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*Information system for reducing impact of non-communicable diseases
in the community of Gakenke district*

By

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Declaration

I, HIYADUHAYE Dieudonné hereby declare that this study entitled “*Information System for reducing the higher impact of Non-Communicable diseases in the community of Gakenke district*” is my proper work created during the period of the end of my master thesis study in the faculty of health informatics and it has not been submitted elsewhere for the award of any other kind of degree.

HIYADUHAYE Dieudonné

Signature

Dedication

To the Almighty God;

To my Brothers and Sisters;

To all members of my family;

To all my neighborhood;

I dedicate this work.

Acknowledgement

I am very grateful and also extend my lovely appreciation to the almighty God for his mercy, blessing and by whom this work has been made possible.

I acknowledge with gratitude the contributions of the individuals, lecturers, friends and families.

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May God Bless you all

ABSTRACT

Background: Non-Communicable diseases mortality rates remain high all over the world where the percentage of NCDs is over 63% of the total deaths. The shortage of skilled Healthcare Providers with the limitation of Community Health Workers and poor access to guidelines are the most critical problems for the whole population in order to access the service delivery regarding NCDs service. One strategy to support HCPs and Community Health Workers at point of care is to provide easy access to guidelines using computerized Non-Communicable Diseases Check-up Application System. Still, people who get the NCD service are only those who have been attacked and join the nearest healthcare facility to take medicines.

Objectives: The aims of our research are to investigate the healthcare system in order to improve the healthcare service delivery. And after, we propose to develop a new system of NCD check-up application system which will be used in urban/rural Rwanda to test the usability, to understand the perceived needs and attitudes among Community Health Workers to the use of a NCD check-up application system. This will strengthen the community of our country to fight against the NCDs refer to the population of district of Gakenke and increase the level of people education.

Methods: The participants around 319 were selected by using the observation method to get the required information where the cross-sectional approach is used. The study was conducted basing on the individual vital sign and check the current status. This data was collected in the community of Gakenke district with Nemba hospital catchment area of 232, 966 of the total population and it contains 13 sectors, in each sector where we predicted to investigate 25 persons data. After the period of data collection session, the data have been analyzed using a statistical software at the significant level of p value is $< 0, 05$ and the confidence interval of 95 %. We have used the descriptive data analysis and inferential statistics.

Results: The research for Check-up was conducted to carry out the assumption of data collected through descriptive statistics and inferential statistics. The prevalence calculated highlights the attitude and phenomenon of the participant's population. The exploration of the calculated variables helps us to estimate the proportion of the population outcomes. Here, the system will be integrated in the health care structure

and the user of the system will be trained for different activities that it will be able to carry out. The application system will be used periodically in order to give the entire support for the whole population about the NCDs protection and prevention.

Conclusions: The usage of NCD check-up application system will enhance the service delivery for the public health and change the people's attitude and behavior. It will increase the level of education in community and make them productive to the country. During the development and implementation of the system, the design and the implementation of a NCD check-up application system have to be contextualize in order to bring it in good functioning mode; the NCD check-up application system usage will increase the performance needed and it will be continuously monitored during the life processes. The HCPs and CHWs need to be actively consulted during all phases of designing and testing of a NCD check-up application system to enhance its uses.

Keywords: *Information system, Application system, Non-communicable diseases, Reducing Impact, Community, Descriptive statistic and inferential statistic*

LIST OF SYMBOLS AND ACRONYMS

%: Percentage

BMI: Body Mass Index

CHCS: Community Health Checkup System

CHWs: Community Health Workers

CMHS: College of Medicine and Health Sciences

H₀: Null hypothesis

H₁: Alternative hypothesis

HCPs: Healthcare Providers

HTML: Hypertext Markup Language

IRB: Institutional Review Board

IS: Information systems

LMICs: Low and Middle Income Countries

MySQL: My Structure Query Language

NCDs: Non-Communicable Diseases

No: Number

PHP: Hypertext Preprocessor

RAD: Rapid Application Development

RAM: Random Access Memory

RPGS: Research and Postgraduate Studies unit

SDLC: Software Development Life Cycle

SMS: Short Message Service

SPH: School of Public Health

UR: University of Rwanda

WAC: Weighted Associative Classifier

WHO: World Health Organization

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CHAPTER 1: GENERAL INTRODUCTION

Non-communicable diseases are the global burden and threat to major public health challenges for social and economic development worldwide (WHO, 2013).

The global burden for NCDs was 70% of all deaths worldwide in 2017 (WHO, 2017). And NCDs share modifiable risk factors, unhealthy diet, tobacco use, harmful alcohol and lack of physical inactivity (MH, 2017) which lead to being overweight and overweight, raising blood pressure, cholesterol, and finally recent diseases (WHO, 2017).

The NCD percentage of 71% of all deaths was 57 million. The prevalence of deaths including those aged between 30 and 70 years was 15 million from the NCD (World Health Organization, 2018). The burden is highest within low- and middle-income countries, where the percentage of deaths occurred was 85% and 78% of all deaths from the NCD in 2016 (World Health Organization, 2018). Currently, the non-communicable diseases are not well monitored in our country because most cases are found in health care facilities as emergency cases of patient who joined the service when they are carried to health facilities by ambulances or by their home neighbors, sometime they are hospitalized these cases because of their status which cannot be managed at home. Once the health providers who follow the clinical diagnosis of these patients are found that their life status are well improved, they take decision of returning them back to their community and be followed by the community health workers where the patients have to respect the appointment they got from health providers.

This research will lead us to the data collection in order to know how the NCDs are affected by people in healthcare facility and community. This will facilitate to generate an alternative solution of developing a new reliable system. The developed system will be strengthening to mitigate different barriers for non-communicable diseases and generate the high level of accessibility of the service in the implementation of the project (Marquez and Farrington, 2013). This research aim to develop a new system that will be working together internal the project to smoothly direct the NCDs service in our community and it will highlight different level of privileges where every healthcare provider has his/her assigned tasks for his/her daily activities (Kusek and

Rist, 2004). This will make each healthcare provider to be very happy by facilitating his/her job.

1.1 Problem statement of the study

This research aims to explore and investigate the structure of healthcare facilities regarding the NCDs service and remove the barriers which prevent the population to access the service. These barriers include: the cost of the service, time of waiting and the quality of the service delivery. Most people can ask why they may use the system in check-up for NCDs. The answer is that the current system structure does not produce a desired solution. Only healthcare providers can cover the whole community of the catchment area and it consume much time. However, when we use the system, the service will be improved and the way of accessing people anywhere they are it will become easy through the community health workers channel. This protocol will improve the way things are done today by using the technology to speed up the processes.

1.2 Specific objectives

The quantitative research proposal for this research has the following specific objectives:

- To provide easy access for NCD prevalence's;
- To decrease the prevalence rate of the deaths of NCDs;
- To promote the usability of the systems and identify the people who have been attacked with NCDs in community;
- To increase the level of awareness and attitude change in the community regarding the non-communicable diseases (NCDs).

1.3 Research questions

How can NCDs service use the information system to facilitate the usage of the service in the community?

1.4 Hypothesis

H1: There is system which could be used to facilitate the usage of the NCDs checkup service in the community.

1.5 Significance (i.e.: rationale) of the study

The calculated prevalence shows that within this study, we have gotten the abnormal ranges of 54.9% for blood pressure, 12.5% for blood glucose and 28.5% for body mass index (BMI). Both female and male had the similarity of equal chance to get blood pressure where 85 participants with high blood pressure and 4 participants with low blood pressure were males and 83 participants with high blood pressure and 3 participants with low blood pressure were females; for the blood glucose we found that women have shown a higher chance for diabetes attacks where 27 had high blood glucose and 7 had low blood glucose; men have shown a lower chance of getting diabetes attacks where 5 had high blood glucose and 1 had low blood glucose. The calculated P-value using t-Test with one sample test the result equal to 0,000, it means that the p-value is very high significant to the level of less than 0,001 ($<0,001$) for each case. For these cases, the null hypothesis (H0) will be rejected and declared it to be false whilst the alternative hypothesis (H1) is accepted and declare it to be true. The comparison between the current system which is manual and it cannot enable the accessibility of the information anytime/anywhere the healthcare providers want to use it. With the new one you can simply use your identifier to get all information of anybody and check that he/she is in normal range or abnormal for Non-Communicable Diseases. The system will help people to increase the level of NCDs education and understand the ways of preventing them against NCDs attacks by Harmful use of Alcohol, Physical inactivity, Salt/sodium intake, Tobacco use, Raised blood Pressure, sugar and obesity. These kinds of diseases can be prevented by reducing the above key risk factors. As change, in our community we have Community Health Workers (CHWs) who can help their neighborhoods to get understand the general benefits of limiting or preventing the NCDs. Once the CHWs are well trained for manual and regulation with limitation, they can overcome the problem of shortage healthcare providers that we have in our country. Due to scalable nature of web based system, it could be expanded by including some functions that could calculate the ranges of each

category of each type of diseases. Today, the CHWs do consultations, give medicines, and take lab tests for the mothers and their children through the community level. When the country leaders give them the opportunities for this community side, it can bring desired goals.

1.6 Limitation

The limitations of this study were that during the research session the working environment has encountered challenges, the first is the shortage of employees, where most health facilities have limited number of employees who are requested to fulfill all the duties and responsibilities, sometime they were not able to provide all other services delivered in the community. The second is the lack of trained staffs to provide the NCDs service delivery to the public health. The third which have been very crucial in our investigation the financial funds were insufficient to carry out the desired goals.

1.7 Strength for the study

With the limitation above, our country leaders have increased their efforts to elaborate the knowledge in healthcare sector through education and increase the number of employees can deliver the good service to the population. As the funds were insufficient, we request for the additional support to the government in order to carry out the desired goals which should improve the life of the population.

1.8 Subdivision of the research project

This work will be subdivided into seven chapters:

Chapter one will be the introduction. It will contain the definition of the key terms, the background of the study, the problem statement, the objectives, the research questions and the significance of the study.

Chapter two will be the literature review. It will contain different readings in relation to the research subject.

Chapter three will be the methodology. It will contain the study area, the study design, the study population, the study sample and the sample size, the sampling strategy, the data collection methods and procedures, data analysis techniques/method and the procedures, limitations of the study and the ethical considerations.

Chapter Four will include the results of the study.

Chapter Five will include the software that will be used.

Chapter six will include the discussion of the study.

Chapter seven will include conclusion, recommendation and appendix of the study.

CHAPTER 2: LITERATURE REVIEW

The literature review gives the reader the picture gotten from different writings and shows them what others have done in their previous research activities. Refers to our case, we explored the information which are used to monitor and control the Non-Communicable Diseases (NCDs).

The following table shows the current progress monitor report of 2017 compared with non-communicable disease country profile of 2018. We have explained the example of our country (Rwanda) retrieved to the global health report where the total population in the survey were 11 630 000 (WHO, 2017) and 11 918 000 (World Health Organization, 2018). The total number of NCDs deaths is around 31 000 which are equal to the percentage of 45% of all deaths caused by NCDs in 2017 while the total number of NCDs deaths is around 29 100 which are equal to the percentage of 44% of all deaths caused by NCDs in 2018 (World Health Organization, 2018). The total population died and the age are between 30 and 70 years old, the percentage is equal to 20% (WHO, 2017) and 18% (World Health Organization, 2018). As it is shown in the table below, most country which is developed have the high percentage of deaths of NCDs. Once a country is developing the economic through the way of increasing their incomes, it develops also the high risk of getting harm for NCDs. For the case of our country, the percentage of risks for prematurity deaths and the total deaths for NCDs was decreased.

The following table is retrieved into the reports as the sample that shows the current statuses for example of each country shown:

Country	Year of publication	The country population	NCD death rate	Total number of deaths in NCD	Risk of premature death for NCD
Rwanda	2018	11,918,000	44%	29 100	18%
Rwanda	2017	11,630,000	45%	31 000	20%

Table 1: Table of current progress monitor report

Source: Non-communicable diseases reports (WHO, 2017)(World Health Organization, 2018)

2.1 NCD risk factors

As they said above term, defined like any kind of things or activities which can contribute to the non-communicable. Marquez and Farrington have talked about the smokers and alcohol abuse that they are the most developing a higher body mass index (BMI), injuries, and hypertension diseases (Marquez and Farrington, 2013). The common risk factors are cited as the following: the tobacco use, the alcohol abuse, the physical inactivity and the unhealthy diet.

i) Nutrition

Refers to the document of Abrahams and Marquez, they have talk about nutrition transition in the countries which are in low and middle income in Africa (Abrahams, Mchiza and Steyn, 2011). When we talk about the nutrition, most people understand the daily meal they take to save and protect or to build their bodies. The meal must have some of the following characteristics: contains protein, calorie, and lipid and so on. People of these countries are still facing the problem of stunting and underweight depending on their stage of the ages, there is a low number of prevalence of women who are overweight and obesity (Marquez and Farrington, 2013).

ii) Alcohol

According to Anderson, Chisholm and Fuhr the alcohol is substance consumed in many drinks which can harm the human being. Most countries have taken measures to the number of consumers where the leader set some protocol to increase the cost for them and make lesser easy available. (Anderson, Chisholm and Fuhr, 2009)

iii) Tobacco

The most people with tobacco consumption have developed the non-communicable diseases. Some of these diseases are respiratory diseases, cardiovascular diseases, cancers and diabetes. The enumerated NCDs are developed through the tobacco, alcohol, malnourished, and physical inactivity risk factors (WHO, 2017). The countries in low and middle incomes have applied the high cost on tobacco taxes in order to decrease the number of usage. And it has proven that the people at high risk are the

most consumer of tobacco, these are include the young and poor people who are in the age of productivity (Ii, 2010)

iv) The physical inactivity

We can define it as the people who are unable to practice different activities using their body. According to the World Health Organization (WHO) (Ogunbanjo, 2016), many country lost their financial to support the number of disabilities. This risk factor is one of the major NCDs like coronary heart disease, diabetes, colon cancer and breast cancer. This is the among four (4) risk factors known in common like smoking, an unhealthy diet, physical inactivity, and alcohol abuse (Fornias *et al.*, 2015).

v) The unhealthy diet

According to Ridder *et al.*, they have defined a healthy diet as the diet which can be consumed as some kinds of foods and brings to the beneficially individual the good health (Ridder *et al.*, 2017). For the unhealthy diet the food intake that lead the body to harmful effects. Most country with people consumed the food at the high quantity, it seemed that they were the best nourished all over the world and have the low prevalence rate morbidity and mortality (James *et al.*, 2001). Even those who took the unexpected food in abundant, it has led them to the unhealthy diet.

2.2 Health information system

Refers to the term of health information system everyone understand the system which can be used to accomplish some tasks like to collect data, data compilation, data analysis and data dissemination (Lemay, 2010). These systems are used in health sector and other sectors to improve the quality of service and meet with the timeline. The data collected will contribute in transformation of raw data into information and help decision making (Karuri *et al.*, 2014). In the health structure, we use health information system as a tool of monitoring and evaluation in data usage (Karuri *et al.*, 2014). The developed systems have been developed by incorporating some data mining technics or algorithms.

2.2.1 Data mining algorithm for diagnosis the non-communicable diseases

Data mining is a way transforming a big data into useful information. It can be defined as a process of analyzing the big data for the decision making and it may lead the researchers to proceed different steps that oriented them to the knowledge presentation and dissemination (PPG Dinesh Asanka And, 2017). By implementing the data mining processes, we embedded many algorithms to get the desired solutions. Some of these algorithms are: Association algorithm, clustering algorithm, decision tree algorithm, and so on. For our case, let discuss a little bit on clustering and decision tree algorithm which take apart of the system development

a) Clustering algorithm

According to Razan Paul, Abu Sayed and Md. Latiful Hoque have used K-means and K-mode to predict the likelihood of diseases (Patil and Kumaraswamy, 2009). They have developed the algorithm which were used both continues and discrete data. Their research had shown that combining both algorithm and background knowledge had produce the excellent results (Patil and Kumaraswamy, 2009). However, the clustering algorithm is used in data mining to predict the diabetes and heart attacks for human being. And it will return reliable and consistent results.

b) Decision tree algorithm

Asma A. AlJarullah has used the decision tree algorithm to predict the developing diabetes using Pima Indians data set (Iyer, Jeyalatha and Sumbaly, 2015). She had investigated a number of 724 females with a number of six attributes which are patient pregnant, plasma-glucose, diastolic BP, BMI, Diabetes pedigree function (DPF) and Age (Santillán-Doherty *et al.*, 2002). And the Weka software had been used to construct the decision tree (Kaur and Chhabra, 2014). Their research has two phases which were pre-processing at the first stage and the decision tree construction at the second stage (Abdul, Rasool and Premchand, 2011). They found the accuracy of decision tree model were 78.177% (Asanka, 2017).

By Aswathy Wilson, Jismi Simon, Liya Thomas and Soniya Joseph have been using data mining algorithms to predict the chance of getting heart diseases. They had been

using K-means clustering with decision tree, WAC (Weighted Associative Classifier) with apriori algorithm and Naïve Bayes (Iyer, Jeyalatha and Sumbaly, 2015). They have used different attributes for their research to predict the heart attack. The attributes used were age, sex, blood pressure and blood sugar. The WAC was used to classify the data set and the apriori algorithm was used to find out the frequent item set. The Naïve Bayes rule was used to create the model with predictive capabilities (Abdul, Rasool and Premchand, 2011). The decision tree algorithm was used to make a decision. The classification of these algorithms in this was shown that the K-means clustering with decision tree offers the high accuracy of 83.24% and Naïve Bayes 81% (Iyer, Jeyalatha and Sumbaly, 2015). The codes below explain the example of decision tree implementation in use.

Example for decision tree:

Function hypertension Range (value)

```

{ Var dis= document.getElementById ("diastolic").value;
  Var sys= document.getElementById ("systolic").value;
  If (dis=="")
    {Dis=0 ;}
  If (sys=="")
    {Sys=0 ;}
  If ((sys >= 140) && (dis >= 80))
    {document.getElementById ("hypertension_status").value="
      You have abnormal range high blood pressure " ;}
  Else if (((sys >= 90) && (sys <= 139)) && ((dis >= 60) && (dis <= 79)))
    {document.getElementById ("hypertension_status").value="You are in
      the normal range";}
  Else if ((sys <= 89) && (dis <= 59))
    {document.getElementById ("hypotension_status").
      Value="You have abnormal range low blood pressure";}
  Else {document.getElementById ("hypertension_status").value
    ="Mismatch";
    //alert ("Mismatch") ;}
}

```

2.3 SOFTWARE DEVELOPMENT LIFE CYCLE

According to Boehm, a software development methodology is a way of managing a software development project. The software development life cycle involves in the different phases of data collection and specifications to produce the corresponding codes to generate the desired system (Boehm, 1983). As Burbach said, the spiral and waterfall model are somehow the same, because they shared most key aspects (Burbach, 1998). Let us describe a little bit, the examples of the common methodologies are used today:

2.3.1 Waterfall methodology

It is the most fundamental of different model which takes the precedence order of the activities. From the start to the end of this model, the processes of activities are followed one each other mean that are sequentially. Its main activities start with the requirement analysis and definition, followed by system and software design, implementation, integration, and end by operation and maintenance of the system. (Futcher, 2007) (Royce, 1970)

The following figure describes the waterfall model phases:

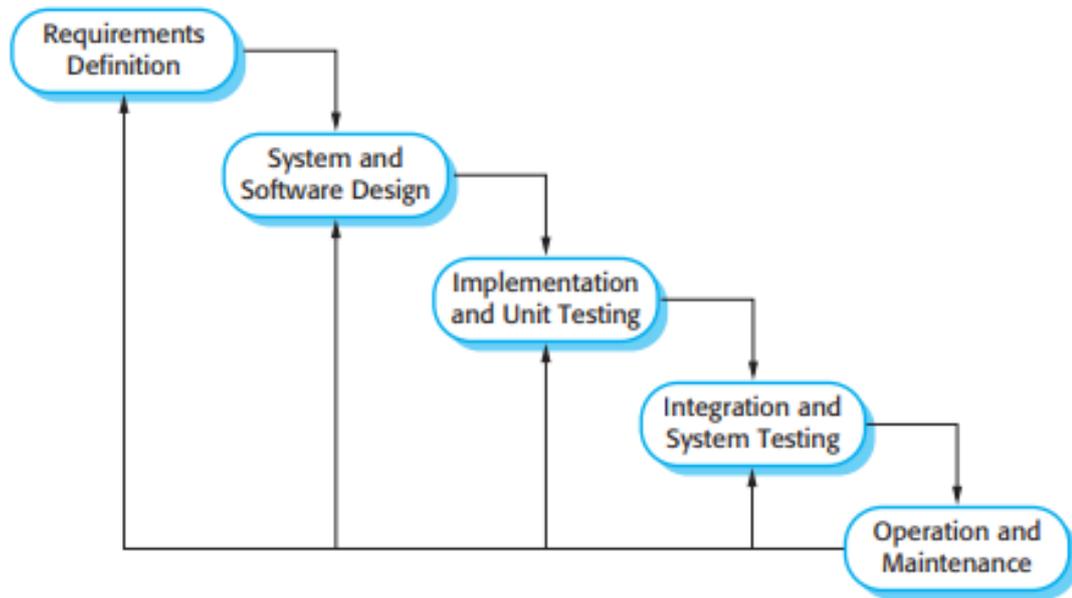


Figure 1: Waterfall model for SDLC

Source: Second source from a model for integrating information security into the software development life cycle (Futcher, 2007).

2.3.2 Conclusion

As conclusion, around the world many countries are suffering from NCDs, some of them are those countries with the higher income which have the high percentage of people who suffer from them. The low and middle income countries are struggling with the problem generating their income through different industries that help them to transform the daily diets (WHO, 2013). However, the almost factor which comes at the top level is to develop many product from industries which will be difficult to control and monitor their ingredients. Regarding the system development, different live cycle for the system development methodologies are too many some software development companies are using their own developed methodology today.

CHAPTER 3: METHODOLOGY FOR THE STUDY

3.1 Study description

This study has been consisted of investigating the knowledge and practices of NCDs service in the community of Gakenke District. The participants' data was retrieved in the archives of data collected during the seminal of NCDs Campaign. Data was analyse to get the phenomenon, the situation and the prevalence of the estimated proportion of the population. All the data used during this research project will be kept confidential, means no names will be required. The research will add to the knowledge of NCDs and Information system literature that is lacking in Rwanda and will be significant to promoting best practices in health care service.

3.2 Study area

The study area of this study is at the health centers level and the community that offer NCDs Checkup services in the community of Gakenke district. Geographically Gakenke district is located in Northern Province as it is shown on the map below of our country.

Population by District

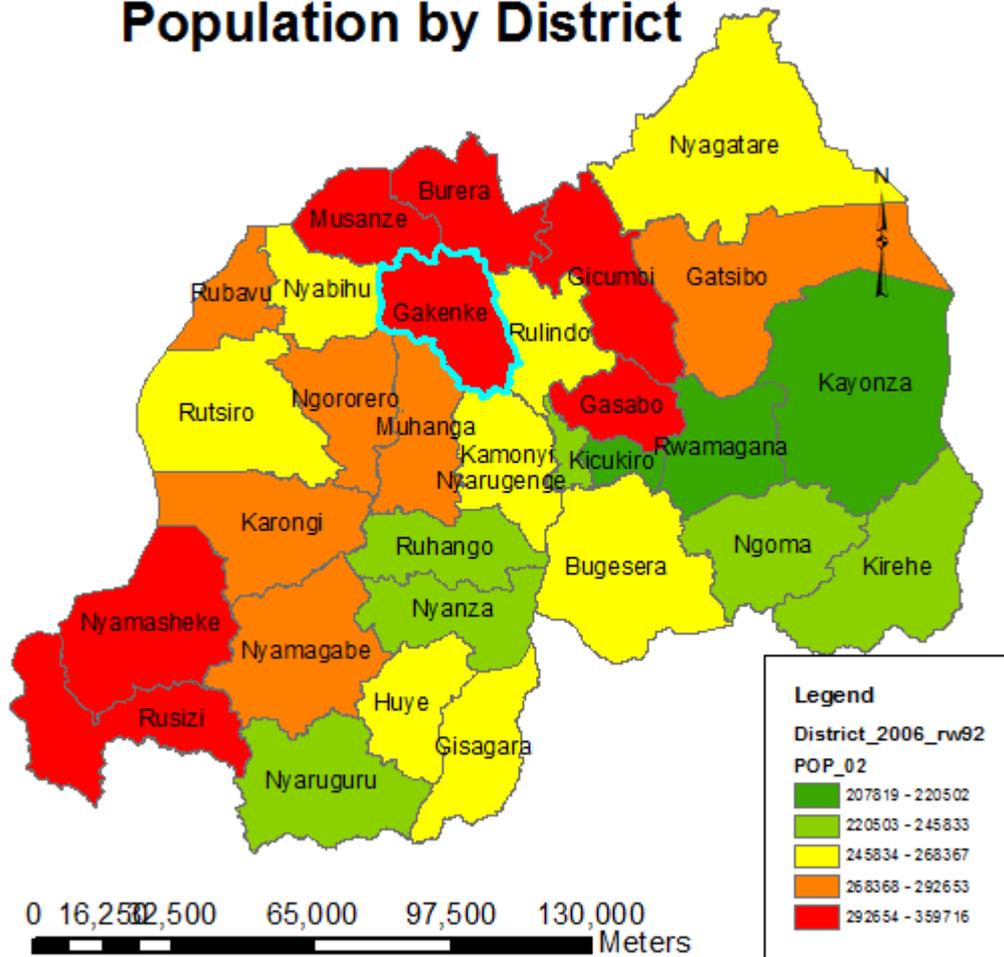


Figure 2: Demonstration of study area on the map

Source: (Author) Primary source using GIS

3.3 Study design

The study design that we have been using during our research study is the documentation method where we have chosen the cross-sectional study in this study session. The method will help us to explore the prevalence of the phenomenon, the situation, the problem and attitude of the taken cross-sectional population.

3.4 Study population

The population for this study was included the administration staffs, medical staffs from different health facilities institutions who offer NCDs Checkup services, and the people in the community of Gakenke district who use NCDs services..

3.5 Study sample & sample size

The sample of 319 has been extracted from 1556 files of participants and they will help us to calculate the estimated proportion of the population when we consider the coefficient of confidence which is 95% and the interval of significant is 5%.

By using the formula of Taro Yamane, it helps us in our research to determine the sample size of the participants which will be used the overall investigation for this study. The greater sample size is, the best high level of precision is found. Formula to calculate the sample size:

Where n = Sample size,

N = Total Population estimate, $N = 1556$

E = error, $e = 0,05$

$$n = \frac{N}{1+N(e)^2} = \frac{1556}{1+1556(0,05)^2} = \frac{1556}{1+1556(0,0025)} = n = \frac{1556}{1+3,89} = \frac{1556}{4,89} = \mathbf{318,200409}$$

Where the sample size calculated from the data collection is approximately to **319**

3.6 Sampling strategy

The sampling strategy which has been used for this study is the cross-sectional study. By using this kind of sampling method, our research will be able to cover all 13 sector of Gakenke district in the catchment area of Nemba hospital. In each sector, we wish we could get data from the total number of approximately 25 participants in order to get the sample size of 319 participants.

3.7 Data collection methods & procedures

The data collection methods that have been used are the secondary source that uses documentation method to get the descriptive data analysis and inferential statistic.

3.8 Data analysis techniques

The data analysis techniques which have used were the IBM SPSS (Statistical Package for Social Science) for data manipulation, analysis and reporting; where the descriptive statistics and inferential statistics for data analysis are applied.

3. 9 Ethical considerations

The study was approved and ethical clearance has been given by the Institutional Review Board (IRB) of the College of Medicine and Health Sciences, University of Rwanda before data collection. The IRB has given us the confirmation letter which has been presented to the direction of Nemba Hospital in order to get the required information regarding the research project. The data collected during the session of this research will be kept in computer with a password protection to ensure its security and integrity.

CHAPTER 4: RESULTS

4.1 DESCRIPTIVE ANALYSIS AND INFERENTIALS STATISTIC

4.1.1 Introduction on data collection

During the session of our research, all data collected allows us to analyze them by using the IBM SPSS as descriptive statistics and inferential statistics for data analysis. The used data have been collected in November 2017. The data collected gives us the direction of getting the prediction to the prevalence rate and other numerical data analysis gotten which is flexible to the information system of data analysis.

4.1.2 Discussion of the results

a) Statistics

The total population used in my research shown in the above table which the total number equal to 319 and are considered as valid values, for the missing values we have null value which it means that all cases have been completed or represented to all data collected during our research session.

i) Descriptive Statistics for sex

	Frequency	Percent	Valid Percent	Cumulative Percent
F	188	58,9	58,9	58,9
Valid M	131	41,1	41,1	100,0
Total	319	100,0	100,0	

Table 2: Table of gender with their frequency

Source: (Author) Primary source from IBM SPSS

As the frequency are shown in the above table, we have used data of one hundred and eighty eight (188) for women and one hundred and thirty one (131) for men which correspond to the percentage of 58,9 % of women and 41,1 % of men.

b) Descriptive Statistics for ages

	N	Minimum	Maximum	Mean	Std. Deviation
AGE	319	35	87	52,96	12,786
Valid N	319				

Table 3: Table of ages with their occurrence

Source: (Author) Primary source from IBM SPSS

With descriptive statistics, the data presented in the above table shows that the minimum age of the participant was 35 years old and the maximum age was 87 years old, the mean is 52, 96 and the standard deviation is 12,786 regarding the age of all the participants presented during this work session of the data collection.

Once we are considering the histogram, the mean is 52, 96 determine the center of the graph and the standard deviation is 12,786 determine width and height of the graph which describes that the age of participant does not follow normal distribution (H1). With the normal distribution (H0) should be presented as peaks in the middle and be a symmetrical shape.

By describing each participant age, the shown histogram describes the frequency of each range for the interpretation.

c) T-Test

One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
AGE	319	52,96	12,786	,716
SYSTOLE	319	129,03	20,130	1,127
DIASTOLE	319	75,83	12,864	,720
Blood Glucose	319	91.47	17.273	.967
BMI	319	21.88	3.018	.169

Table 4: Table of ages with their occurrence

Source: (Author) Primary source from IBM SPSS

One-Sample Test

	Test Value = 100000					
	T	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Age	-139611,375	318	,000	-99947,038	-99948,45	-99945,63
Weight	-188167,340	318	,000	-99,943.569	-99,944.61	-99,942.52
Systole	-88611,373	318	,000	-99870,975	-99873,19	-99868,76
Diastole	-138736,977	318	,000	-99924,169	-99925,59	-99922,75
Blood Glucose	-103309,581	318	,000	-99,908.534	-99,910.44	-99,906.63
BMI	-591640,026	318	,000	-99,978.116	-99,978.45	-99,977.78

Table 5: Table of one sample test with respect of 100000 values

Source: (Author) Primary source with IBM SPSS

After one-sample test, the statement of significant level could be accepted and return the possible prediction using the test value of 100.000. However, the case p-value of the two tailed significant for each case equal (0, 000) which means that the T-test values are less than 0, 001 and it very significant for the study; we reject the null hypothesis and declare the H0 to be False. The alternative is considered to be true (H1) for each case (Munson, 2016)(PETROVICS, 2012).

d) The prevalence of participants ages

After analyzing the age of participants, the descriptive statistics which is described in the table below using category of ages, and the interval between one category to another equals to six (6). The frequency of each category is calculated from the lower to the upper ranges in ascending order and the results are shown that the percentage of frequencies are distributed in descending order. This means that the more age increase the lesser chance to get service decrease (participation in the research). The elder population is the most exposed to NCDs as the high risk factor.

Category	Frequency	Percent (%)	Cumulative Percent (%)
35-40	70	21.9	21.9
41-46	45	14.1	36.1
47-52	51	16.0	52.0
53-58	51	16.0	68.0
59-64	37	11.6	79.6
65-70	34	10.7	90.3
71-76	16	5.0	95.3
77-82	8	2.5	97.8
83-88	7	2.2	100.0
Total	319	100.0	

Table 6: Prevalence of distributed categories for ages

Source: (Author) Primary source with IBM SPSS

e) Prevalence of the blood pressure measures

After analyzing the data collected during our research project for the blood pressure, the results is shown that we have the prevalence of 2.2% of blood pressure which is low, 52.7% of blood pressure which is high (includes pre-hypertension and hypertension cases) and 45.1% for blood pressure which is normal. The analyzed data for our study are shown that the total blood pressure calculated using the IBM SPSS with the abnormal range is 54.9%. And it is shown that the community of Gakenke district has crucial issues of solving the problem, the population will suffer from blood pressure diseases with a high percentage 54.9% which is greater than a half as it is shown with the table below.

Category	Frequency	Percent (%)	Cumulative Percent (%)
Low	7	2.2	2.2
Normal	144	45.1	47.3
High	168	52.7	100.0
Total	319	100.0	

Table 7: Prevalence of distributed blood pressure

Source: (Author) Primary source with IBM SPSS

f) The cross tabulation of sex and blood pressure

sex * blood pressure Cross tabulation					
		blood pressure			Total
		Low	Normal	High	
Sex	Female	3	102	83	188
	Male	4	42	85	131
Total		7	144	168	319

Table 8: The cross tabulation of sex and blood pressure

Source: (Author) Primary source with IBM SPSS

The calculation of the cross tabulation highlighted the total females we have for each categories of blood pressure. The first category of low blood pressure we have 3 females and 4 males, the second category we have normal range of 102 females and 42 males and the third category of high blood pressure which has 83 females and 85 males within our research study. It is shown that there are a great number of 175 participants who are candidates for the heart diseases.

g) Prevalence of the blood glucose measures

By analyzing the data of blood glucose, the results show that we have the prevalence are classified into three categories, the first category is >60mg/dl blood glucose (Low abnormal range), the second category is classified between 60 and 120mg/dl blood glucose (Normal) and the third category is < 120mg/dl of blood glucose (High abnormal range) of 2.5% for low blood glucose, 10% for high blood glucose and 87.5 for the normal blood glucose total abnormal range is 12.5%.

Category	Frequency	Percent (%)	Cumulative Percent (%)
>60mg/dl=Low	8	2.5	2.5
60-120mg/dl=Normal	279	87.5	90.0
121 mg/dl and above=High	32	10.0	100.0
Total	319	100.0	

Table 9: Prevalence of the distributed blood glucose

Source: (Author) Primary source with IBM SPSS

h) The cross tabulation of sex and blood glucose

sex * blood glucose Cross tabulation					
		Blood glucose			
		>60mg/dl (Low)	60-120mg/dl (Normal)	<120 mg/dl (High)	Total
Sex	Female	7	154	27	188
	Male	1	125	5	131
Total		8	279	32	319

Table 10: The cross tabulation of sex and blood glucose

Source: (Author) Primary source with IBM SPSS

The table above describes the data analyses of our research study and classifies them into three categories; the first category cover the range of > 60mg/dl which contains 7 females and 1 male, the second category contains the data of the range between 60-120mg/dl which is 154 for females and 125 of males and the third category contains the data of the range <120 mg/dl which has 27 of females and 5 of males. During the research session, we find that there are 40 participants of new cases which are candidate for the diabetes disease.

i) Prevalence of the body mass index

The prevalence of the body mass index is distributed in three categories. The first category cover the range of 0 to 18.4 Kg/m² (underweight), the second category cover the range of 18.5 to 24.9 Kg/m² (normal range) and the third category cover the range of 25 Kg/m² and plus (overweight). By analyzing the calculated data, which is fund from the height and weight of the participants. The results shows that we have the percentage of 9.1% of the underweight, the 19.4% of overweight which include the pre- and obese cases and the 71.5% of the normal range. The total number of abnormal ranges equals to 28.5%.

Category	Frequency	Percent (%)	Cumulative Percent (%)
0-18.4	29	9.1	9.1
18.5-24.9	228	71.5	80.6
25 and +	62	19.4	100.0
Total	319	100.0	

Table 11: Prevalence of the distributed body mass index

Source: (Author) Primary source with IBM SPSS

The cross tabulation of sex and body mass index

This table below describes the cross tabulation of three categories where the first category is 0 to 18.4 Kg/m² which contains 15 females and 14 males, the second category is 18.5 to 24.9 Kg/m² which contains 132 females and 96 males and the third category is 25 Kg/m² and the above which contains 41 females and 21 males.

sex * BMI Cross tabulation					
		BMI			Total
		0-18.4	18.5-24.9	25 and +	
Sex	Female	15	132	41	188
	Male	14	96	21	131
Total		29	228	62	319

Table 12: The cross tabulation sex and body mass index

Source: (Author) Primary source with IBM SPSS

4.1.3 Strength of the study

The baseline of the research project refers to the use of the current healthcare structure protocol which it has many barriers. Some of the barriers are: the shortage of staff, lack of training of employees, waiting time and the cost of the service delivery. To strengthen the service delivered of NCDs to the public health, it requires integrating the guidelines of using computerized non-communicable diseases check-up application system and it will remove most the barriers once the requirements will be well set.

4.1.4 Weakness of the study

During the research study, we did not include all NCDs types because some of them are had to be checked because they require higher and expensive materials with the expert physicians. Referring to the example of cancer diseases, our country has one institution in charge of these types of diseases and others did not have measurements to measure them. Some of these diseases are: Asthma, injuries, and so on.

4.1.5 Conclusion

As conclusion, basing on our results we can make inference statistics to predict the prevalence of the population data regarding to the descriptive statistics analysis, this research shows that the community of Gakenke district there are too many people who are exposed to the hypertension diseases with the incidence rate of 54.9% is very crucial to the community of Gakenke district. Other cases have the incidence rate of 12.5% blood glucose and 28.5% for BMI. It could be better to train as many employees or community health workers as possible in order to detect and remove the barrier of accessing the service at the health facilities and it will cover the geographical coverage.

CHAPTER 5: DEVELOPMENT OF WEB BASED MODEL

5.1 System analysis

During the process of developing of the project, we have choose to follow the waterfall model which processes all phases in sequential way such that the starting point is the requirements specification, followed by software design, implementation and testing, integration, and ended by operation and Maintenance phase.

5.2.1 Analysis of the system requirements

In the first part of methodology, we have discussed on methodology of data collection and data analysis, scope of our study in order to highlight the problems or errors for the current method used by health care providers only. In the proposed prototype of using NCDs checkup system in our community, the community health workers will be able to collect the require information for people regarding the BMI measurement: the Hypertension measurement and the diabetes measurements which determine the quantity of glucose of any individual and calculate the range of the blood pressure. For each sample, there are specific tool to collection the required information. For BMI we use scale to measure weight and stadiometers to measure height, for blood pressure we use blood pressure monitor tool and for Diabetes we use blood glucometer. These information will consist of different findings that the system will use to provider the person who have been tested the status of his/her measurements. By using this system all people will be checked for the NCDs for the community side and health care providers will remain at the health facility to give the service those who have been checked for the diseases and their status became abnormal. The table below shows the essential materials required to be used in the community:

Scale for measuring weight	Blood pressure monitor	200cm wall mounted height meter	Blood glucose meter
			

Table 13: Material used to measure the different tests

Source: Second source from google.com

The scenario below describes how the proposed prototype in the system could work using the above materials. As it is shown in the above table, it is simple to implement the project where anyone who has been educated for the level of senior six primaries can be trained for the practice will be able to carry out the same activity which could be done by the healthcare providers once the system is used. The execution of the project will be done by the CHW who organize the session of workshop of screening his/her neighbors for the NCDs, after taking the measurement for each material, then the data will be entered into the system. The system will play a great role of helping the CHW to analyze the data corrected and suggest the next step of clinical diagnosis. With the NCDs checkup system, the community will monitor and control all the risk factors of NCDs.

As the organization structure illustrate in the figure 8 of the healthcare hierarchy in Rwanda, the system operate at the community health level and the health facility including healthcare post level. It will encourage the population to become more familiar with the community health checkup system (CHCS)

RWANDA HEALTHCARE HIERARCHY SCHEMA

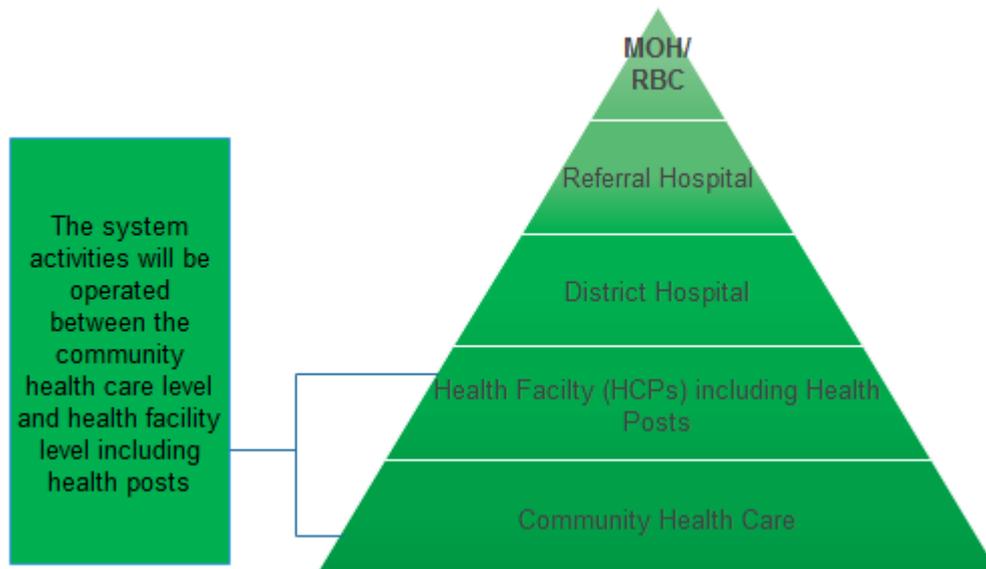


Figure 3: healthcare hierarchy of Rwanda

Source: (Author) From Edraw Max designing tool (Ministry Of Health, 2018)

The schemas of the proposed protocol for NCDs checkup in the community

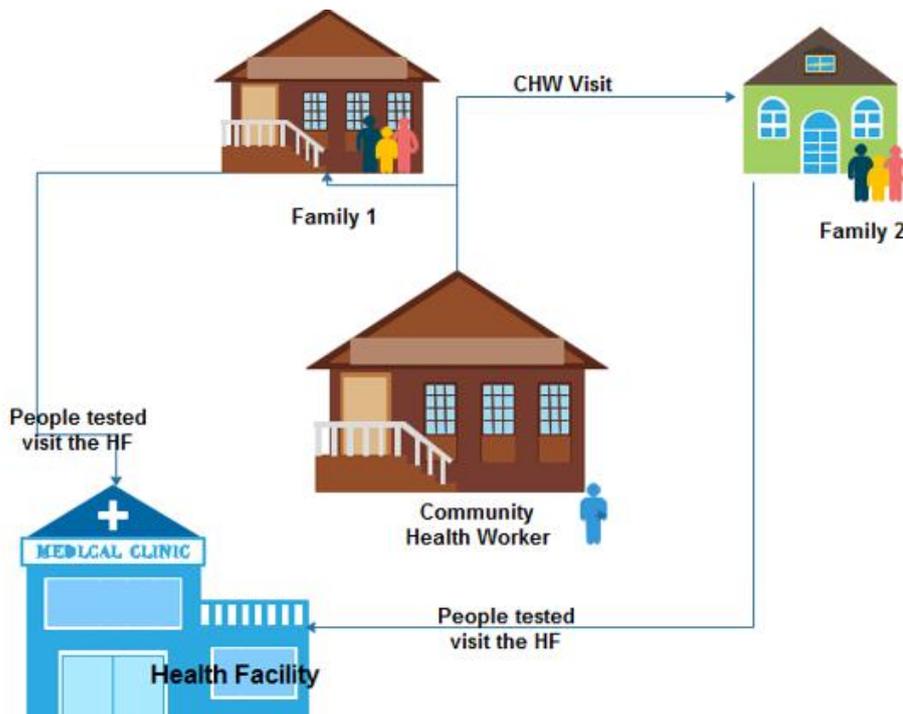


Figure 4: CHWs checkup scenario in the community

Source: (Author) Primary source using Edraw Max designing tool

5.1.2 The current system in use

The current system in use can be defined as the system which is used at the healthcare facilities till to day. Presently all NCDs checkup method is implemented by only health care providers in their working health facilities and they combined all their tasks with the science of outreach in community where the health care providers perform the sensitization using meeting and screen the population for NCDs checkup. Sometime the health care provider did not cover all people they have during this working session while most people who have attending the meeting session have a great potential of being screened to know their life status. Within the current method used, the health care providers did not harmonize their activities to cover the catchment area. Because of the shortage number of employees, the country still struggling with the problem of solving it through the educational sector and empower health sector. On the other hand, we have chance in our country of integrating the community health workers who works as volunteers and they cover the whole community. For example, they have been used in the implementation of RapidSMS and it has achieved the desired goal. In the proposed system, CHWs are the key driver to achieve the desired objectives. The figure bellow illustrates the existing method which has been used by healthcare providers to deliver the NCD checkup service to people.

The schemas of the current protocol used for NCDs checkup in the community

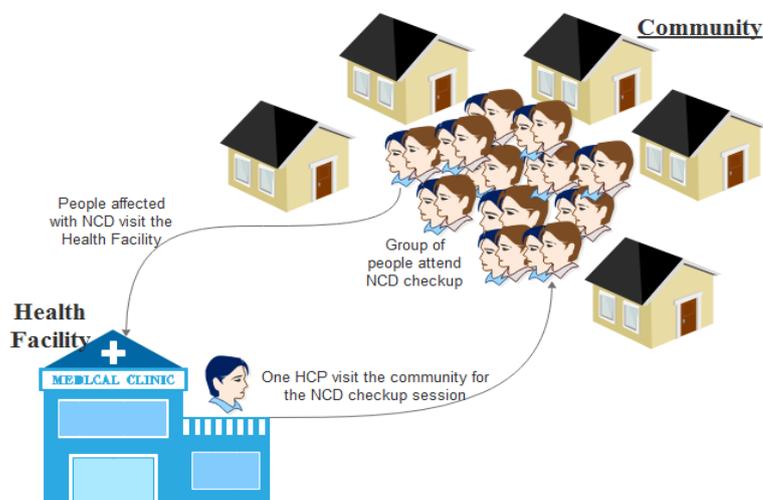


Figure 5: HCPs checkup scenario in the community

Source: (Author) Primary source using Edraw Max

By implementing the above scenario in the health sector, the health protocol illustrates the current prototype used in Rwandan healthcare services; the system of healthcare hierarchy demonstrates the staffs' challenges. Some of the major challenges are as the follow:

- The government of Rwanda still struggle with the NCD control and prevention service which is not started till now at the healthcare facilities including the health posts and the service delivered is not affordable for all.
- The limitation of resources is the critical issue to make NCDs services available to all.
- The shortage of staffs in healthcare to access the whole community.

5.1.3 The system requirement statement

With the hardware platform standards, the data security and system recovery when the problem occurs with the system failure, this will provide some controls, administration, and operation to improve the response of the patient healthcare.

I believe that every health facility have the same organization structure where different service delivered are common at each level health facility, the flexibility of the system have been built to allow easy customization of the system.

5.1.4 Specific requirement

1. Function requirement

It captures the behaviors of the structured system with the system performance. These behaviors could be described as some activities performed by the system, and functional requirement of the system to accomplish all the necessary services to be delivered by the system. These project functions include user login, people registration, and user registration, people test, reporting dashboard, hypertension status, systolic, diastolic, diabetes status, glycaemia, BMI status, height, weight, sms queue, sms sent, transfer, diet and setting. The functions are described as follows:

- a. **User login:** When the user open the index form, he can logging in using the username and password that have been registered in the database. Once the user forgets the username and password, he/she will send a request to the administrator of the system to give him/her the new one.

- b. People registration:** this is the process of giving people the identifier for the application system and it will be done once for a particular person. The given identifier will be used for the future purpose of the people treated using the system.
- c. User registration:** this is the process of giving the user or employee the identifier for the application system and it will be done once for a particular person (user). It will facilitate to distinguish users privileges.
- d. People test:** the people screen in the community, his/her measurement taken will be entered into the system to see the feedback for the measures.
- e. Reporting dashboard:** this is the dashboard that helps the user to calculate the prevalence of people screened with the specified period.
- f. People checkup:** this is the dashboard for the input values of different aspects for the non-communicable diseases screened from the individual.
- g. Hypertension status:** the people screened in the community with their results are obtained using blood pressure meter. It is where we find the abnormal range low, normal range and the abnormal range high (hypertension). The unit of blood pressure is mmHg (Levy *et al.*, 2018).
- h. Systolic:** it is the upper variable located in the place of in the place of numerator for the calculation of the blood pressure
- i. Diastolic:** it is the lower variable located in the place of denominator for the calculation of the blood pressure
- j. Diabetes status:** the people screened in the community with the result are calculated basing on the blood glucose of the body. The unit of blood glucose is mg/dl (Levy *et al.*, 2018).
- k. Glycaemia:** it is the quantity of blood glucose/ insulin calculated to determine the range of the value obtained.
- l. BMI status:** the people screened in the community with the result calculated from the height and weight of the individual in order to get the normal range, the abnormal range low and high. The BMI unit is Kg/m^2 (Levy *et al.*, 2018).
- m. Height:** it is the lower variable located at the place of denominator for the calculation of the body mass index. The height unit is meter (m)
- n. Weight:** it is the upper variable located at the place of numerator for the calculation of the body mass index. The weight unit is Kg
- o. SMS queue:** this is the result of the algorithm which processes all sms and holds them, once their status is still 0 (the 0 means the status which is not sent to the participant).

- p. **SMS sent:** this is the result of the algorithm which processes all sms and holds them once their status is still 1 (the 1 means the status which is sent to the participant).
- q. **Transfer:** once the participants are screened and their status is abnormal low or high, they must contact the health care providers for the general diagnosis.
- r. **Diet:** this is defined as the products/nutrients that the screened participant should consume to maintain the normal range for each of the type of any non-communicable diseases.
- s. **Setting:** This is the result of the algorithm which helps the users to set their marital status, their addresses, different groups and user roles which have been created, and change or set the user username and user password.

2. Non function requirement

Non function requirement: they are the main characteristic which describes the property of different technologies which can be used for the system security, system performance, system maintainability, and so on. On the other hand, it plays a great role of expressing the behavior of the system and accomplishes the organizational structure of the system. Basing on the function requirement and non-function requirement, we come up with the following requirements in terms of hardware and software:

a. Hardware requirement:

Processor: inter Pentium Processor, Intel Celeron, and so on

RAM: 256 MB and above (NITA, 2013)

b. Software requirement:

Database server: MySQL

Programming language: HTML and PHP

Operating system: Windows 7,8,10 (Christensen and Thayer, 2015)

5.2 System and software design

5.2.1 Data flow diagrams

These diagrams concentrate upon the data needed to support the information requirements of the system. What is needed for the input and what are the processes that convert it? It provides the notation of the structure, static pieces of documentation,

communication tool. Before describing different levels of data flow diagram, we have to introduce the basics components that are used in data flow design.

The following table represents data flow notifications:

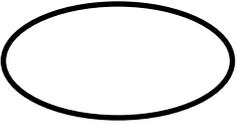
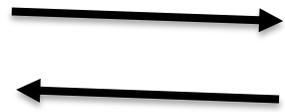
	<p>The external entity: this is the notation of the starting point which is the source and it is used also on the end point of the flow chart.</p>
	<p>The icon for the process: It is the small design of the simple task in the sequential process that are linked together to generate the output from the input data.</p>
	<p>Data store & retrieve: it is the design which get the information that helps in process completion</p>
	<p>Allow: The allow define which is the external entity take action and indicate the direction of each process performed from one entity to another</p>
	<p>Task to perform: There exist into the system development process where each process has the specific tasks to accomplish</p>

Table 14: Data flow notations

Source: Primary source from Microsoft office 2013

The data flow diagram of this project has classified into three levels. Level 1 is the schema which describes the contextual data diagram and it conceives the picture of the project. Level 2 is the schema which describes the process of the system development from the starting point to the last point it means that data collection start by people registration to the point of data storage in the database. Level 3 is the schema which defines the way things are done it means that it explains the execution of the project.

5.2.2 Context diagram of NCDs checkup application system

First level of data flow diagram indicates the contextual diagram. This diagram conceptualizes the Community Health Checkup System (CHCS), the whole picture of NCDs checkup system shows the interaction of the system with its environment in

terms of data flows. The contextual schema describes the limitation of the NCDs checkup system (the scope of the system). The following figure is the context diagram of NCDs checkup system to be developed:

a) Data Flow Diagram level I

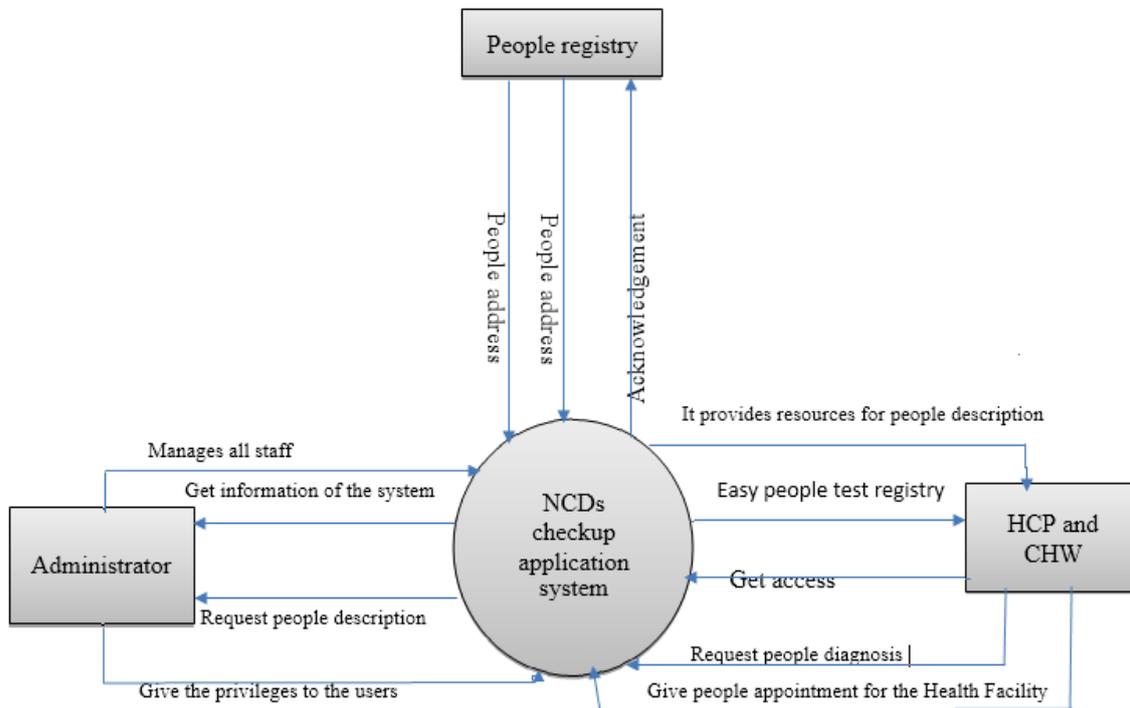


Figure 6: Data flow diagram level I (CONTEXT DIAGRAM)

Source: (Author) Primary source using Microsoft office 2013

b) Data Flow Diagram level II

The figure below describe the major components of the database system developed using the apache PHP. There are different entities that are linked together to form one database for NCDs checkup system, some of them are: People registration, test, User privileges, user registration and appointment it is intended to give the overview of the architecture used during the development of the system. By using MySQL database management system it will help us to manipulate all the transaction done during the implementation of the system.

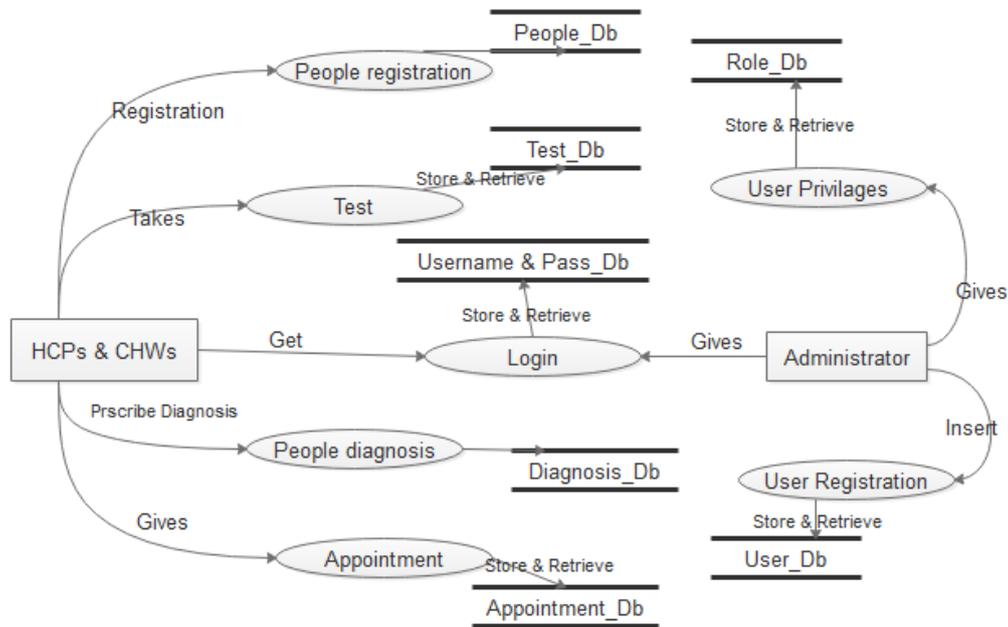


Figure 7: Data flow diagram level II

Source: (Author) Primary source using Edraw Max designing tool

c) Data Flow Diagram level III

This data flow diagram synthesizes the common features of the system to be developed, by referring to different tools highlighted in the system analysis of requirement, the health community worker will take measurement and gives to the facilitator (may be data manager and others who are specialist on using computers) to enter data into the system. Then after, the system will return the feedback (results) for the entered data related with body mass index, blood pressure measure and blood glycaemia of an

individual.

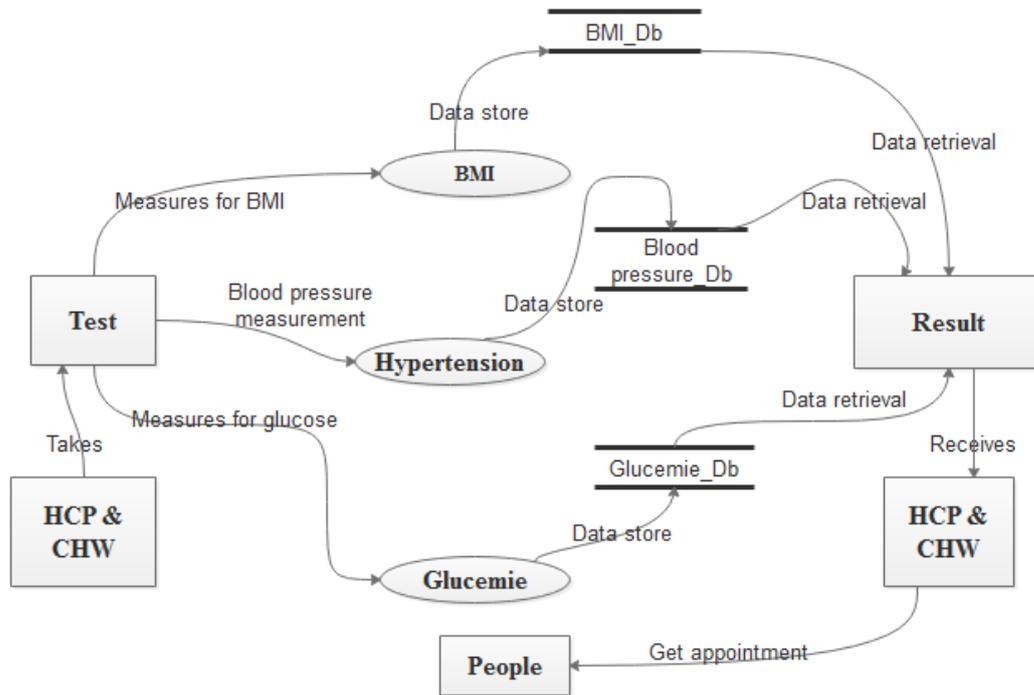


Figure 8: Data flow diagram level III

Source: (Author) Primary source using Edraw Max designing tool

5.2.3 Entity relationship diagram with their attributes

The following figure describes different attributes for each entity of our desired database to store and retrieve (manipulate) different types of data. This diagram highlights relationship between two or more entities. The number 1 represents the single task, N character represents many (means that it is one-to-many relationship) and M character also represents many (means that we have many to many relationships). The underlined word for each entity is the primary key which helps to remove duplicate of data in our database.

The schema of the entity relationship diagram

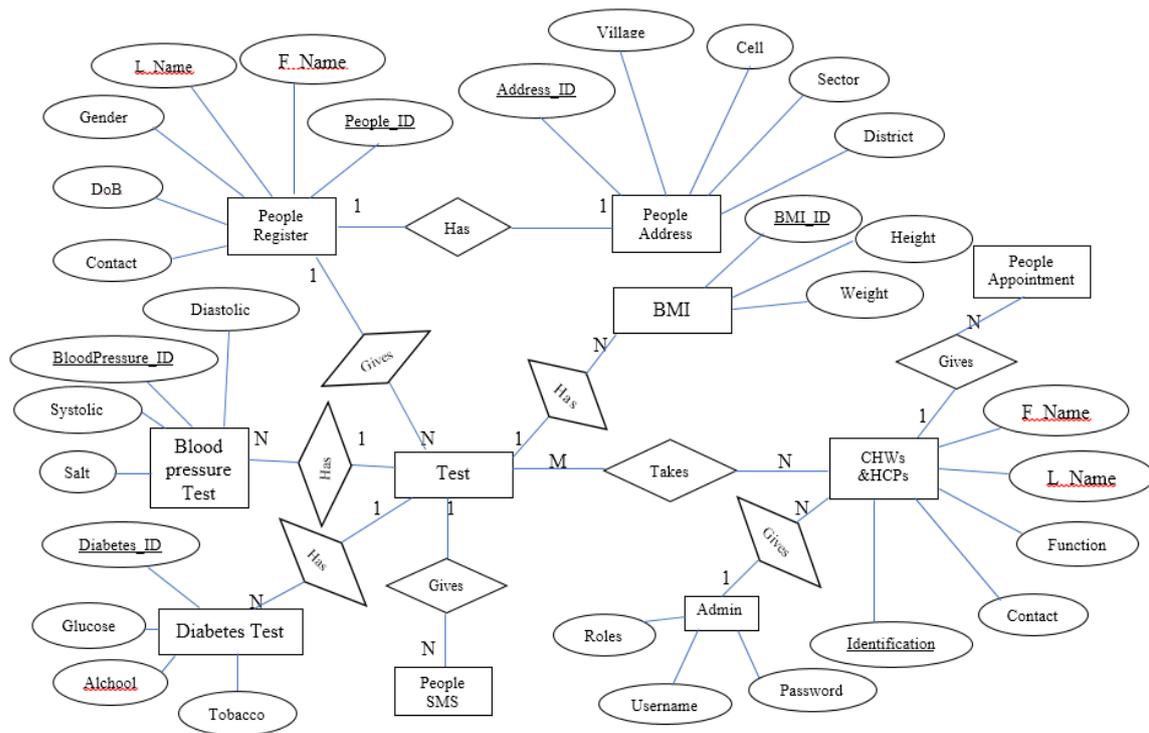


Figure 9: Entity relationships diagram

Source: (Author) Primary source using Microsoft office 2013 (Bagui and Earp, 2003)

5.3 Implementation and unit testing

5.3.1 The system description

The system is built into three major components. One is the client side program which presents different interfaces for each function of the developed features of the system (NCD Checkup system) which help to interact with the user though internet connection. It is developed using some language like HTML or XML. The second component refers to the web application server which processes the client's requests before it can send responses. Here, it is the part which is developed in PHP programming language. This application server handles all requests made by the clients (All Users), Developers and Programmers and expert analysts for the system testing, it is also used to remove errors that are unexpectedly into the system. The application server registers the remote objects, after apply health facility policies, privacy and rules, process data to reduce the load on database. The third component is the database server that helps to manipulate the required functions. Both servers and clients are installed on separate machines connected over network and both servers

need to be started before the clients. The following figure illustrates the information that is produced with the above description to facilitate a well understanding of the project implementation.

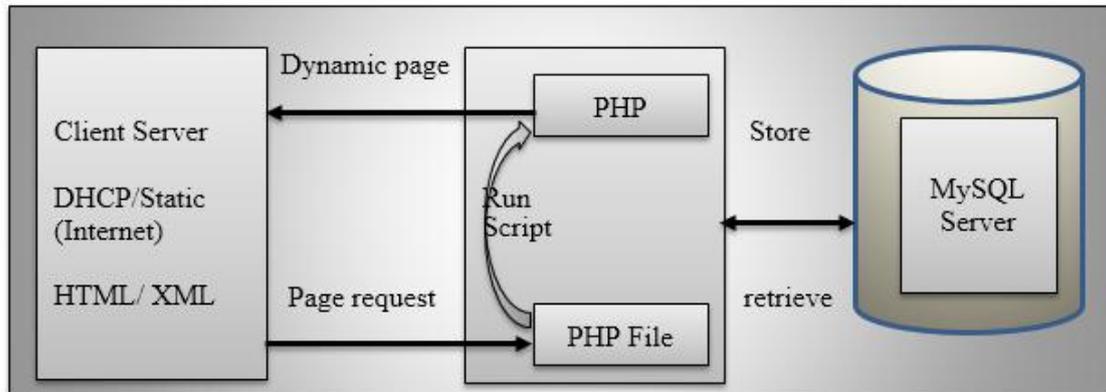


Figure 10: Description of the system

Source: (Author) Primary source using Microsoft office 2013

a) User login layout

Once you have started the system, either on-line or off-line, the displayed screen will prompt you to enter your registered username and password. After entering the required information click on login button to log into the application. Once you forget your password the system give the link, you can click on the "Forgot password?" link. You must have informed the system of your email address and the server must be properly configured to send emails. The system has another option to remember for you the username and password when the checkbox is checked.

Figure 11: User Login

Source: Snapshot using NCDs checkup system

By using the system, the users will be able to enter in the system and manipulate anything that he/she has right. As the system administrator will be in charge of managing all cases of NCDs checkup in the community, the system will have the facilitators who are familiar with the computer system to register people and enter their records in order to see the interpretation made by the system. The form below will be used to register new people in the system by entering the first name, middle name if he/she has, last name, gender, date of birth as personal information. He/she will also enter the parent information includes Contact phone, father names and mother names. He/she will enter the address of the person which includes the village, cell, sector, district, province and the person next kin info that include the next of kin names and next of kin phone. Then he/she click on save button to keep the information.

b) People registration information

Figure 12: People information registration

Source: Snapshot using NCDs checkup system

c) The registered people Layout

The registered people will be viewed through the menu of people and all info related him/her will be displayed, when the member who facilitate the community health workers to register all the required information find that there is some errors he/she

double click on the person and get back to the form used before by the registration process.

The figure 18 bellow describe the registered people layout:

ID	First Name	Middle Name	Last Name	Gender	Date of Birth	Father names	Mother names	Contact phone	Village	Cell	Sector	District	Province
PE17533JKA7S	Jean de Dieu	Jado	TWAGRIRAYEZU	M	1984-01-01	HABUMUGISHA Gilbert	KABAGWIRA Anathalie	0788524463	Gasharu	Musezero	Gisozi	Gasabo	City of Kigali
PE17533FENY2	karinjabo	Medal	Kalisa	M	1999-08-15	Kalisa	Mukamusoni	0788524463	Kilimbi	Musezero	Kilimbi	Kibuye	WEST

Figure 13: People registered view

Source: Snapshot using NCDs checkup system

d) The registered people Layout (continued)

Date of Birth	Father names	Mother names	Contact phone	Village	Cell	Sector	District	Province	Next of Kin Names	Next of Kin phone	Action
1984-01-01	HABUMUGISHA Gilbert	KABAGWIRA Anathalie	0788524463	Gasharu	Musezero	Gisozi	Gasabo	City of Kigali	USANGANY'WINKUYO BAZIGAGA Hyacinthe	0788721792	Edit Authorize Delete View
1999-08-15	Kalisa	Mukamusoni	0788524463	Kilimbi	Musezero	Kilimbi	Kibuye	WEST	Tito	0785074532	Edit Authorize Delete View

Figure 14: People registered view

Source: Snapshot using NCDs checkup system

e) People test performed for checkup

The following dashboard is named the “**person checkup**” it is the most important for our system because it will have all information the community health workers will need to test the individual who will join their service. By entering the data into this form the PHP programming language will help to compute different calculation and comparisons where it is possible. For the **BMI Index info**, the BMI is calculated basing on the height and weight of anybody. This is the two components of the formula used to calculate the body mass index of each individual. They are different ranges for BMI index: the underweight range which is the BMI range that is under 18.5, the normal range which is the BMI between 18.5 and 24.9 and the overweight

range for the BMI is between 25 and 29.9, and the abnormal range high which is obese the BMI is greater or equal 30. For our system the overweight range and obese range are include in the range of overweight only. The above ranges are obtained by the calculation of weight (Kg) divided by the height * Height in (m²) and the unit is Kg/m².

By including these ranges of overweight and obese ranges in one range, it is because the community health workers will only need to see if someone needs a help for the abnormal ranges which include the underweight, overweight and obese and refers them to the nearest health facilities. The healthcare providers will get the people referred by the CHWs and they will be only the one who will need the full details to diagnose and prescribe the medication/ recommendation for the patient.

For the blood pressure ranges which the **hypertension info**, we take a look on systolic on the top number and diastolic on the bottom number various and compare them. For the **low blood pressure** the values are under 90 for systolic and 60 for diastolic, the **ideal blood pressure** systolic is between 90 and 120 while diastolic is between 60 and 80, the **pre-high blood pressure** systolic is between 120 and 140 while the diastolic is between 80 and 90 and the **high blood pressure** for systolic is between 140 and 190 where for diastolic is between 90 and 100. In the system, we have used only three ranges which are **abnormal range low** for the **low blood pressure**, the **normal range** for the **ideal blood pressure** and **abnormal range high** which include the **pre high blood pressure** and **high blood pressure**. The unit of blood pressure is mmHg.

The blood glycaemia ranges which is the Diabetic info, we compare the values of the measurement taken by the Blood glucose meter where we take three ranges the abnormal range low which under 60 mg/dl, the normal range is between 60 and 120 mg/dl and the last is the abnormal range high which is over 120 mg/dl. After completing the required information, the user will click on save button to keep the information.

The figure 20 below demonstrate the used dashboard to enter the taken values and return the right range of the individual measured during the working session in the community.

The screenshot shows the 'Person checkup' control panel with the following sections:

- Person Vital Signs Information**
 - BMI info:** Person ID (p_id), Height (m) (height), Weight (kg) (weight), BMI Value (bmi_value), BMI Status (bmi_status).
 - Hypertension info:** Systolic (systolic), Diastolic (diastolic), Hypertension status (hypertension_status).
 - Diabetic info:** Glucemie (glucemie), Hégrobinegrique (0), Glucoserie (0), Diabetic status (diabetic_status).
- Did you consume any of the following in last one month?**
 - Alcohol (NON), Tobacco (NON), Salt (NON), Sugar (NON).

A 'Save' button is located at the bottom left of the form.

Figure 15: Person checkup/ Vital sign information

Source: Snapshot using NCDs checkup system

f) Person checkup view

The following figure shows different results on the taken measurement for each type disease we have described above. Once the same individual tested before return for the checkup control the system will keep the current values only and the first will be replaced by the recent value.

The screenshot shows the 'Person Checkup' control panel with a table of results. The table has the following columns: ID, Person, Height (m), Weight (kg), BMI Value, BMI Status, Diastolic, Systolic, Hypertension status, Glucemie, Hégrobinegrique, Glucoserie, Diabetic status, Alcohol, Tobacco, Salt, and Sugar.

ID	Person	Height (m)	Weight (kg)	BMI Value	BMI Status	Diastolic	Systolic	Hypertension status	Glucemie	Hégrobinegrique	Glucoserie	Diabetic status	Alcohol	Tobacco	Salt	Suga
BM175334R3T	Jean de Dieu Jado TWAGIRAYEZU	1.8	65	20.1	Ubuizima bwiza	80	140	Ufite umuruduko wamaraso	56	0	0	Ufite isukari nke mumaraso	YES	YES	NON	NON
BM175332NSZJ	Jean de Dieu Jado TWAGIRAYEZU	1.8	90	27.8	Ufite umubyibuho ukabije	78	110	Ufite ubuzima bwiza	120	0	0	Ufite isukari ringanyye	NON	NON	NON	NON
BM17533Y545V	Jean de Dieu Jado TWAGIRAYEZU	1.8	78	24.1	Ufite ubuzima bwiza	78	100	Ufite ubuzima bwiza	110	0	0	Ufite isukari ringanyye	NON	NON	NON	NON
BM17533TAN4N	Daniel Kamuhanda	1.75	65	21.2	Ufite ubuzima bwiza	60	145	Ufite umuruduko wamaraso ukabije	140	0	0	Ufite isukari irengaye irenwe	YES	YES	YES	NON
BM175334RDRD	Jean de Dieu Jado TWAGIRAYEZU	1.7	90	31.1	Ufite umubyibuho ukabije	70	120	Ufite ubuzima bwiza	50	0	0	Ufite isukari nke mumaraso	NON	NON	NON	NON
BM17533CMX7E	Jean de Dieu Jado TWAGIRAYEZU	1.7	90	31.1	Ufite umubyibuho ukabije	70	120	Ufite ubuzima bwiza	50	0	0	Ufite isukari nke mumaraso	NON	NON	NON	NON
BM17533YBW07	Jean de Dieu Jado TWAGIRAYEZU	1.7	90	31.1	Ufite umubyibuho ukabije	70	120	Ufite ubuzima bwiza	50	0	0	Ufite isukari nke mumaraso	NON	NON	NON	NON
BM17533B7168	Adeline HIYADUTUNZE	1.65	67	24.6	Ufite umubyibuho ukabije	85	142	Ufite umuruduko wamaraso ukabije	70	0	0	Ufite isukari ringanyye	NON	NON	YES	YES
BM17533OZ20B	Habimana Felicien	1.65	59	21.7	Ufite ubuzima bwiza	102	148	Ufite umuruduko wamaraso ukabije	98	0	0	Ufite isukari ringanyye	YES	YES	YES	NON

Figure 16: Person Checkup view with their results

Source: Snapshot using NCDs checkup system

g) The Diet for People who have been checked up

This figure describe the basic steps to create the diet for the patient

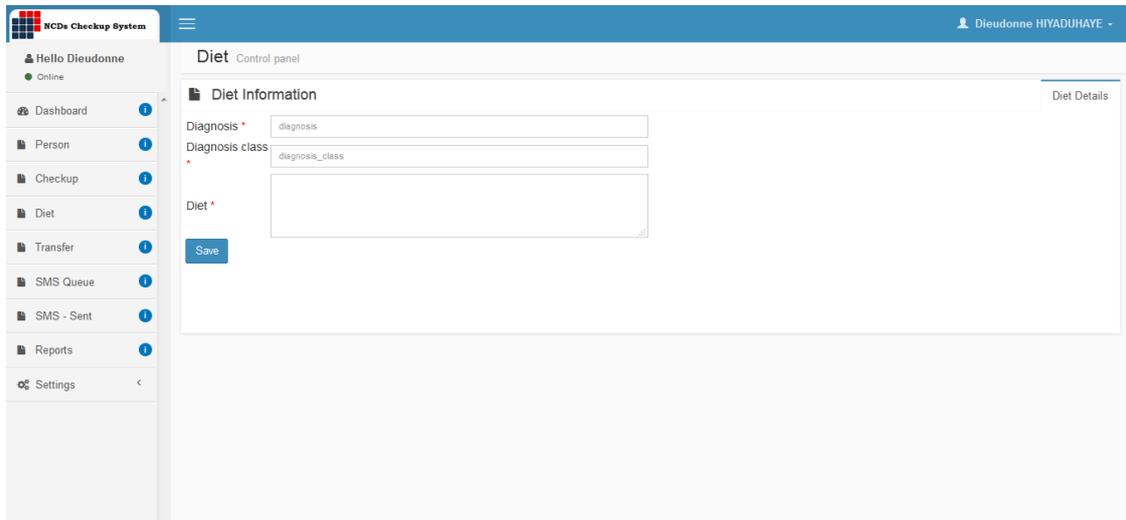


Figure 17: The Diet for people who have been checked up

Source: Snapshot using NCDs checkup system

h) Diet for each prescription

This figure shows a number different diets created and it gives the additional rights which are given the user who will be in charge of completing the form

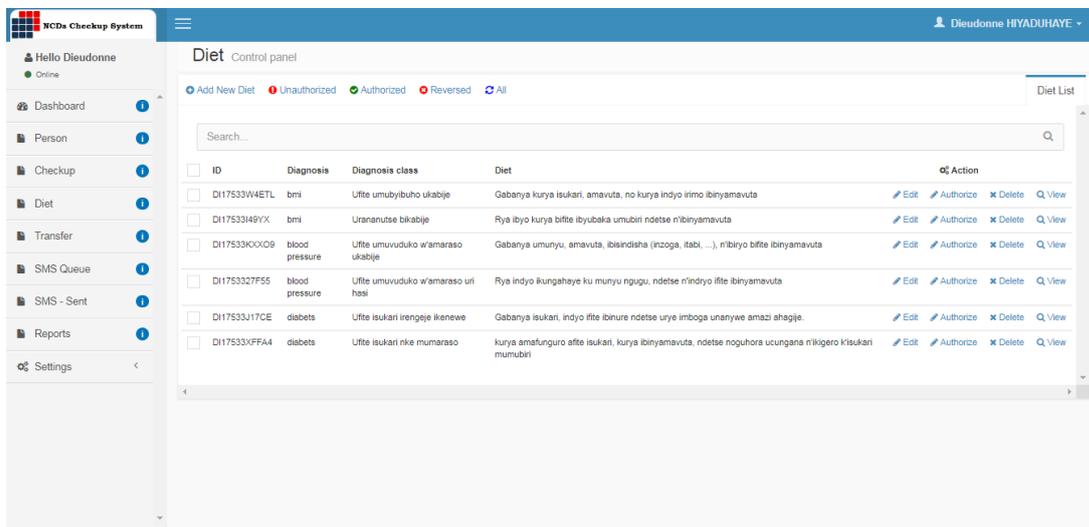


Figure 18: The Diets for people view status

Source: Snapshot using NCDs checkup system

i) SMS sent to the people checked up

The following shows the repository of the SMS sent by the system to the person who have been checked using the system. It gives to the user the information regarding the SMS, when SMS was sent the status changes from 0 to 1. The 0 status describe the failure of the SMS sent.

ID	Person ID	Sender	Receiver	Message	Sms	Email	Message Date	Sms status	Email status	Action	
<input type="checkbox"/>	BM17533DPHB7	PE17533JKA7S	CHCS	0784501061	You are Overweight. Diet: Reduce sugar, Oil, and eat very low fat meals You are Abnormal range Low. Diet: Eat very medium salt, fats food You are Hypo Glucemie. Diet: Increase sugar and calories you eat, and always monitor sugar levels	1	1	2018-10-12 00:00:00	1	0	Edit Authorize Delete View
<input type="checkbox"/>	BM17533OGBEJ	PE17533JKA7S	CHCS	0784501061	You are Underweight. Diet: Eat fats and calories food	1	1	2018-10-05 00:00:00	1	0	Edit Authorize Delete View
<input type="checkbox"/>	BM175331NNC6	PE17533JKA7S	CHCS	0788524463	You are Overweight. Diet: Reduce sugar, Oil, and eat very low fat meals You are Abnormal range High. Diet: Reduce salt, oil, alcohol, and fats food You are Hypo Glucemie. Diet: Increase sugar and calories you eat, and always monitor sugar levels	1	1	2018-10-15 00:00:00	1	0	Edit Authorize Delete View
<input type="checkbox"/>	BM175338HSTD	PE17533JKA7S	CHCS	0788524463	You are Overweight. Diet: Reduce sugar, Oil, and eat very low fat meals	1	1	2018-10-15 00:00:00	1	0	Edit Authorize Delete View
<input type="checkbox"/>	BM17533TOGI	PE17533JKA7S	CHCS	0788524463	You are Abnormal range High. Diet: Reduce salt, oil, alcohol, and fats food	1	1	2018-10-15 00:00:00	1	0	Edit Authorize Delete View

Figure 19: SMS sent to the people checked up view

Source: Snapshot using NCDs checkup system

j) Report dashboard

This reporting form is designed to help the users to generate a simple report for a specified period. To do this task, you start in application by double click on report application and then fill your desired information and end by click on generate button to get the report.

Reports Control panel

+ New Operation Report Controls

Date From: End Date: -- Select type -- -- Select District -- -- Select Sector -- [Generate](#)

Figure 20: The system reporting dashboard

Source: Snapshot using NCDs checkup system

k) The summary Report for the people checked up for NCDs

By using this report summary, the user can view the current status of the people checked who are already in the database. To enter to the display you just click on the Dashboard in the application menu and then you get the displayed information. For each kind of the checked diseases, the system has option of view all people with the related common disease. Once you click on it, it gives you the entire list with the whole address. This report summary gives the report through three different ways. First it uses Pie to get numbers and their percentages, second it uses the cumulative graph to the percentages of the stored people and the third is to give the numbers of people checked for the checked diseases and gives the numbers of people who are abnormal range for each category of the disease and it gives the total population checked.

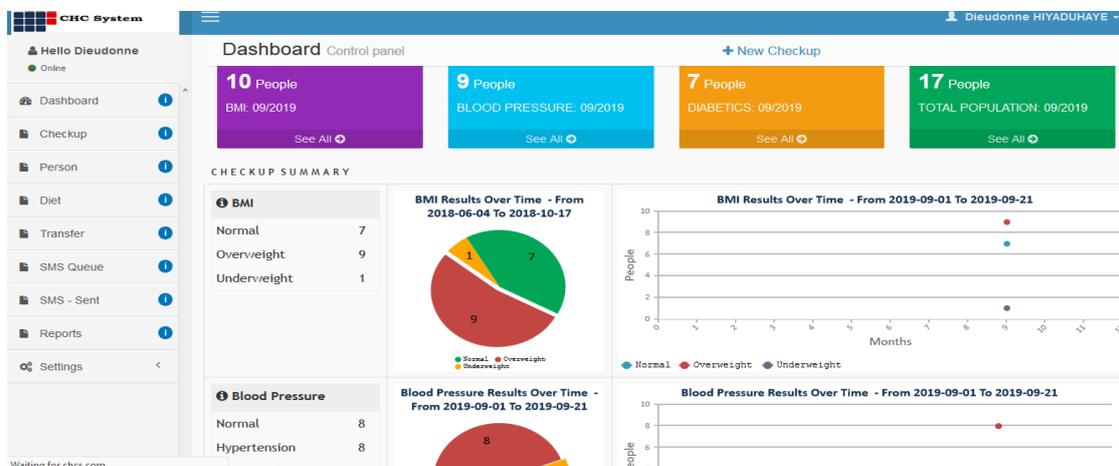


Figure 21: The summary report for the people checked up for NCDs

Source: Snapshot using NCDs checkup system

l) The user control information

The following displays, shows the user interface which is used to create the new user. The system administrator will be able to give the user the username and password. And he or she classify into the created group, here each group has privileges which are different to another group.

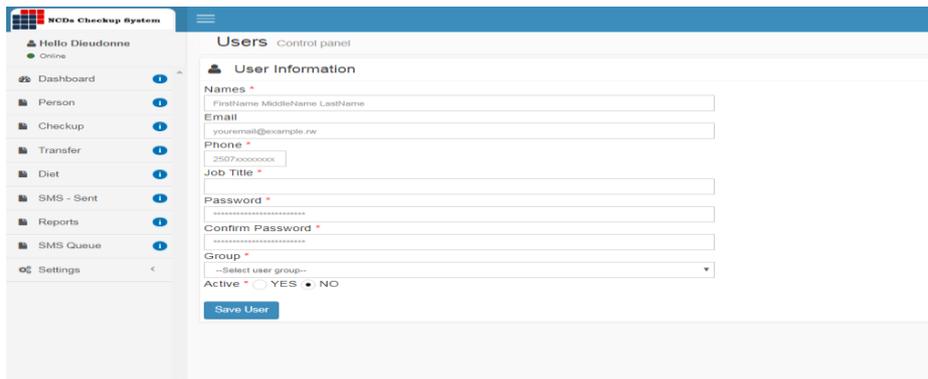


Figure 22: The user information registration

Source: Snapshot using NCDs checkup system

m) The dashboard for group creation

The following describe the figure list of group which has been created to use the system. Each group has different right to manipulate in the system usage. The system administrator will be able to set this different groups and assigning the roles for each group.

+ Add New Group		Search...	
<input type="checkbox"/>	#	Group Name	Action
<input type="checkbox"/>	1	Super Admin	Edit Delete
<input type="checkbox"/>	2	Admin	Edit Delete
<input type="checkbox"/>	3	Super User	Edit Delete
<input type="checkbox"/>	7	Administration	Edit Delete
<input type="checkbox"/>	9	abajyanama	Edit Delete

Figure 23: The dashboard for group creation

Source: Snapshot using NCDs checkup system

n) Assigning roles for the user

The following figure shows privileges that are assigned to the users. When you create a new system user

Group
Super Admin

Application
User

Functions
 INSERT (I)
 UPDATE (U)
 SELECT (S)
 DELETE (D)
 ALL (L)
 Print (P)
 Select All

Description

Visible to users * YES NO

Save

Figure 24: The user role dashboard

Source: Snapshot using NCDs checkup system

o) The user application for the system

The user application system is the fields created which will help the user to interact with the system. These applications are developed to provide different services to the users.

Applications Control panel

+ Add New Application

Search...

<input type="checkbox"/>	#	App Name	App Short Name	Action
<input type="checkbox"/>	1	User	USR	Edit Delete
<input type="checkbox"/>	2	Application	APP	Edit Delete
<input type="checkbox"/>	3	Role	ROLE	Edit Delete
<input type="checkbox"/>	7	Group	GRP	Edit Delete
<input type="checkbox"/>	66	Dashboard	DSH	Edit Delete
<input type="checkbox"/>	21	Report	RPT	Edit Delete
<input type="checkbox"/>	24	Passwordreset	PR	Edit Delete
<input type="checkbox"/>	64	health_facility	HF	Edit Delete
<input type="checkbox"/>	65	transfer	TF	Edit Delete
<input type="checkbox"/>	63	sms_queue	SQ	Edit Delete

« 1 2 3 »

Figure 25: The applications used for the system

Source: Snapshot using NCDs checkup system

5.4 System integration

The phase of system integration will require the individual data to be entered into the system by using the healthcare provider to test whether the used fields are corresponding with their needs, once the field does not meet with the customer requirement, the system should return to the developer or programmer until the last stage of the customer satisfaction.

5.5 The operation and maintenance phase

This phase will take the whole live of the system once the user meet with challenges like the unexpected errors, the system maintenance agent will be ready to correct them and the service operation continue smoothly. With this phase, the system implementation will be easy realized in short time. Before starting using the system, the user will be trained for the main features of the system and different activities to be performed. With the training all trained user will be familiar with the system and become facilitator in each catchment area.

CHAPTER 6: DISCUSSION

This study highlights different findings of our research. And it is divided into two parts:

1. The first part covers the methodology and results gotten.
2. The second part covers the development of web based model.

In the first part of methodology and results gotten, we have used the documentation method within cross-sectional study to cover the population of 319 as sample size; the study area was Gakenke district with the catchment area of nemba hospital. However, the study was explored different outcomes where the descriptive analyses gave us to the results of blood pressure with the abnormal ranges which have the prevalence of 54.9% within 83 females and 89 males among the participants, the abnormal ranges of blood glucose cover the prevalence of 12.5% within 56 females and 35 males and the abnormal ranges for the BMI have the prevalence of 28.5% within 34 females and 6 males. This prevalence's gotten from the study helps us to predict the estimated values of the collected samples for the population of Gakenke district. It is proven that the population with this prevalence's, almost a greater than a half of participants among them are candidates to the NCDs especially hypertension and low blood pressure, the results with the abnormal ranges will be cross checked into different indicators of NCDs and sent to the next stage of follow-up in order to be diagnosed.

The second part cover the development of web based model, where we followed the waterfall model processes to accomplish all stages required to get the final product. These stages are: system requirements and specification, system design, implementation and testing, integration, and ended by operation and Maintenance. The application system designed will operate at the application layer of the TCP/IP protocol or OSI model to provide all services required (Stallings, 2010)(Parziale *et al.*, 2006). As the figure 26 highlight the flow chart of different processes and decision made to get life improved using the system. The application system designed will facilitate the public health to conduct sessions for the community checkup and follow-up for diagnostics in different levels of healthcare facilities. This application system will facilitate the data collection and calculation for the result of each participant and generate the resume of the result gotten by using the algorithms and send the SMS to

the participant. It will also help in the data analyses and dissemination (Lemay, 2010) (Karuri *et al.*, 2014)

The flow chart of the CHCS system to reduce the impact of NCDs

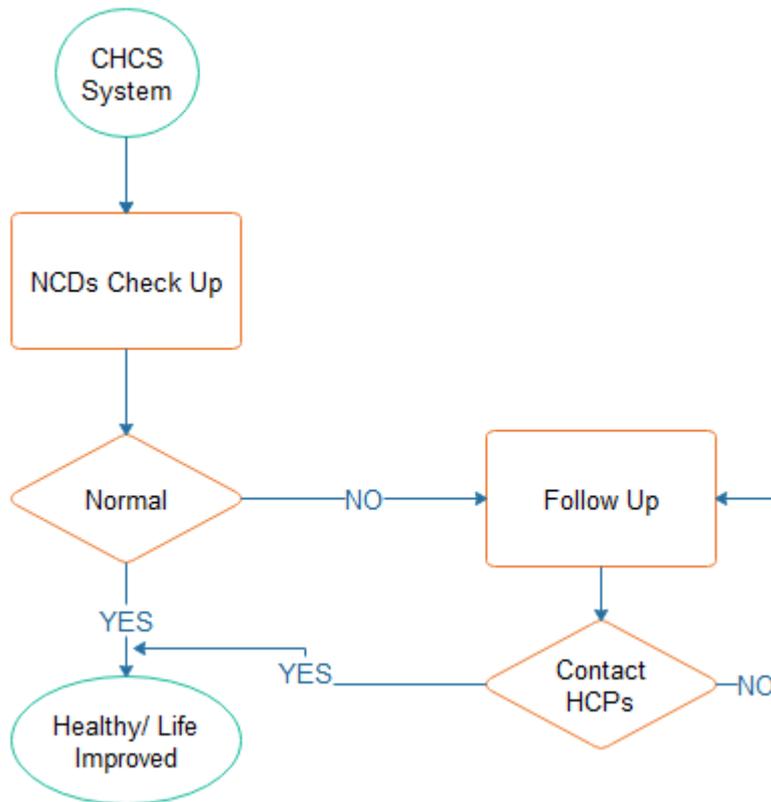


Figure 26: Flow chart to reduce the impact of NCDs

Source: (Author) primary source using Edraw max

Although there is an existing healthcare structure protocol for monitoring and evaluation of the current method (Lemay, 2010) with different indicators which well set for NCDs, they need assistance of health information system to harmonize the healthcare activities within the public health in order to strengthen the community follow-up for the NCDs. Once the country leaders accept to system integrated in healthcare structure, it will speed up the usage of the NCD service and increase the level of awareness of the population through their community. As Anderson, Peter Chisholm, Dan Fuhr and Daniela said in their findings, they have mentioned on how many countries took different measurements to reduce the risk factors where the cost of alcoholic substance have increased to make them lesser available (Anderson,

Chisholm and Fuhr, 2009) and increase the level of providing information and education as knowledge changes.

CHAPTER 7: CONCLUSION AND RECOMMENDATIONS

7.1 Conclusion

This work of NCDs check-up diseases have a great ambition to educate and screen people in Urban and rural community in order to minimize the limited number of the people who get the service at the healthcare facilities and accelerate the service delivery for the public health (WHO, OECD, 2018). During the process of our research work, all activities or objectives have achieved and the prevalence has gotten to highlight the problem in order to bring the improvement in the sector of health care service. As we found that the prevalence of blood pressure is 54.9% Including pre-high and high blood pressure it should be taken into consideration. By the end this exploration, we have suggested this developed application system that could be used to help CHWs and HCPs to check the NCDs for population that they are in charge to provide a good service. For the other hand, the system will increase the level of usability; it will change the human behavior, attitude for the NCDs and help them to get a quick access to the service delivery for the nearest health facilities. By using this system, the risk of premature death of targeted NCDs (WHO, 2017) will be also reduced and increase the level of productivity for the nation. The design and the implementation of a NCD check-up application system have been contextualized; the usage of the NCDs checkup application system performance need to be continuously monitored by the HCPs and CHWs need to be actively consulted during all phases of design, testing and implementation of a NCD checkup application system to enhance its use.

7.2 Recommendations

This research is developed on behalf of Rwandan people to reduce the high prevalence or incidence of the prematurity death was 20 % and the total death of NCDs was 45% In 2017 (WHO, 2017) regarding the community of our country; refers to our objectives, the prevalence gotten shows the problem with blood pressure where 54.9% of the participants are candidates to the hypertension diseases. The system follow-up will help in the usage of the NCD service for the public health in order to decrease the prevalence of the abnormal ranges of each category for the highlighted diseases and it will increase the productivity level of our community. We suggest the following recommendation:

1. We recommend the district to integrate the system in their community to explore the outcome (Olney and Yoon, 2007).
2. The University of Rwanda gain this product as the other document to help our brothers and sisters who will attend the faculty of health informatics to get the general context of their background in the field of health sciences and explore the outcome for the innovation of our future.
3. The district hospital will benefit for the developed system to easy the interaction between patients and healthcare providers in order to facilitate the service delivered.

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Appendix

i) SPSS data set for analysis with data view

data set -v1.sav [DataSet1] - IBM SPSS Statistics Data Editor

Visible: 5 of 5 Variables

	sex	age	BMI	bloodpressure	bloodglucose
1	1	2	2.00	2	3.0000
2	1	1	1.00	2	2.0000
3	1	6	2.00	2	2.0000
4	1	5	2.00	2	2.0000
5	1	6	2.00	2	2.0000
6	1	4	2.00	2	2.0000
7	1	5	2.00	2	2.0000
8	1	1	2.00	2	2.0000
9	1	4	2.00	2	2.0000
10	1	1	2.00	2	2.0000
11	1	2	2.00	2	2.0000
12	1	7	2.00	2	2.0000
13	1	2	3.00	2	2.0000
14	1	4	2.00	2	2.0000
15	1	3	2.00	3	2.0000
16	1	4	2.00	3	2.0000
17	1	3	3.00	3	2.0000
18	1	9	2.00	3	2.0000
19	1	4	2.00	3	2.0000
20	1	2	2.00	3	2.0000
21	1	6	3.00	3	2.0000
22	1	1	2.00	3	2.0000

IBM SPSS Statistics Processor is ready | Unicode ON | 2:14 PM 9/1/2019

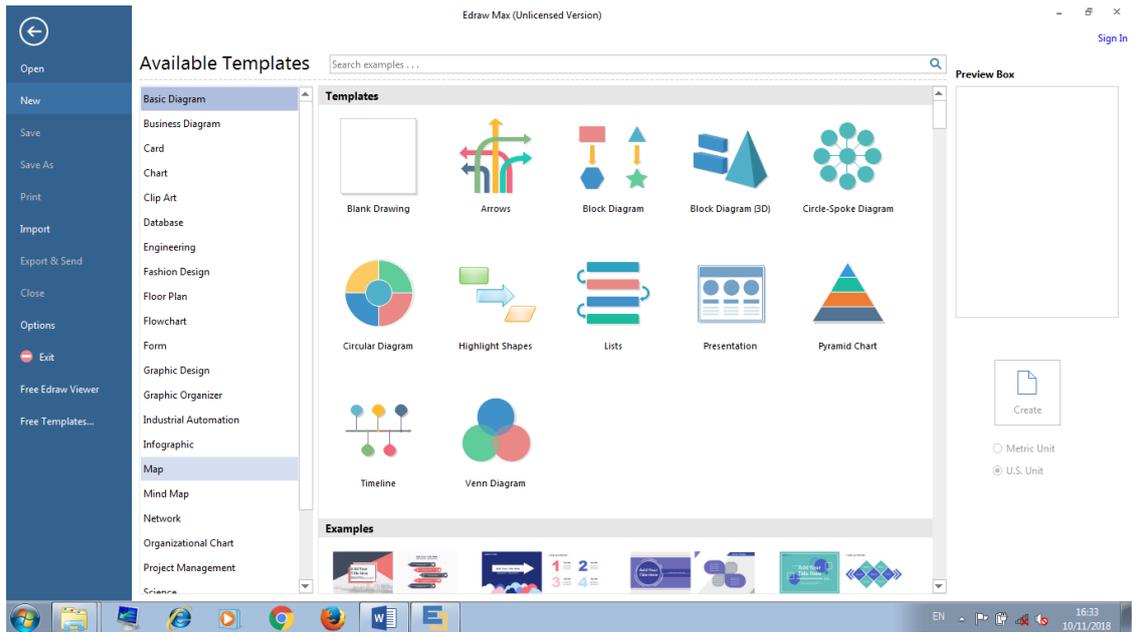
ii) SPSS data set for analysis with variable view

data set -v1.sav [DataSet1] - IBM SPSS Statistics Data Editor

	Name	Type	Width	Decimals	Label	Values	Missing	Columns	Align	Measure	Role
1	sex	Numeric	3	0		{1, Female}...	None	8	Right	Nominal	Input
2	age	Numeric	9	0		{1, 35-40}...	None	8	Right	Scale	Input
3	BMI	Comma	4	2		{1.00, 0-18}...	None	8	Right	Nominal	Input
4	bloodpressure	Numeric	8	0		{1, Low}...	None	8	Right	Nominal	Input
5	bloodglucose	Numeric	8	4		{1.0000, >6}...	None	8	Right	Nominal	Input
6											
7											
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iii) Edraw Max designing tool



iv) Letter for data collection



College of Medicine and Health Sciences
School of Public Health
Remera Campus
Health informatics
HIYADUHAYE Dieudonné
Reg. No: 217294251
The 20th, August 2019



To the General Director of Nemba Hospital

RE: Data collection for NCDs checkup research project

Dear Sir,

I am student at the University of Rwanda, School of Public Health, College of Medicine and Health Science, department of Health Informatics postgraduate level.

This is a NCDs research project which I am going to conduct in your catchment area for the side NCDs checkup in community in order to complete my master thesis. This is to request for the usefulness information resources and support that could be used in the prototype of designing the computerized system which can interoperate between community health workers (CHWs) and health facility providers (HFP) to screen the people that they are in charge of providing the health care service.

The information you will provide me, will be treated confidentially and it will be only used for the academic purposes.

Your cooperation is highly appreciated.

Sincerely,

HIYADUHAYE Dieudonné