

Table 7: Data Collection

Information	Instrument	Institution	Data type
PCR results reporting at NRL	Secondary data- DBS PCR quarterly reports, Laboratory PCR results log books	NRL/ Biomol section	Qualitative
PCR results reception at Health Center	Secondary data- TRACnet .NRL PCR results log books,	NRL/ BioMol section	Qualitative
Demographic data /Study participants	Structured questionnaire	NRL Fifteen Health Centers	Quantitative
Reporting by Province	Structured questionnaire	Fifteen health Centers	Quantitative
PCR results reporting at NRL	Structured questionnaire	NRL	Quantitative
PCR results reception at Health Center	Structure questionnaire	Fifteen health Centers	Quantitative

Source: (Researcher - Primary and Secondary data)

The researchers aim was to collect a 100 percent sample if the situation permitted as all PCR samples are referred to NRL and results disseminated using TRACet system. This aim was achieved in both NRL and fifteen (15) HC that are among those that refer their PCR samples to NRL. The secondary data collection instruments were used to get PCR test samples referred to NRL and results available and also to fill the gaps that might have occurred while using the questionnaire

5.3 Data Analysis

Data analysis used both qualitative and quantitative strategies. Rwanda, National Phone and internet based reporting system (TRACnet PCR laboratory module) for children born on HIV+ patient's case study concentrated on the use of descriptive analysis techniques. The findings were presented in a variety of frequency tables, tables, pie charts and histograms to illustrate the research questions and the data is presented in subtitles which are; PCR sample reception and results dissemination to HC and PCR results reception at HC.

5.4 Refer of PCR samples at NRL.

PCR test is only performed country wide by NRL. Therefore all HC eligible to prescribe PCR will refer their samples to Kigali based NRL. The figure below shows the HCs and the number of samples referred to NRL between March 2010 to March 2011.

Table 8: PCR Samples Referred to NRL from HC

HC	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total
Muhima	82	25	23	37	14	27	13	21	6	7	20	0	**38**	**313**
Gikondo	17	12	7	16	13	29	9	21	17	11	11	8	**20**	**191**
Kimironko	20	9	9	19	7	26	8	9	20	11	36	10	**14**	**198**
Ruhengeri	16	6	12	20	17	5	13	14	5	15	17	8	**7**	**155**
Rwaza	0	2	0	0	1	0	0	0	0	0	1	2	**0**	**6**
Busogo	0	4	0	1	0	3	0	0	1	0	0	1	**2**	**12**
Kivumu	8	7	18	0	15	15	8	4	11	10	9	8	**5**	**118**
Kamonyi	4	0	6	8	2	8	10	7	5	16	2	4	**4**	**76**
Musambira	0	4	3	0	2	0	9	1	3	4	3	3	**6**	**38**
Nyagasambu	7	0	3	17	3	4	4	11	0	22	0	3	**0**	**74**
Rwamagana	0	9	2	4	18	7	9	0	11	8	6	3	**1**	**78**
Rwinkwavu	21	32	23	12	13	22	25	31	16	3	25	2	**6**	**231**
Rwankeri	4	0	0	7	0	9	6	0	0	3	4	3	**7**	**43**
Kora	6	0	0	4	2	5	3	3	2	6	2	2	**5**	**40**
Bigogwe	5	5	0	0	4	5	0	4	0	2	1	4	**4**	**34**
Total	**190**	**115**	**106**	**145**	**111**	**165**	**117**	**126**	**97**	**118**	**137**	**61**	**119**	**1607**

Source: (NRL March2010-March2011, laboratory PCR specimen and sample reception log book.)

Table 8 above shows that one thousand six hundred and seven (1607) PCR samples were referred to NRL from HC during the study period (Mar 2010-Mar 2011). Note that Muhima HC from Nyarugenge District Kigali urban had the highest number of PCR samples while Rwaza HC from Musanze District Northern Province has the least. Muhima being in Kigali and Rwaza in upcountry, it is believed that more HIV positive patients are located in urban hence more patients than Rwanza. The Demographic Health Study (DHS) 2012 indicated that the HIV preference is 3% country wide.

When the PCR results arrive at NRL, the are received at sample reception section and subjected criteria of sample acceptance or rejection to before transfer to their respective for processing. The table shows the number of PCR samples transferred to molecular biology section.

Table 9: PCR Samples Received in NRL Molecular Biology 2010-2011

HC	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total
Muhima	68	20	23	29	14	18	13	21	6	36	27	5	36	316
Gikondo	3	21	15	8	10	9	24	17	10	16	12	9	15	169
Kimironko	14	9	9	21	7	23	8	2	20	17	15	9	14	168
Ruhengeri	16	6	7	20	16	5	12	13	5	15	19	8	8	150
Rwaza	0	2	0	0	1	0	0	0	0	0	1	0	0	4
Busogo	0	6	0	0	0	1	8	1	5	0	2	1	2	26
Kivumu	21	13	18	4	3	22	8	4	11	9	19	8	6	146
Kamonyi	4	20	8	3	2	1	9	7	5	17	1	14	4	95
Musambira	0	4	3	0	2	0	6	1	1	4	4	2	1	28
Nyagasambu	0	0	3	17	3	4	4	10	0	0	1	0	0	42
Rwamagana	0	9	4	4	18	7	5	0	11	6	5	6	3	78
Rwinkwavu	20	32	17	12	0	22	25	31	19	3	25	2	4	212
Rwankeri	4	4	0	7	0	9	6	0	0	8	0	3	10	51
Kora	0	0	0	4	13	5	12	9	2	6	2	7	5	65
Bigogwe	0	8	4	12	4	5	4	8	8	2	1	4	4	64
Total	**130**	**122**	**94**	**129**	**93**	**109**	**119**	**93**	**84**	**136**	**109**	**76**	**108**	**1614**

Source: (NRL Molecular Biology March 2010-March 2011, PCR laboratory register book)

One thousand six hundred fourteen (1614) PCR samples were received in molecular lab section from NRL reception as indicated in table 9 above. You will note that the total number of PCR samples increased slightly by seven (7) samples which is approximately 1 %. In normal circumstances, the samples received in molecular biology should be less than those received at the main reception. Since the two systems are being used i.e. electronic and paper based, its possible that the data mangers could have made errors by counting the samples twice. The researcher observed that samples that come from DH that one of HC above is attached are counted differently at the reception while counted same in molecular lab section.

Table 10: PCR Results Disseminated by TRACnet laboratory module

HC	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total
Muhima	17	4	5	7	10	23	8	16	13	24	1	2	17	147
Gikondo	7	6	10	0	7	11	11	13	13	6	0	2	8	94
Kimironko	8	6	8	12	12	9	10	4	17	20	1	2	8	117
Ruhengeri	9	1	7	7	5	3	11	8	10	6	1	5	11	84
Rwaza	0	0	0	0	1	0	0	2	1	0	0	0	0	4
Busogo	0	4	4	1	2	4	4	1	2	0	3	0	4	29
Kivumu	2	0	5	6	12	2	3	0	7	2	2	0	0	41
Kamonyi	8	3	2	6	12	2	4	0	6	5	0	0	2	50
Musambira	2	2	3	0	4	1	5	0	3	4	0	1	1	26
Nyagasambu	3	1	12	8	4	0	11	2	4	0	0	0	2	47
Rwamagana	3	2	5	1	5	0	3	0	4	0	2	1	1	27
Rwinkwavu	11	20	3	1	12	19	44	12	15	4	0	0	0	141
Rwankeli	5	3	3	2	3	6	5	0	0	6	0	1	6	40
Kora	5	1	5	6	7	5	7	6	0	6	0	1	6	55
Bigogwe	3	5	0	6	6	2	5	6	1	1	0	0	5	40
Total	**83**	**58**	**72**	**63**	**102**	**87**	**131**	**70**	**96**	**84**	**10**	**15**	**71**	**942**

Source: (TRACnet PCR laboratory module accessed on 8th Aug 2012)

Table 10 shows the total number of PCR results disseminated by TRACnet PCR lab module in form of SMS. Note that 58 % of PCR results from molecular lab section were disseminated by TRACnet module and the rest by paper based system. Therefore the above confirms that the TRACnet PCR laboratory system confirms to system and information quality dimensions of D&M's information systems success model.

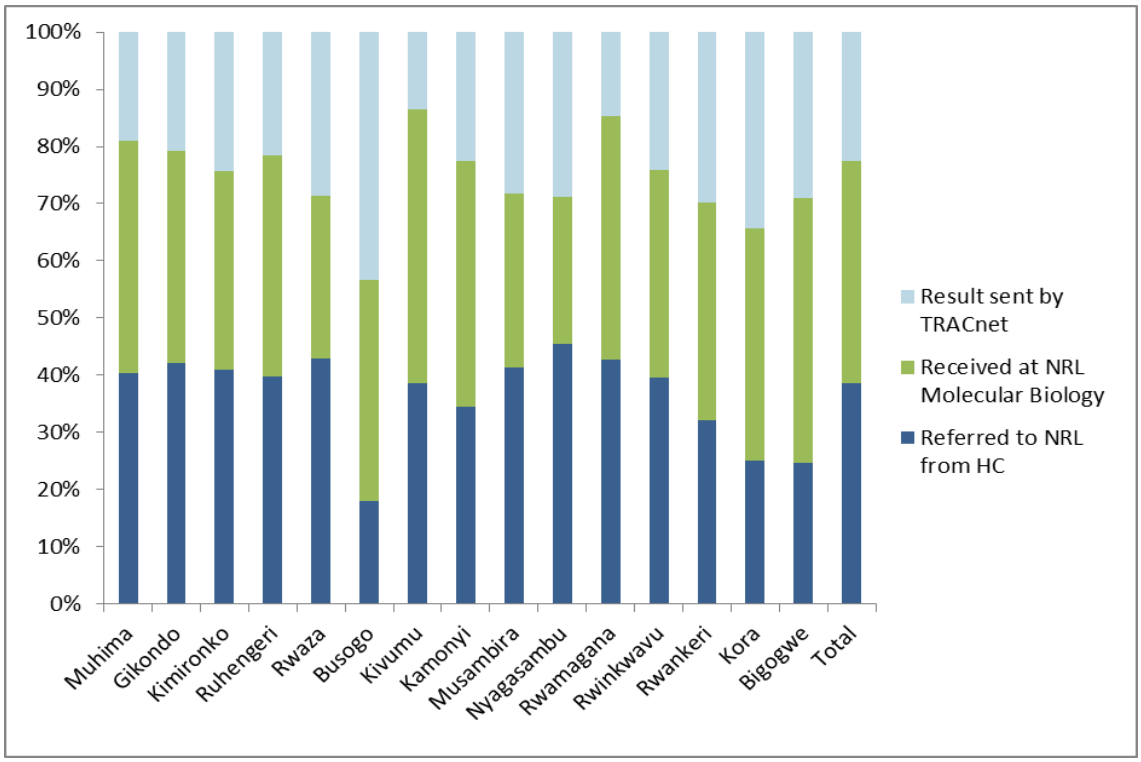
Table 11: A comparison of PCR samples received at NRL reception, molecular lab and results disseminated by TRACnet laboratory module.

HC	Total no. of PCR samples referred to NRL from HC	Total no. of PCR samples received in NRL molecular lab	Total no. of results sent by TRACnet inform of SMS
Muhima	313	316	147
Gikondo	191	169	94
Kimironko	198	168	117
Ruhengeri	155	150	84
Rwaza	6	4	4
Busogo	12	26	29
Kivumu	118	146	41
Kamonyi	76	95	50
Musambira	38	28	26
Nyagasambu	74	42	47
Rwamagana	78	78	27
Rwinkwavu	231	212	141
Rwankeri	43	51	40
Kora	40	65	55
Bigogwe	34	64	40
Total	1607	1614	942

Source: (Researcher-Secondary data compiled from NRL PCR specimen reception book, molecular biology PCR register book and TRACnet PCR laboratory model)

Table 11 shows a comparison between the PCR samples referred to NRL from fifteen HC, the NRL molecular biology and results sent using TRACnet. It is observed that the total number of PCR samples which were referred to NRL reception by; Busogo, Nyagasambu, Rwankeri, Kora and Bigogwe HC were different to that referred by NRL reception to molecular laboratory section. You will note that 942 results inform of SMS were disseminated From researcher's findings, one major cause was reporting out of reporting period due to; equipment service interruption, PCR reagent stock out, staff unavailability (those responsible to record PCR data) and frequent internet connection failure. The indifference in sample reception at different levels is further highlighted in figure 15 below.

Figure 15: PCR samples received at NRL reception, molecular laboratory and results transmitted by TRACnet module.

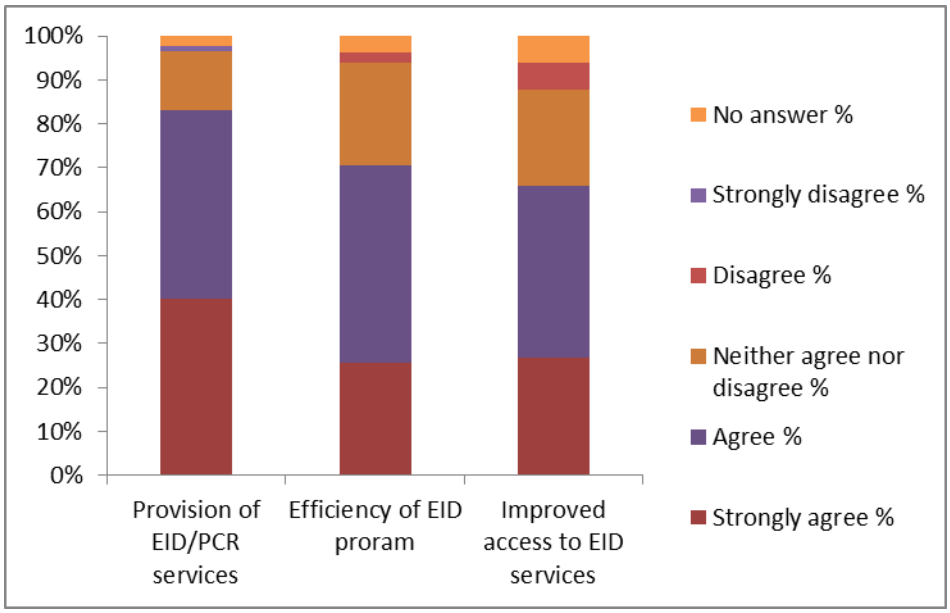


Source: (Researcher- Secondary data from the questionnaire on question B.5.3 see the Appendix A)

Table 15 above shows analysis of quantitative data from three sources many PCR results are not sent back to HC using the TRACnet PCR laboratory module. Some PCR samples seem to be lost both between referring to NRL,testing results and TRACnet. Rwaza from Musanze DH in Northern Province and Musambira HC from Kamonyi DH southern province received the highest number of SMS 4 and 26 respectively. Busogo HC in musanze DH Northern province received more SMS than the samples sent. The incorrerance number of samples and SMS disseminated that should act as a basis for system's end users adoptability is doubted. Therefore based on the above, the D&M's system quality and information quality is also violated.

5.4 PCR Results Dissemination at nrl. The introduction of TRACnet PCR laboratory module to disseminate PCR results did not eliminate the earlier paper based system. The NRL maintains both systems. However, the former is used to improve the EID program through reduced results PCR results TAT whiles the latter is used all the year around.

Figure 16: Impact of TRACnet PCR Laboratory Module on Management of PCR Results

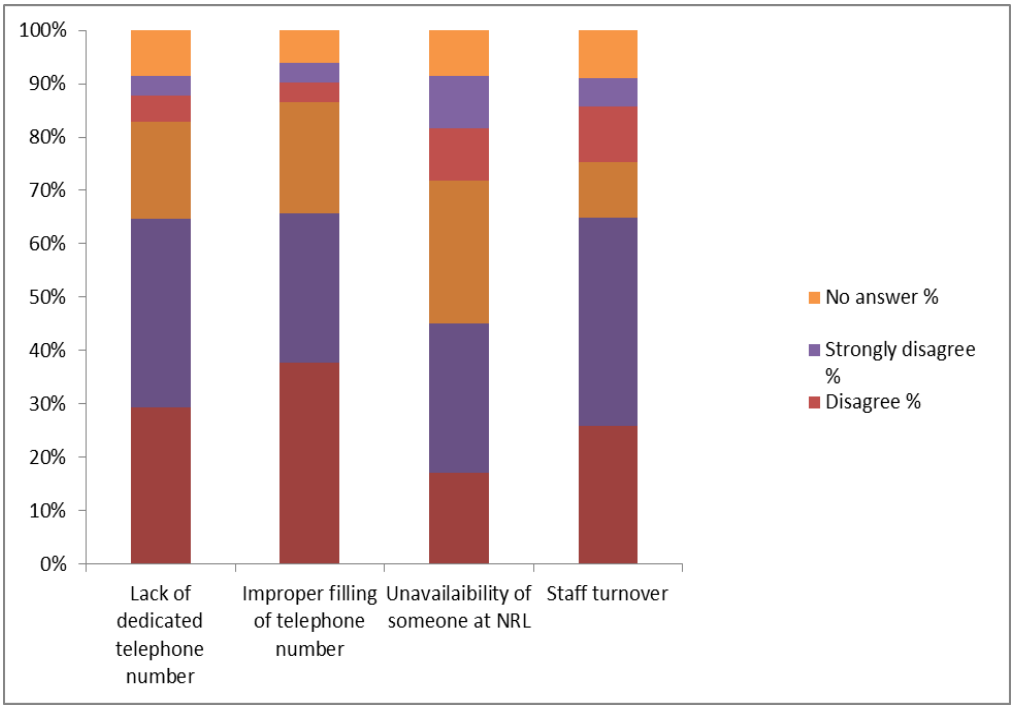


Source: Researcher-Primary data compiled from the questionnaire on question B.1.4 see the Appendix A)

Figure 16 above shows how TRACnet PCR laboratory module has impacted greatly on management and quality of PCR laboratory results in terms of prevision of PCR results in timely manner, efficiency of EID program and improved access to EID services for children born on HIV+ mothers. This was confirmed by majority of respondents choosing to agree. This confirms the confidence the users have in TRACnet as a result of quality results at both NRL and HC and also the reduced TAT which ultimately leads to the net befits functional of D&M's information system success.

However much users have confidence in the system, sending PCR results to wrong telephone numbers is one of the inefficiencies which was found with TRACnet PCR laboratory modules. This inefficiency needs to be addressed if the system was to work efficiently and effectively.

Figure 17: PCR results received on wrong telephone numbers:

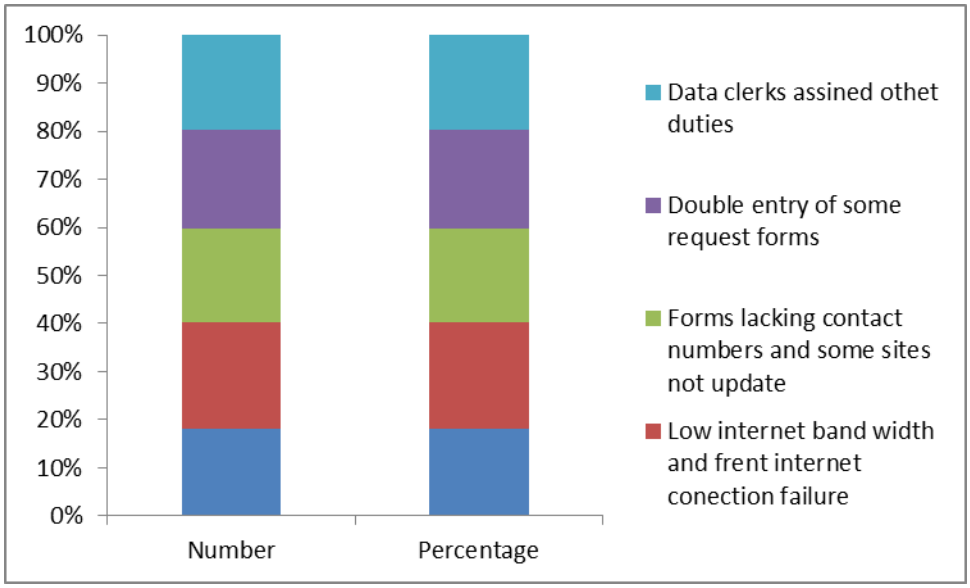


Source: (Researcher-Primary data compiled from the questionnaire on question B.1.7 see the Appendix A)

From figure 17 above, majority of the respondents chose to agree that some of PCR results are sent to wrong telephone numbers and among the reasons provided included; lack of mobile telephone and fulltime airtime dedicated to TRACnet data managers/system administrators at both NRL and HC, wrong telephone numbers which are improperly filled on patient sample requisition form, results sent before validated due to unavailable person to conduct this activity and laboratory staff turnover. By addressing the above raised issues, net befit dimension of D&M to both individuals and the institutions derived from user's intention to use the TRACnet PCR laboratory module, its daily use and user's satisfaction will be honored.

The existence of the inefficiencies that hinders TRACnet's effective and efficient performance is a result of the challenges that it faces in its daily management which latter affects quality of results produced at NRL and these challenges are found at different levels of the system usage such HC, NRL and the ISP.

Figure 18: Challenges which TRACnet PCR laboratory module is facing

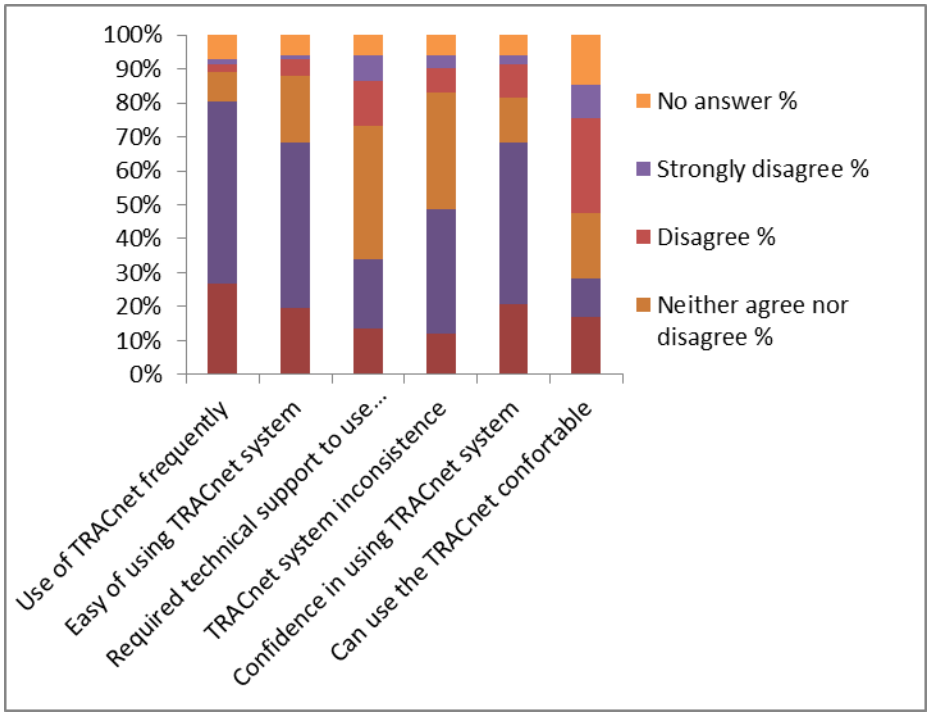


Source: (Researcher-Primary data compiled from the questionnaire on question B.5.4 see the AppendexA)

Figure 18 above shows some of the challenges TRACnet PCR laboratory module is facing in its two way delivery of laboratory patient results which include; improper feeling of patient sample requisition forms, slow internet band width and patient forms missing the phone numbers of the contact personnel. The majority of respondents chose yes that these challenges exist. The researchers' findings indicate that most of the challenges are based at the HC lever where the patients sample's proper collection prerequisites such as; well filled patient demographic data to the forms are met. All this is conduct at the HC during the patients sample collection. Based on D&M's Model of IS Success all the above involve System quality when it comes to internet, information quality for proper recording of telephone numbers. Therefore, the challenges facing the TRACnet system lead to poor system and information quality according to D&M's model.

Although the TRACnet's challenges lead to inefficiencies and ultimate non effective performance, the respondents to the researchers structure questionnaire appreciates the system and indicate their ability to use the system to complete some laboratory and program tasks as indicated in figure 19 below.

Figure 19: Users ability to complete tasks using TRACnet PCR laboratory module



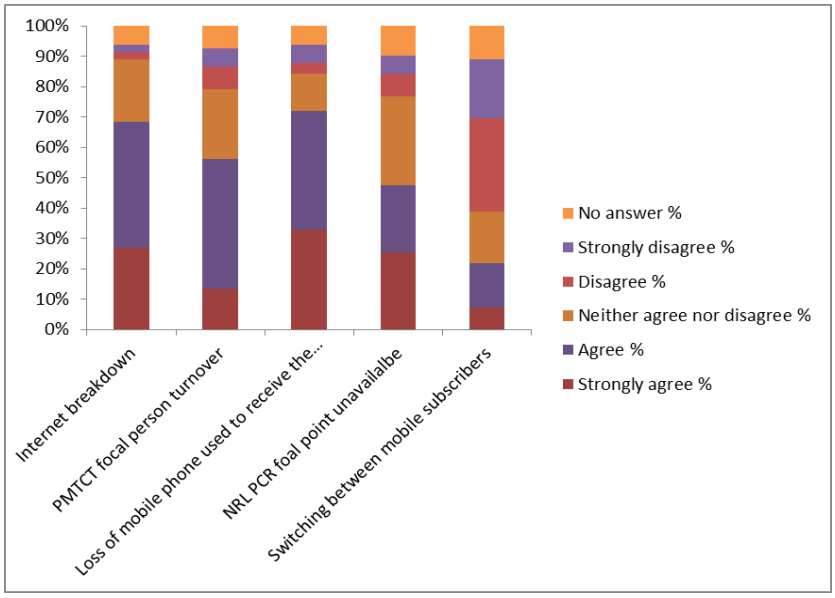
Source: (Researcher-Primary data compiled from the questionnaire on question B.7 see the AppendixA)

The researchers used the stacked type of bar chart. Figure 19 above shows the system end users ability to use the system in completion of some laboratory and EID program tasks to improve patient health care and quality of services. The majority of respondents chose agree that the system should be used frequently. They expressed strong confidence in using the system due to its easy and consistence way while providing the patients results. Inability to use the system without support of a technician, majority chose neither agree nor disagree and disagree on the no need to learn a lot of things before using the system. The strong confidence and systems consistence is a result of user satisfaction which is derived from the constant and daily use of TRACnets PCR

laboratory model and therefore the users appreciation is an indication that they intent to continuously use the system.

Majority of respondents on the inability to use the TRACnet PCR laboratory module without support of a technician was neither agrees nor disagrees in figure 21. Considering the challenges faced by the system, it is possible that some PCR results are not disseminated by the system as indicated in figure 20 below.

Figure 20: PCR results dissemination without TRACnet laboratory module



Source: (Researcher-Primary data from the questionnaire on question B.7.9 see Appendix A)

Figure 20 above shows why some PCR results are not sent using the system. The majority of respondents chose agree for; internet breakdown, PMTC focal person turn over and loss of mobile telephone that is used to receive PCR results in form SMS. Unavailability of focal PMTCT personnel at NRL, majority did not neither agree nor disagree while majority disagreed with changing the mobile subscriber from the current one (MTN).

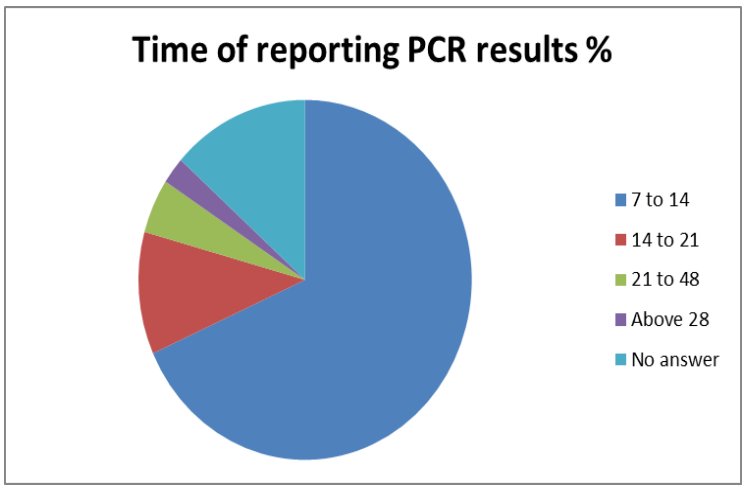
One of the challenges faced by TRACnet system as seen in figure 18 is the low internet bandwidth and frequent internet connection failure. TRACnet being a web and phone based systems cannot function effectively if there is no enough and constant internet connection besides telephone

network coverage. It is evident therefore that majority of respondents chose agree on internet breakdown as one of the reasons why some results are not sent using the system.

The other significant reason why PCR results are not sent using the TRACnet is the loss of the mobile telephone. In figure 17, majority of respondents chose agree to lack of dedicated mobile telephone as the cause to results sent to wrong telephone number. The study findings indicate that neither laboratory personnel at NRL nor HC uses office work dedicated mobile phone instead use their personal phone. The majority in figure above also confirms that losing the telephone causes stoppage of results dissemination. One can conclude that absence of enough internet and official dedicated telephone to use is affecting the quality of the TRACnet PCR laboratory module and the information it delivers and ultimately the net benefits to the system end users as well.

The quality of laboratory services depends on the shorter results TAT and the official PCR TAT is seven (7) days. Figure 21 below shows the timing/frequency of reporting and receiving PCR laboratory results inform of SMS.

Figure 21: Time of reporting and receiving PCR results



Source: (Researcher-Primary data from the questionnaire on question C.3.3 see Appendix A)

Figure 21 above shows that the normal frequency that the laboratory results in form of SMS are submitted into the system and received at HC. The majority of respondents chose yes between 7 to 14 days. Given the inconsistence and challenges such as slow internet and lack of mobile telephone to facilitate the effective performance of TRACnet PCR model, the users still indicated

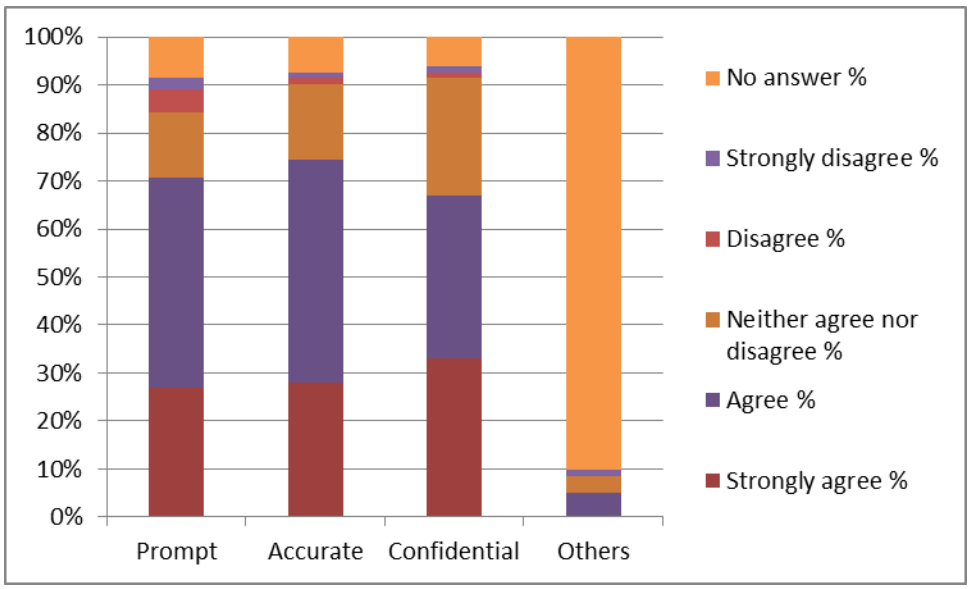
that the system performs to some levels of required standards. This means that if the already identified weaknesses are addressed, then the TRACnet PCR would effectively serve its purpose and obeys D&M's IS success model dimensions

5.5 PCR Results Reception at HC

5.5.1 EID efficiency, results TAT and improved access to EID program

The efficiency of EID program has been improved due to the introduction of TRACnet PCR laboratory model where the laboratory focal point receive PCR results inform of SMS. Respondents (62) were surveyed among them 48 agreed with 16 strongly agreeing that the EID program is efficient. This is highly confirmed with a strong relationship between receiving PCR results at the HC and efficiency of the program from p-value of 0.017. (Appendix)

Figure 22: Accuracy, promptness and confidentiality of PCR results



Source: (Researcher-Primary data from the questionnaire on question B.5.2 see Appendix A))

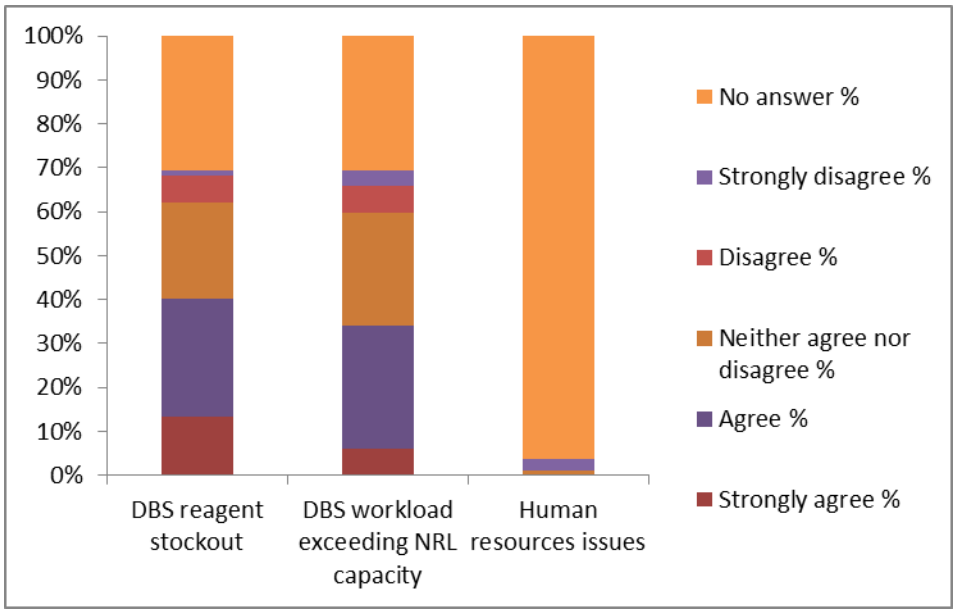
Figure 21 above, shows the extent at which the results provided by TRACnet PCR laboratory module are prompt, accurate and confidential. The majority of the respondents chose to agree that PCR results reported by the system comply with the above.

One of the objectives of introducing the system was to reduce PCR results TAT and in so doing the clinician is able to know the patients status in terms of positive or negative and also the EID

program management by enrolling the child for early treatment when it found that the patient is positive. The majority of respondents choosing agree is a strong signal that TRACnet PCR model has done a tremendous job on EID program management.

Much as there has been improved EID management, due to the systems promptness and accuracy, some delay still exist as seen in figure 23 below.

Figure 23: Delay in reception of PCR results



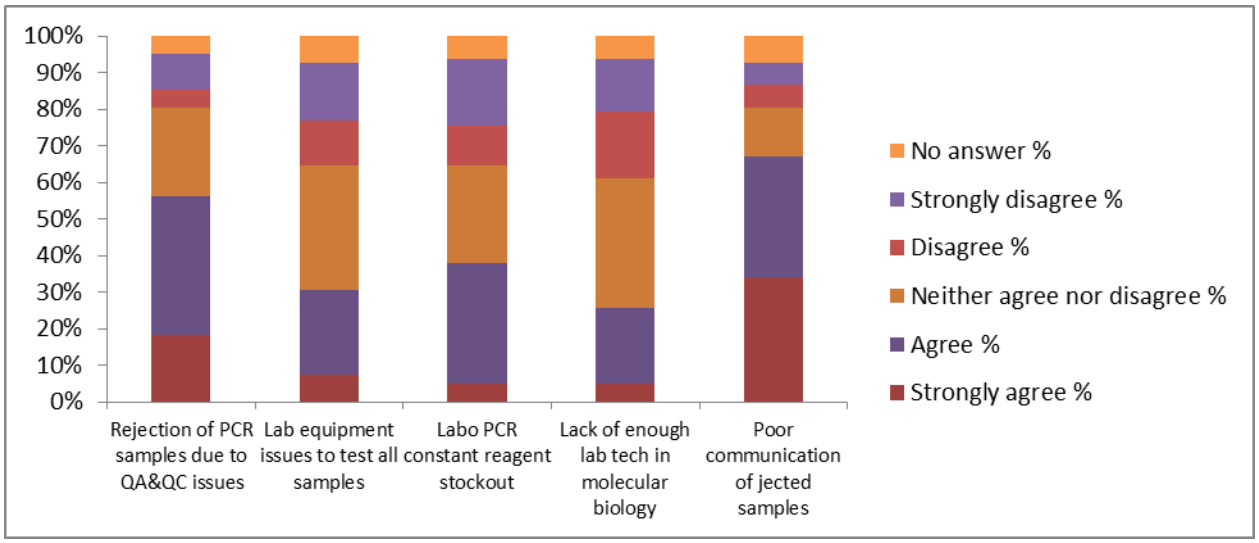
Source: (Researcher-Primary data from the questionnaire on question B.1.5 see Appendix A)

Figure 22 above shows a significant number of respondents who expressed their dissatisfaction about the continued existence of delay in receiving the PCR results that affects the efficiency of EID program and patients results TAT as well. PCR constant reagent stock out, workload exceeding NRL capacity and human resources issues were among the causes of delay. Majority of respondents chose agree to PCR reagent stock out, laboratory workload and human resources being some of the root cause of delay. Although the majority of respondents chose to agree that delay exists, the table 11 indicated that the comparison of numbers of PCR samples arriving at different levels differs. Looking at the causes critically, you will find that they contribute to the

delay as well. Therefore the researcher concludes that system is not part of the delay in receiving results at HC.

Having seen that samples get lost at some points of reception before testing is performed, the researcher believes this contributes significantly to the mismatch of number of samples received at NRL and PCR results received at HC as indicated in figure 24 below.

Figure 24: Mismatch of samples received at NRL and results disseminated to HC



Source: (Researcher-Primary data *from the questionnaire on question B.5.3 see Appendix A)*

Figure 23 above shows why some of the results provided to HC by TRACnet system do not correspond to the number of samples sent to NRL. Majority chose to agree that this happens due to QA/QC issues, constant PCR reagent stock out and poor communication of number of rejected samples. Laboratory equipment capacity to handle all PCR samples, insufficient laboratory biotechnologist, and majority chose neither agree nor disagree.

The NRL is the only laboratory in the country (Rwanda) that performs the specialized tests which among them is PCR test for children born on HIV+ parents. When samples referred to NRL for such particular testing are found to be inadequate, the laboratory SOP stipulates that such samples should be rejected. However, this should be effectively communicated to the HC where the samples came from. In this case PCR samples are also subjected to follow this laboratory best practice.

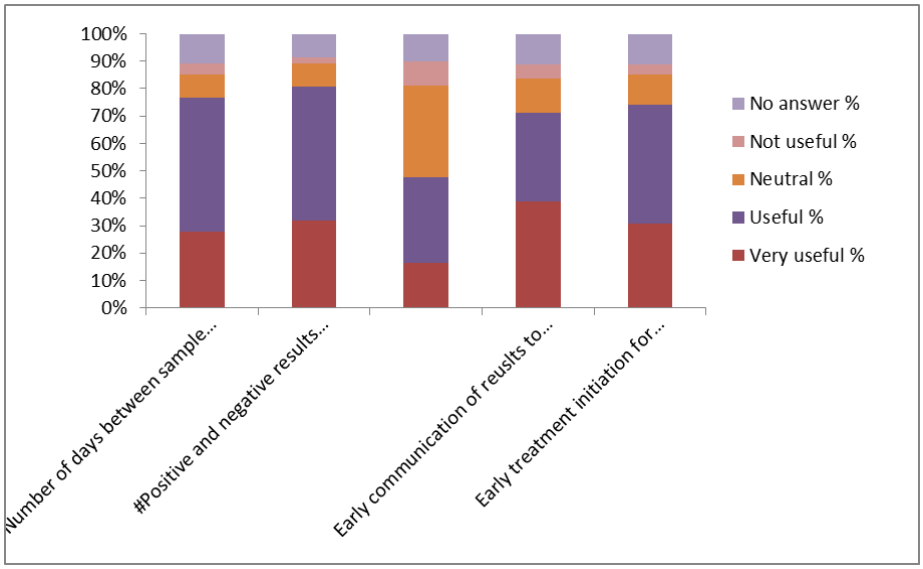
The researcher found out that sometimes, the work of testing PCR samples is interrupted due to; laboratory equipment servicing, staff unavailability to mention but a few.

One major factor identified that affects the PCR testing is the constant reagent stock out. This occurs periodically and it is thought that the cause might be the quantification and forecasting process of the laboratory consumables in addition to laboratory supply chain management process in the country.

It was noted that as the work of PCR testing is interrupted, the HC keeps sending the PCR samples to NRL which in turn creates a backlog of PCR samples and as soon as the testing resumes, the laboratory technicians do not apply the First in First out (FIFO) methodology.
Therefore, the researcher found these to be some of the reasons why there is mismatch of samples received at NRL and results disseminated to HC.

In conclusion, as long as such issues are not addressed, the TRACnet PCR laboratory module adoptability and its performance will be questioned and hence hindering the effort that would see other laboratory test incorporated in the system. The early communication of PCR results is useful not only to the mother of the child but also to other EID program aspects as indicated in figure 25 below.

Figure 25: Usefulness of PCR laboratory results disseminated by TRACnet system



Source: (Researcher-Primary data from the questionnaire on question C.5.1 see Appendix A)

Figure 24 above shows the usefulness of the PCR results disseminated inform of SMS by TRACnet laboratory module. This helps in provision of quality results which in turn improve health care for children born on HIV + parents. The majority responded that it is very useful for early communication to the HIV+ mother the status of her child. Majority also responded that it is useful knowing average number of days between: sample taking, reception and results availability at NRL, results reception at HC are known, timely identification of number of positive and negative results at every HC that refers PCR samples and follow up of early initiation of treatment for positive infants is useful. The rest were neutral.

Knowledge of average days a sample takes before the results are available is useful not only for the patient but also other stake holders of MoH involved. Such stake holders include Camerwa, Supply Chain Management System (SCMS) when it comes to HIV drug purchase and distribution

CHAPTER 6

CONCLUSION, RECOMMENDATIONS, AND FUTURE RESEARCH

6.1 Conclusion

In line with a case study approach a multitude of data was collected and analyzed. The study followed D&M Model of Information Systems Success model trying to answer the major research question namely; to what extent is the TRACnet PCR laboratory module providing stakeholders with quality laboratory test results that can optimally support the national laboratory network quality of PCR test results?

In chapter two, the TRACnet objectives were elaborated and it will now be evaluated in terms of the findings and analysis in chapter 5 to answer the major research question.

6.1.1 To examine the impact of IT on patient laboratory data management

The study on TRACnet PCR laboratory module found that the introduction of system impacted greatly on management of patient laboratory data. This was confirmed by the respondents who chose "agree" to the question on how they felt about using the system to manage PCR results.

The data management of PCR results has improved dramatically especially on reduced results TAT. (Figure 2) shows the shift in time taken to receive PCR results at HC from months to seconds. The beneficiaries of this impact include; children, mothers and EID program managers. The mother gets a confirmatory SMS that a child is either positive or negative. When the results are positive, the health care providers help the mother enroll the child for early treatment initiation.

6.1.2 To assess the promptness and confidentiality of PCR laboratory results as TRACnet's PCR laboratory module provides

The majority of respondents agreed that the results which are sent by TRACnet PCR laboratory module are accurate, prompt and confidential. However, from the findings, the researcher suggests that a further and thorough investigation be conducted to determine the real impact of using the system to manage patient results through timely provision of PCR results. The researcher found

that some samples get lost before they are tested and even the results disseminated by the system do not correspond to samples tested in molecular biology laboratory.

The study also found that the laboratory personnel use their personal telephone to receive the results in form of SMS. Therefore the confidentiality of the results is questionable due to lack of official dedicated telephone for PCR results reception.

6.1.3 To evaluate the challenges that TRACnet PCR laboratory module encounters in its two way delivery of patient laboratory test results

The reference and delivery of PCR samples and their results follow a two way approach i.e. electronic and paper based. The electronic has improved significantly the results TAT. However, during the study, the researcher found that both approaches face a number of challenges and majority of respondents agrees in (figure 18). According to this figure, improper feeling of patient sample requisition form plays a major role. Other challenges include; frequent internet failure, low internet connection as well as NRL data clerks' involvement in other activities were also identified.

However, the most and critical one is where patient forms miss the telephone numbers of contact personnel or the double entry of telephone numbers on one form that leads to clerk's confusion and failure to know the real contact personnel.

6.1.4 To conduct an analysis on whether TRACnet PCR laboratory can be used to transmit other laboratory test results other than those of HIV/AIDS

The majority of respondents expressed strong support of incorporating other laboratory test results besides PCR. The reason was that, these other tests their results take long to reach the patient hence reducing the quality of laboratory services.

6.1.5 To suggest possible recommendations on how TRACnet PCR system can be improved so as to sufficiently address the problem of the system inefficiencies

One of the objectives of conducting the study on TRACnet was to come up with suggestions on how the system can be improved. From the researcher findings, the TRACnet PCR laboratory module could perform effectively if the following are looked into;

- Recruitment of enough data clerks to deal with PCR results issues other than being involved on other activities that hinder them disseminate results in time.
- NRL and HC to buy the mobile telephone and monthly airtime that will officially be dedicated for PCR results reception and this should be kept at the health laboratory.
- Proper and effective communication of rejected samples due to QA/QC issues should be established.
- HC should identify focal point personnel whose real mobile telephone numbers must be communicated to NRL and these numbers should be the only one put on the patient sample requisition form.
- Finally, the NRL in collaboration with VOXIVA should organize human resources capacity building in terms of training all people involved in using TRACnet system and proper feeling of the sample requisition form.

From the above evaluation of TRACnet objectives, the researcher used his findings and analysis in chapter five to answer both major and minor research questions below;

6.1.6 Major Research Question

The major research question was about to know the extent the PCR laboratory module is providing stakeholders with quality laboratory PCR test results that can optimally support national laboratory network quality of laboratory results. Tied to this was question was the accurate number and proportion of PCR laboratory results disseminated by NRL to HC using the TRACnet laboratory module.

The accurate number of PCR laboratory results that were disseminated to HC using TRACnet is 942 results. This figure was obtained through logging into the TRACnet system and searcher

through fifteen (15) HC that have been receiving SMS from March 2010 through 31st March 2011. The proportionate is 58% of all samples received in molecular biology section.

6.1.7 Minor research questions

Answering the major research question, the researcher was able to get answers for minor questions as well. Following were questions;

- The impact of IT on patient's laboratory data management – The researcher findings indicated that there has been tremendous improvement for PCR results TAT.
- To what extent are the results provided by TRACnet PCR laboratory module system accuracy, prompt and confidential- The majority of respondents agreed that with the introduction of the system, the results are prompt and accurate. However, the confidentiality was questionable.
- What are the challenges that TRACnet PCR system encounters in its two-way delivery of patient laboratory test results- The researcher found a number of challenges the system encounters notably;
    - Frequent internet connection failure;
    - Low internet connection band width;
    - NRL data clerks involvement in other laboratory activities;
    - Improper feeling of patient sample requisition form and constant reagent stock out.
- Can TRACnet PCR system enable the transmission of other laboratory test results other than those of HIV/AIDS- From majority of respondents and system administrators, the researcher found that incorporation of other laboratory test results is needed and possible.
- What are possible recommendations that would be suggested to TRACnet PCR system developers and administrators to improve the dissemination of patient laboratory test results- The following recommendations emerged out of analysis
    - Recruitment of enough data clerks to deal with PCR results issues;
    - NRL and HC to buy the mobile telephone and monthly airtime and dedicated for PCR results reception;
    - Timely and effective communication of rejected samples to HC;

- HC to identify focal point personnel whose real mobile telephone numbers should be communicated to NRL;
- NRL in collaboration with VOXIVA to organize training to all people involved in using TRACnet system.

From the data analysis and findings, it is clear that the TRACnet system has improved the laboratory PCR results TAT. However, there exists a mismatch between the samples referred to NRL from HC and within NRL sections. Findings also indicate that results disseminated by the system do not correspond to the numbers of samples referred to the NRL. It is therefore clear that there is a significant close relationship between the number of PCR samples received at NRL and the results dissemination using the system.

Through the Government of Rwanda (GoR) vision 2020 especially on the use of ICT for social economic development several initiatives are being done for Rwandan population to have better health care services. Such initiatives include; provision of health insurance to all, provision of free ARVs to those infected with HIV to mention but a few and good progress for improving and creating a favorable health care climate in Rwanda has been registered.

6.2 Recommendations

Recommendations on TRACnet system need to be realistic and take into account the Rwanda's vision on ICT, policy and established infrastructure and the existing challenges.

In order to improve the TRACnet PCR laboratory module's performance to effectively and efficiently transmit PCR results while conforming to national results TAT, the researcher used his conceptual framework and D&M's Model of IS Success as a basis to map out the way forward and make recommendations. The researcher believes that this will ensure a better use of the system to improve the results TAT and better management of patient results.

6.2.1 TRACnet adoptability

For the MoH stake holders (NRL, HC and VOXIVA) to adopt the use of the system it's and quality of information must be satisfactory and appreciated. Since the TRACnet uses a two way approach, inefficiencies in one system affects the other as well.

6.2.2 System performance

The TRACnets' performance will determine the frequency at which the end users intend to use it, its use and the users' satisfaction. The researcher's findings indicate that during the study period TRACnet performance to deliver results stands at 58%.

6.2.3 Incorporation other laboratory test results.

The users' satisfaction derived from systems performance will encourage the systems administrators and laboratory policy makers to advocate for the inclusion of other laboratory test results and this will only be determined by the systems service quality. From majority of respondents, it is evident that incorporation of other laboratory test results is a necessity. However, the researcher's findings indicate that TRACnets service quality at the moment requires some improvements before incorporation of other laboratory test results. Based on the above findings, the researcher suggests recommendations to the stakeholders (MoH, NRL, HC and Voxiva) to improve on the current systems inefficiencies caused by the challenges earlier mentioned.

MoH

- Should help NRL address the issue properly feeling the form by synthetizing the HC administration
- Should facilitate and mobilize for funds to pay the additional required staff and endorse recruitment since these could not be fitting on the current organogram

NRL

- Should conduct a research on why samples get lost in order to avoid the mismatch of samples and results disseminated with the system
- NRl should improve on the existing data management procedure to avoid data inconsistence.
- A mobile telephone should be availed for staff at the sample reception with a monthly subscription to communicate the laboratory network.
- The in charge at the NRL sample reception should check and ensures that the mandatory fields on the sample requisition form are properly field before accepting the specimen.
- Internet connection should be maintained and upgraded to a speed that matches the workload on the TRACnet
- NRL through MoH should request heads of HC to identify the focal point to receive the results with his telephone numbers officially communicated to NRL.
- NRL should identify or recruit staff to PCR activity and this staff should not be assigned other duties as it interferes with work related to the system.
- NRL should communicate to the HC the number of rejected samples due to QA/QC issues.
- There should be period data audit done at both reception and molecular biology unit to verify whether the work on TRACnet is being properly done.
- NRL should introduce customer satisfaction assessment and suggestion boxes to understand the feeling the laboratory personnel from network have and the appreciation they have towards the quality of work done.

HC

- Administration to ensure that laboratory personnel understand the magnitude of having a well filed laboratory request form.
- Avail a mobile telephone number to receive results. This should not be the personnel's own phone number
- Should identify the focal personnel to receive the results with his telephone number communicated to NRL.
- Should ensure that all forms accompanying samples to NRL bear the mobile telephone number which will be used to send the results

Voxiva

- Should carry out training on the system usage since there have not been periodical trainings on the system**.**
- It needs to conduct a country wide study to obtain the perceived attitude of the systems usefulness.

6.3 Future Research

- The researcher observed disparity in sample numbers at various NRL sample reception points. For example, the number of samples received in molecular biology in which PCR test is conducted is greater or less than that received at central sample reception. Therefore further research should be conducted to ascertain the root causes of this mismatch. This study should include other laboratory tests other than PCR and should focus mainly on;
    - Mode and method of sample transportation
    - Sample tracking
    - Data management
    - Data quality
- Previous studies on the TRACnet focused on system performance and adoption by the end users and absorption of technology by HC. Findings suggested that the quality of data was questionable. Sabin et al. (2012) study on TRACnet which was conducted between 2004-2010 with objective of evaluating the national anti-retrieval treatment program found that TRACnet facilitated planning and expansion of treatment access. This study found that Rwanda is the only country in sub-Sahara Africa to have employed a cell and web based monitoring and evaluation system of a national ART program. The system has provided essential information to program planners to facilitate the broader expansion and decentralization. However, this study found that the system has one limitation of reported data being aggregated at HC which makes it difficult to describe specific patient-level demographic and clinical characteristics, outcomes, or events.
- Other IS studies such as HINARI, HER's, telemedicine, e-health, Indian healthcare projects etc... resulted in improved access to scientific information, improved data collection and processing which in turn enhanced the decision making in healthcare systems, production of accurate and up to date information that provided support to HIV/AIDS treatment and management. In our study, it was found out that PCR results dissemination was not adequate. However, most users seem to appreciate the system though the researcher has a feeling that the respondent's enthusiasm may also be just to please the researcher. Therefore a wider research covering all the HC using the system should be carried to obtain the country lever picture of the system.

- The design and installation of TRACnet PCR laboratory module as per November 2009 EID symposium recommendations discussed in chapter one includes improving coverage of EID/PCR services on planning, training of providers, EID/PCR laboratory sample transportation and use of IT to disseminate-reporting of laboratory results. As the current study is only a case study, it needs to be developed into a full-fledged research into a whole EID sector with specific emphasis on the impact of the implementation of the program for the children born on HIV+ mothers.
- The study concentrated on the use of IT and excluded other program specific areas such as planning training and sample transportation. The study should be extended to include these areas as well as taking into account the unique implementation of national web based laboratory system for patient results (TRACnet PCR module) and use of SMS technology for broadcasting other program messages.

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APPENDIX A

Study Title: Impact of IT on patient laboratory data management

Case: Rwanda's national phone- and internet-based reporting system (TRACnet) for children born on HIV+ patients

Please read this document carefully before you decide to participate in this survey.

This study is part of the requirement for the award of a Master of Business Administration (MBA) that I am reading with Maastricht School of Management (Netherlands) and the School of Banking & Finance (Kigali) with a Project Management option. It also serves to improve RBC/National Reference Laboratories' HIV/AIDS electronic reporting system, named TRACnet PCR laboratory module. The objective of this study is to collect data/information that will guide the researcher to write his thesis but also will help to improve the performance of the TRACnet PCR laboratory module system. You will be asked to provide information on the TRACnet PCR laboratory module system that you have been using to report/receive Early Infant Diagnosis (EID) PCR results data as part of the Prevention of Mother–to-Child Transmission (PMTCT) program. This includes your knowledge of the system, trainings received, and your perception of the usefulness of the system.

Please express your opinion honestly. Your responses will remain confidential and will not be shared with anyone. Your name won't be recorded or quoted in any report. You have the right to withdraw at anytime during the interview without consequences. We appreciate your assistance and co-operation in completing this questionnaire.

Your participation in this survey is completely voluntary. There is no penalty for not participating. You may also refuse to answer any of the questions we ask you.

The survey requires approximately 45 minutes of your time.

Do you feel comfortable participating in this survey? **Yes** ☐ **No** ☐

For more information on the study, please contact: The principal investigator of this study

John Baptist MUGISHA

Email:mugisha2000@yahoo.com,jbaptist.mugisha@rbc.gov.rw

Tel: 0788841787

SECTION A:

A.1 Facility profile

A.1.1 Province……..

A.1.2 District name……

A.1.3 Health Center name……..

A.1.4 Health Facility type/ Health Center (HC)/ /National Reference laboratory (NRL)

A.1.5 Does your facility have computers? **Yes** ☐ **No** ☐

A.1.8 If Yes how many are currently functional……..

A.1.8 Does your facility have Internet connectivity? **Yes** ☐ **No** ☐

A.2. General Information about end-user

A.2.1 Job Title

(a)Head of Health Center…**Yes** ☐ **No** ☐

(b)Laboratory manager **Yes** ☐ **No** ☐

(c) others

specify……

……

SECTION B: INDEPENDENT VARIABLE

B.1: System Adoptability

B.1.1 Are you reporting and receiving PCR laboratory results using TRACnet PCR laboratory model? (***Both NRL& HC respondents***)

Reporting NRL ☐ **Yes** ☐ **No**

Receiving HC ☐ **Yes** ☐ **No**

B.1.2 When did you start using TRACnet PCR laboratory model to send results (**NRL respondent**) SMS)**?**

.....

B.1.3 When did you start to receive PCR results in form of SMS? **(HC respondent**).....

B.1.4 This *part of the questionnaire is about how the TRACnet PCR laboratory module has impacted on management and quality of PCR results? . Please be frank and rate honestly its impact to the scale of 1 to 5. (Both NRL and HC respondents).A (1) means strongly agree, (2)*

Agree, a (3) Neither agree nor disagree, (4) means Disagree, and (5) Strongly disagree.(**Both NRL & HC respondents**)*.A (1) means greatly impacted, (2) means impacted, a (3) Neither impacted nor dissimpacted, (4) means there was no impact, and (5) greatly not impacted.*

B.1.4.1	Provision of EID/PCR results in a timely manner (reduced results TAT)?	1☐ 2☐ 3☐ 4☐ 5☐
B.1.4.2	Efficiency of EID program	1☐ 2☐ 3☐ 4☐ 5☐
B.1.4.3	Improved access to EID/PCR services	1☐ 2☐ 3☐ 4☐ 5☐
B.1.4.4	Other?	1☐ 2☐ 3☐ 4☐ 5☐

B.1.5 Delays in receiving PCR results Do you still experience delays in receiving EID PCR results contrary to Max set results TAT**? Yes** ☐ **No** ☐ (**HC respondents**)

B.1.6 If yes, what do you think is the cause?

B.1.6.1	DBS laboratory reagent stock out	1☐ 2☐ 3☐ 4☐ 5☐
B.1.6.2	DBS work load exceeding NRL capacity	1☐ 2☐ 3☐ 4☐ 5☐
B.1.6.3	Human resources issue	1☐ 2☐ 3☐ 4☐ 5☐
B.1.6.4	Other? Specify	1☐ 2☐ 3☐ 4☐ 5☐

B.1.*7* *This part of the questionnaire is about your opinion on why some of the PCR results in form of SMS are sent to wrong telephone numbers. Please be frank and rate honestly what you think could be the cause to the scale of 1 to 5. (Both NRL and HC respondents).A (1) means strongly agree, (2) Agree, a (3) Neither agree nor disagree, (4) means Disagree, and (5) Strongly disagree.*

B.1.7.1	Lack of dedicated telephone number for TRACnet PCR results at HC	1☐ 2☐ 3☐ 4☐ 5☐
B.1.7.2	Improper feeling of telephone numbers to the sample requisition form at HC	1☐ 2☐ 3☐ 4☐ 5☐
B.1.7.3	Unavailability of someone at NRL to validate the results before they are disseminated to HC	1☐ 2☐ 3☐ 4☐ 5☐
B.1.7.4	Staff turnover in the laboratory network (those responsible for EID program)	1☐ 2☐ 3☐ 4☐ 5☐

B.2 Data management skills:

B.2.1 Level of education

(a)Primary ☐

(b)Secondary ☐

(c)University ☐

B.2.2 Training on TRACnet PCR laboratory module **(**Training process and impact on end-users)

B.2.2.1 Have you been formally trained to use TRACnet PCR laboratory (**Both HC&NRL respondents**)? **Yes** ☐ **No** ☐

B.2.2.2 How many times have you been trained between March 2011 and March 2012?.....

B.2.3 How many days did it take in total (cumulative training days**)?**

......

B.2.4 who trained you (Check all that apply)

NRL ☐ Colleague ☐ Voxiva Inc ☐ Others ☐

B.2.7 Have you been provided with appropriate training materials that help you use the TRACnet PCR laboratory system? (**Both NRL& HC respondents**) **Yes** ☐ **No** ☐

B.2.8 If yes, in what format did you receive them? *Choose all that is appropriate*

A) Visual CDs

B) Power point presentations

C) Books

D) Audio materials

B.2.9 If no, what would you like as training material?

a).....b)

.....c)...

.....

d)……

B.3 Proper records of telephone SMS (Use of mobile telephone to receive PCR laboratory results), results backup and storage at NRL:

B.3.1: Does NRL/ HC have a PMTCT focal person? **Yes** ☐ **No** ☐ **(Both NRL &HC respondents)**

B.3.2: Has the focal person changed the job since **March 2011-March 2012**? **Yes** ☐ **No** ☐

B.3.3 If yes, was it communicated to NRL? (HC respondents.....

B.3.4: Does the focal person have a mobile telephone dedicated for PMTCT PCR results reception? **Yes** ☐ **No** ☐ **(Both NRL& HC respondents)**

B.3.5: How often does the focal person register PCR results in patient's file/log book? *Choose three that are appropriate* (**Both NRL&HC respondents)**

A) As soon as the results arrive by SMS ☐

B) When the telephone message option is full ☐

C) As soon as results are available from molecular biology department

D) No registration is conducted ☐

B.3.6: Does the focal point person back up the SMS results? **Yes** **No** ☐

B.3.7: If yes, how are SMS and PCR results backed up for future reference? *Choose all that is applicable* (**NRL**&**HC respondents**) ☐ ☐

A) Re-registering the SMS data into laboratory results log book and filling hard copy of results ☐

B) Using flash disks ☐

C) Using external hard disks

D) Backing them using the file server ☐

B.5 System Performance

B.5.1 Data quality: The management of the TRACnet PCR laboratory module system requires appropriate documentation to facilitate the proper use of the system. Is there any protocol for the TRACnet PCR laboratory results dissemination to end-users of the system?

Yes ☐ **No** ☐

If yes how is the protocol dispatched to end users**?**

.....

B.5.2 To what extent are the results provided by TRACnet PCR laboratory module prompt, accurate and confidential (**NRL &HC respondents**)?

B.5.2.1	Prompt	1 2 3 4 5
B.5.2.2	Accurate	1 2 3 4 5
B.5.2.3	Confidential	1 2 3 4 5
B.5.2.4	*Others (specify)*	1 2 3 4 5

B.5.3 This *part of the questionnaire is about your opinion on why some of the HC receive PCR results in for SMS that do not correspond to samples referred to NRL. The researcher is interested in knowing why this happens? Please be frank and rate honestly the usability of the system on a scale of 1to 5 .A (1) means strongly agree, (2) Agree, a (3) Neither agree nor disagree, (4) means Disagree, and (5) Strongly disagree.*

B.5.3.1	Rejection of some of the DBS samples due to QA&QA	1 2 3 4 5
B.5.3.2	Laboratory equipment capacity to handle all samples referred to NRL at the same time to obey 7 days TAT	1 2 3 4 5
B.5.3.3	Laboratory PCR reagent constant stock out	1 2
B.5.3.4	Lack of enough laboratory biotechnologists in molecular biology department to handle PCR activities	1 2 3 4 5
B.5.3.5	Poor communication to HC about the number of rejected PCR samples due to QA&QC	1 2 3 4 5

B.5.4 What are the challenges the TRACnet PCR laboratory module encounter in its two way delivery of patient laboratory results? (**Both NRL&HC respondents**)

B.5.3.1	Improper feeling of mandatory fields on laboratory request form	1 2 3 4 5
B.5.3.2	System slowness due to low internet band width or frequent internet connection failure.	1 2 3 4 5
B.5.3.3	Laboratory forms lacking contact mobile numbers and some sites not updated in the system	1 2 3 4 5
B.5.3.4	Double entry of some laboratory request forms	1 2 3 4 5
B.5.3.5	Data entry clerks having other responsibilities and no enough time for data entry resulting into piling of	1 2 3 4 5

	results entry and submission of SMS to sites	

B.6 Functionality:

B.6.1 Perceived confidence to use TRACnet PCR laboratory (PMTCT coordinator, Titulaire+ NRL)

This part of the questionnaire is about your perceived confidence in performing tasks related to the use of TRACnet PCR laboratory. High confidence indicates that you can perform the task, while low confidence means room for improvement or training. I'm interested in knowing how confident you feel in using TRACnet PCR laboratory. Please be frank and rate your confidence honestly. Rate your confidence for each situation with a number from the following scale or 1-5? (1 = not confident at all; 2=Not confident; 3=Neutral; 4=Confident; 5 = highly confident)

B.6.2	I can report program data on the system (NRL)	1 2 3 4 5
B.6.3	I can navigate on the web interface without help (**T**)	1 2 3 4 5
B.6.4	I can post a request for help or a message on the system (NRL)	1 2 3 4 5
B.6.5	I can access my health facility data on the system (T)	1 2 3 4 5
B.6.6	I can compute trend from bar charts on the TRACnet PCR laboratory system (NRL)	1 2 3 4 5
B.6.7	I can explain findings & their implications **(T)**	1 2 3 4 5
B.6.8	I can use TRACnet PCR laboratory data for identifying gaps and setting targets for my program (**T)**	1 2 3 4 5
B.6.9	I can use TRACnet PCR laboratory data to make various types of decisions **(T)**	1 2 3 4 5
B.7.0	I can export data from the TRACnet PCR laboratory t system to other formats (Excel, PDF, Text) for further analysis (NRL)	1 2 3 4 5

B.7: ***TRACnet PCR laboratory usefulness***

This part of the questionnaire is about your ability to complete some tasks on TRACnet PCR laboratory and the level of resources consumed in performing these tasks. The researcher is interested in knowing how usable is the TRACnet PCR laboratory system for you? Please be frank and rate honestly the usability of the system on a scale of 1 to 5. A (1) means you strongly agree, (2) means you agree, a (3) indicates that you neither agree nor disagree, (4) means you disagree, and (5) indicates that you strongly disagree.

B.7.1	I would like to use the TRACnet PCR laboratory system more frequently	*1* ☐ 2 ☐ 3 ☐ 4 ☐ ☐
B.7.2	The TRACnet PCR laboratory system is easy to use	*1* ☐ 2 ☐ 3 ☐ 4 ☐ ☐
B.7.3	I would not need the support of a technical person to be able to use TRACnet PCR laboratory system	*1* ☐ 2 ☐ 3 ☐ 4 ☐ ☐
B.7.4	There is no inconsistency in the system	*1* ☐ ☐ 3 ☐ 4 ☐ ☐
B.7.5	I feel very confident using the system	*1* ☐ ☐ 3 ☐ ☐ ☐
B.7.6	I do not need to learn a lot of things before I could get going with this system	*1* ☐ ☐ ☐ ☐ ☐

B.7.7 Does the TRACnet PCR laboratory system have a clear protocol for periodic application and database backups? **Yes** ☐ **No** ☐ es provide proof

B.7.8 Does the TRACnet PCR laboratory module system allow easy management (addition, removal, modification) of roles and permission? **Yes** ☐ **No** ☐

B.7.9 *This part of the questionnaire seeks to know why some PCR laboratory results are not disseminated to HC by TRACnet PCR laboratory module system .The researcher is interested in knowing the reasons behind that. Please be frank and rate honestly the reasons on a scale of 1 to 5 Your opinion on why (Both NRL&HC respondents).A (1) means strongly agree, (2) Agree, a (3) neither agree nor disagree, (4) means Disagree, and (5) Strongly disagree.*

B.7.9.1	Internet breakdown	1☐ 2 ☐ 3 ☐ 4 ☐ 5☐
B.7.9.2	PMTC focal person turnover	1☐ 2 ☐ 3 ☐ 4 ☐ 5☐
B.7.9.3	Loss of mobile phone that has been dedicated to the results reception	1☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

☐ ☐ ☐ ☐ ☐

B.7.9.4	Unavailability of focal personnel at NRL e.g. staff going to leave which leads to accumulation of PCR results	1 2 3 4 5
B.7.9.5	Switching from MTN subscriber to TIGO or AirTel	1 2 3 4 5

B.8.0 What are possible recommendations you would suggest to TRACnet PCR system developers and administrators to improve the dissemination and delivery of patient PCR laboratory results?

.....

.....

.....

.....

.....

B.9 Confidentiality

B.9.1 Does the TRACnet PCR laboratory system have audit functionality? **Yes** ☐ **No** ☐

B.9.2 Describe the role-based security used for the TRACnet PCR laboratory system (levels of role, permissions, management of these roles**)**

……

……

……

……

B.10 Incorporation of other laboratory test results

B.10.1 With your experience in using TRACnet PCR laboratory module to disseminate PCR results, do you think the system can be used to disseminate other laboratory test results?

Yes ☐ **No** ☐

B.10.2 If yes, what are the other laboratory test results would you like to have in TRACnet PCR laboratory module for proper management of the lab results (**Both NRL&HC respondents**)**?**

a) Viral Load

b) CD4

c) PCR

d) Others? **(Please specify)……**

SECTION C: DEPENDENT VARIABLE

C.1. Confidentiality

C.1.2 Does TRAC Plus or NRL sign a non-disclosure or confidentiality agreement of data with Voxiva? **Yes** ☐ **No** ☐

C.1.3 If No, state the reason why

.....

.....

C.2 Quality of laboratory PCR results at HC

C.2.1 Are all fields below on the PCR lab request form filled carefully at the time of PCR sample collection? *Baby id, gender, date of birth, facility, telephone contact (mobile), test type, the sample collection date (**HC respondents**)?* **Yes** ☐ **No** ☐

C.2.2 If no, what do you do in case some of the fields are missing on the patient PCR form (**NRL respondent)?**

a) Reject the sample? ☐

b) Call the PMTCT focal ☐on from the HC where the sample came from and collect then fields? ☐

c) Feel them at NRL? ☐

d) Other? (Please specify)……

……

C.2 .3 Do you record /document received SMS with PCR test results in the laboratory results register (**HC respondent**)? **Yes** ☐ **No** ☐

C.2.4 Do you verify if the received PCR results correspond to the submitted lab request form for the exposed infant (s)? (**HC respondents**) (*You are supposed to read twice and delete SMS once registered*).

Yes ☐ **No** ☐

C.2.5 Are there people dedicated for TRACnet PCR laboratory module results for below activities? (**NRL respondents**)

A) Data entry

B) Data verification

C) Results verification

D) Submission of results to sites?

C.3 Timely manner: PCR TAT to the HC

C.3.1	In your opinion what is the main purpose of TRACnet (***To choose only three****?)*	***Reducing TAT*** ☐ ***Better results*** ☐ ***Better follow up*** ☐ ***Decision making*** ☐ ***Prevent HIV transmission*** ☐ ***Facilitate PMTCT program management***
C.3.2	Would you please mention the TRACnet PCR laboratory reporting/dissemination (data transmission) mechanisms which you are most familiar with (***To choose only three***)	***system /Telephone (voice)*** ☐ ***Web/Interne*** ☐ ***PDA*** ☐ ***SMS*** ☐ ***Offline PC client*** ***Other specify*** ☐

C.3.3 Timing /frequency of reporting and receiving PCR laboratory results in form of SMS. What is the normal frequency that the laboratory results should be submitted into TRACnet PCR laboratory module and received at HC in form of SMS? To choose only three? **(NRL&HC respondents)**

A) Between 7 days to 14 days

B) Between 14 days to 21 days

C) Between 21 days to 28 days

D) Between 28 days to more……

C.3.4 Would you please describe the steps you take to prepare the results you want to report into TRACnet PCR laboratory module? (**NRL respondent)** (Data source, laboratory log books, quality control.

A) Results are marked on patient sample requisition form in molecular biology and photocopied ☐

B) The original form is kept in the envelop at reception and a copy is handed to TRACnet data managers ☐

C) Results are entered into the system ☐

D) The copy is kept in the stock ☐

C.3.5 Would you please describe the steps you take when you receive laboratory results by SMS (data source, laboratory log books, quality control)? **HC respondents**.

A) PMTCT/laboratory personnel receive an alert message that in ten minutes will receives PCR SMS results ☐

B) In ten minutes SMS arrives with PCR results which the results are recorded in the laboratory results log book ☐

C) The HC laboratory technician picks PCR results original copy from NRL reception ☐

D) The results on PCR original copy form NRL are compared to the SMS data recorded in the laboratory log book to check inconsistences**.** ☐

C.4 Security measures: Number of breaches into the system

C.4.1 The TRACnet operations and security include**;** hardware, communications links and software. Is routine maintenance conducted? **Yes** ☐ **No** ☐

C.4.2 If yes, how often is the maintenance conducted? **Monthly** ☐ **Quartely** ☐ **Annually** ☐ **Others? Specify**

……

……

……..

C.4.3 What security software are run on the severs that host TRACnet PCR lab module?

.....

.....

C.5 Data use: proper recording of PCR results in patient files/laboratory log books

This part of the questionnaire is about usefulness of PCR laboratory results in terms of providing quality results in order to improve health care for children born on HIV + parents. The researcher is interested in knowing how useful are these results? Please be frank and rate honestly the usefulness of the PCR laboratory results on a scale of 1 to 5. A (1) means very useful, (2) means useful, a (3) indicates that they are neither useful nor disagree, (4) means they are not useful, and (5) indicates that they are not useful at all.

C.5.1 How useful are the lab results reported into and available in TRACnet PCR laboratory module for your daily work to provide quality of care to your patients?

B.5.1.1	Average number of days between: sample taking, sample reception, at NRL, results availability at NRL, results reception at HC are known	*1 2 3 4 5* ☐ ☐ ☐ ☐ ☐
B.5.1.2	Number of positive and negative results at every HC that refers PCR specimens are known in a timely manner.	*1 2 3 4 5* ☐ ☐ ☐ ☐ ☐
B.5.1.3	Automated reports to TRACplus PMTCT department about the PCR results are generated.	*1 2 3 4 5* ☐ ☐ ☐ ☐ ☐
B.5.1.4	Early PCR result communication to the mother is done	*1 2 3 4 5* ☐ ☐ ☐ ☐ ☐
B.5.1.5	Follow up of early initiation of treatment for positive infants is done	*1 2 3 4 5* ☐ ☐ ☐ ☐ ☐
B.5.1.6	I do not need to learn a lot of things before I could get going with this system	*1 2 3 4 5* ☐ ☐ ☐ ☐ ☐

C.5.2 Would you recommend keeping PCR laboratory module in TRACnet? **Yes** ☐ **No** ☐

(Both NRL& HC respondents)

C.5.3 If Yes, Why?

.....

.....

.....

C.6: Use of data delivered by TRACnet PCR laboratory module for decision making (HC)

C.7.1 Have you ever used data from TRACnet PCR laboratory module for decision making about the PMTCT program? **Yes** ☐ **No** ☐

C.7.2 -If yes, check all types of decision made

☐ Daily management of HIV patients ☐ PMTCT program planning ☐ Reorganize clinical services provision at the health facility level ☐ Forecast program needs like staff, finance according to workload ☐

APPENDIX B

REPUBLIC OF RWANDA

RWANDA BIO-MEDICAL CENTRE
NATIONAL REFERENCE LABORATORY – NRL (IHDPC)
B.P 4668 KIGALI

Kigali on

Réf: ……/RBC-IHDPC/NRL DIVISION/2011.

RE :AUTHORIZATION

I would like to authorize Mr. **Mugisha John Baptist**, the current employee of the National Reference Laboratory (NRL), to correct data in your respective health centers.

Mr. MUGISHA is an employee of NRL since 2005 and heads the Unit of Information and Communications Technology (ICT) where he is involved in daily management of ICT activities including dissemination of early infant diagnostics laboratory results using TRACnet '***Polymerase Chain Reaction (PCR)'*** laboratory module.

As part of enhancing professional competency and imroving management of various resources within our ICT Unit, he is pursuing a Masters of Bussiness Administration (MBA)/project management and he is conducting a study on TRACnet PCR laboratory module.

The objective of this study is to collect data/information that will guide him to write his masters thesis but also will help to improve the performance of the TRACnet PCR laboratory module system.

It is in this context that I would like to request you to permit him in your health center and accord necessary facilities while conducting this study.

Please find attached the list of identifed health centers he inteds to visit.

Yours sincerly,

Dr Odette MUKABAYIRE
Head of RBC/IHDPC – NRL Division

P. O. Box 4668, Kigali – RWANDA. Tel.: (+250) 570414/ 570400/570399
Fax: (+250) 570413