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Abstract:

This project will introduce growing in term of attractiveness concept called "e-health". The research will investigate what is the influence of electronic healthcare on the regular healthcare quality and its potential to be developed in the developing region.

Furthermore, to exemplify how various impacts of e-health are in different countries the situation which is presently in Europe will be examined. The trends and current statistic based on the Europe action plan documents will help to understand importance of e-health not only for the patients but also other parties.

Going further, the contrast between developed and developing countries will show the difference in term of quality between healthcare sectors. The additional investigation will focus on the possibility to implement known in developed areas primary eHealth model solution in Tanzania, based on the available technology in this region.

Finally we will design and implement eHealth application which will be concentrate on the primary care. The developed product will be based on the current known models and try to be fitted in to Tanzania technological environment with respecting potential patient's requirements regarding the functionality.

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Acknowledgment

This is the master project in Service development in ICTE "eHealth application – for the rural area in Tanzania". This project is developed in AAU Copenhagen. The project period has been from 02 of February to 10 June.

The project was comprehend by different interested parties which supported and helped us within different stages of the whole process. At the beginning we would like to appreciate the support and guidance of our thesis supervisors – Samant Khajuria and Kim Høgskilde. Their support were the major impact of the decision process which produced the outcomes of this research.

The group would like to thank BlueTown Company for the possibility to collaborate with them in order to produce our results. It was the great experience for us to work within the professional environment on the real life problem.

In addition the contribution of our contact person from Tanzania gave us possibility to gather a real data and opinions from the society in this region. Thanks to Kareen Limbe we had also opportunity to have the insight overview of current situation in Tanzania within the problem area. Her support was priceless for achieving demanded by us objective.

In the development phase the guidance and clues from Per Lynggaard directed us in the right path. His support was invaluable in order to find proper way of design and implementing the solution.

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CHAPTER 1

1. Introduction

This project will introduce the impact of eHealth on the quality of regular healthcare and possibility to develop the primary care e-solution concept in developing area. The positive benefits of eHealth can be observed in many various areas of economy, stakeholders and users standpoint. The ongoing debates and development processes about the current shape of eHealth brings many concerns starting from technical aspects and finishing on the law agreements.

At the first part the project will aim to present the eHealth effectiveness and its evolution in the developed regions. Furthermore by giving an overview of the electronic healthcare influence and benefits the examination about developing areas will show the contrast of healthcare quality between developed and developing countries. The target area in this project is Tanzania which in fact is a developing region. In addition the project collaborates with BlueTown company which is specialized in developing rural areas in Tanzania by providing the reliable Internet connection.

The outcome of performed research will present the initial idea and potential for the e-health development in Tanzania with focus on providing this solution in the countryside areas. The current known primary model of eHealth which is shaping in developed regions, will be compared with Tanzania e-health framework made by Tanzania Ministry of Social Care.

Moreover, by support of BlueTown the raised problem definition based on the previous research will be explored in depth. The data for analysis will be gathered from the real patients and specialist in Tanzania. Furthermore, the conclusion of the research will guide us through the product implementation process. The developed solution will be focused on the improvement of primary care in countryside in Tanzania. Proposed e-health application will cover particular users requirements.

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Besides, the implementation complexity level will be constructed based on the current level of available technology which can be utilized. The functionality of the application will match the needs of patients and specialist in terms of primary care procedures. This will introduce the e-health concept in the new region which is Tanzania. The new innovative solution might bring positive effect on the primary healthcare quality making it more reliable, cheap and convenient to use. If proposed solution will bring constructive feedback, then it might open a way for the progress .The old style healthcare segment could start to be on the evolution process which will incrementally implement new technologies transferring known traditional healthcare in to new electronic wise model known as e-health.

1.1 Motivation and background

This chapter contains theoretical researches in order to present our problem scope in the extensive angle. Additionally under this section we describe also motivation which drives us toward particular research area. The aim is to understanding of e-health concept and its importance in order to increase quality of regular health care. Furthermore the electronic health care solutions as a substitution for traditional health care and the potential benefits are analyzed based on the developed countries.

In the second part the investigation about availability of ICT and technology in developing countries is reflected as a foundation for the possibility of e-health execution in certain level of its complexity. Since the project collaborates with Blue Town Company the area of interest as developing country is Tanzania. In addition the analysis of current health care sector in this area is also presented and reflected as a one of the factor which indicate need for the regular health care evolvement.

1.1.1 *Concept of eHealth*

The e-health is one of the hot-topic nowadays. Many of us have heard about it or read some news about solutions which are used or might be implemented in the near future. However, not many people can explain a clear meaning of electronic healthcare in the modern world perception [1].

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The virtual healthcare concept was present since 1999 and throughout last 16 years this term evolved significantly. The previous known e-health is now use in order to represent not only "Internet medicine" like it was in the primary idea, but also everything what is correlated with the computers and medicine in the virtual world [1, 2].
Seemingly the e-health was first used by the marketing people and corporations rather than academics or scientific environment. The marketers applied the e-health term together with many other words which represents e-concepts like for example e-shopping or e-banking. In the area of growing popularity of ICT this kind of commercials had strong meaning promising to society many values and opportunities which can be provided by the use of Internet in the healthcare industry[1].

As the technology evolved so the e-health improved as well, by covering more healthcare areas. Now many data can be used or accessed virtually because digitalization, virtualization and digital networks progressed tremendously. The evolution enabled among other things to exchange the health related data and improve administration and laboratory processes. New electronic based information's are spread rapidly and then can be accessed through medical journals or other kind of virtual patient's cards. Having access to relevant information through the network might bring many positive reimbursements for medical stuff, doctors and patients [1, 3].

It is also important to indicate the development level of supportive technology needs to go in pair with the virtual healthcare solutions. The advancement of available technologies supposed to be appropriate in order to provide:

- bigger storages capability
- faster networks
- higher processing power
- smaller components
- increased level of security[2]

The technology and electronic health solutions evolve significantly in term of usage the Internet, data and sensors. One of the essential things in the e-health advancement is to produce new information's and such data might be generated by

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use of sensors which are connected to the Internet. One of the good example of such sensors box connected online is today's smartphone [3]

Within the increasing number of profits which e-health can bring there are also challenges which needs to be encountered in order to deliver high quality electronic healthcare system. Amongst various obstacles in the e-health implementation the major issues are with safeguarding privacy, liability issues, consent, eroding confidentiality and access to medical files [3].

- *Evolution of e-health*

Since the number of things connected to the world wide network grew, also the e-health applications and variety of solutions perceived rising tendency. The pervious known applications which before worked in the simple way as a standalone solutions, now are part of the complex system which converge variety of solutions in to one platform. The picture below presents in short the progression path of e-health since last 15 years.

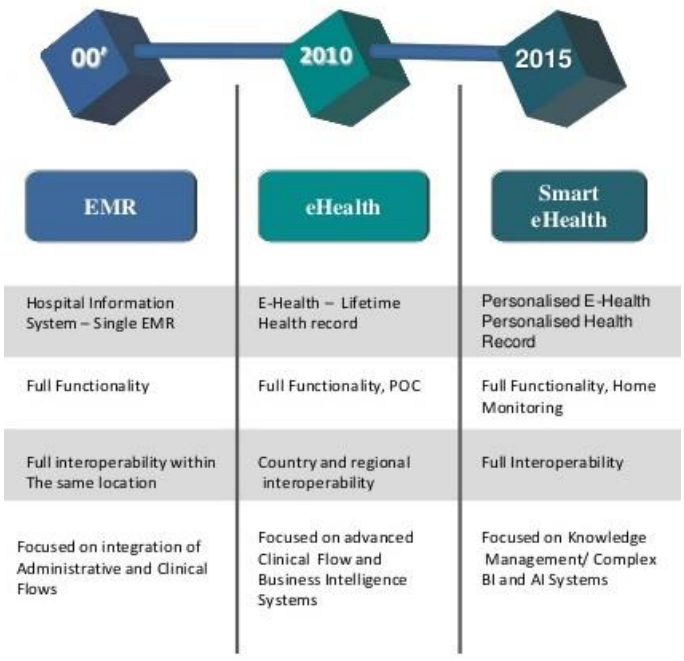

Figure 1.1 Evolution of eHealth[4]

The figure above shows evolution of eHealth concept throughout the last 15years period. The illustration explains the key milestones in each phase including particular functionalities of every solution.

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The image above presents three main stages of the e-health progression. At the first stage the solution called EMR was a first step in the healthcare digitalization. The EMR is software which collects Electronic medical records. Such records might contain health records of the patient or information's from the clinic which can be accessed faster than regular paper based documents. At the beginning each hospital had its own ERM system. The interoperability was limited due the particular location. Nevertheless the hospital administrative tasks were integrated with the clinical flow in better manner than before [3, 4].

During the next years a simple ERM solution has been expanded with more functionality, technology and business verges. The conception of e-health started to have larger meaning than before, by presenting many innovative solutions which aimed to increase quality of healthcare and decrease the physical expenditures at the same time. The new born e-health model provide lifetime health record, functionality and interconnection with the point of care devices(*POC*) and what's the most important the interoperability between regions is also supported. The electronic health care systems known these days provides the advanced maintenance of the clinical flows, administration processes and interconnection with the business intelligence systems which offers high quality medicine and treatment recommendations[2, 4, 5].

The recent occurrences in the e-health progression started to shape currently known concept in to more smart level. The newly born "Smart eHealth" is the next step of evolution and it is still in progress. As the "electronic things" became smarter each year so do e-health follows up. The technology, new solutions, miniaturization and artificial intelligence started to grew drastically in term of advancement providing possibilities which were impossible to accomplish a few years back. By all innovations and new way of thinking the smart e-health starts to become not only a platform, but more intelligent system which can be used as a personal assistant. The new functionality provides personalization of the e-health system and electronic records. In addition the home monitoring is also now possible since the ICT technologies are now more present in the daily life than ever before. Interoperability is fully supported across cities, countries and continents making the data access and exchange process faster than ever. The complex BI and AI systems play a big role in

the new electronic health care solutions increasing not only functionality but also help them grow in term of being smart[3, 4].

It is important to indicate that the reshape process of the e-health throughout its existence was mainly possible because the convergence between technologies and also variety of things connected to the World Wide Web increased. The research made by Cisco Company in April 2011 showed the estimated numbers of devices connected to the network by 2020. The revealed outcomes are presented in the picture below.

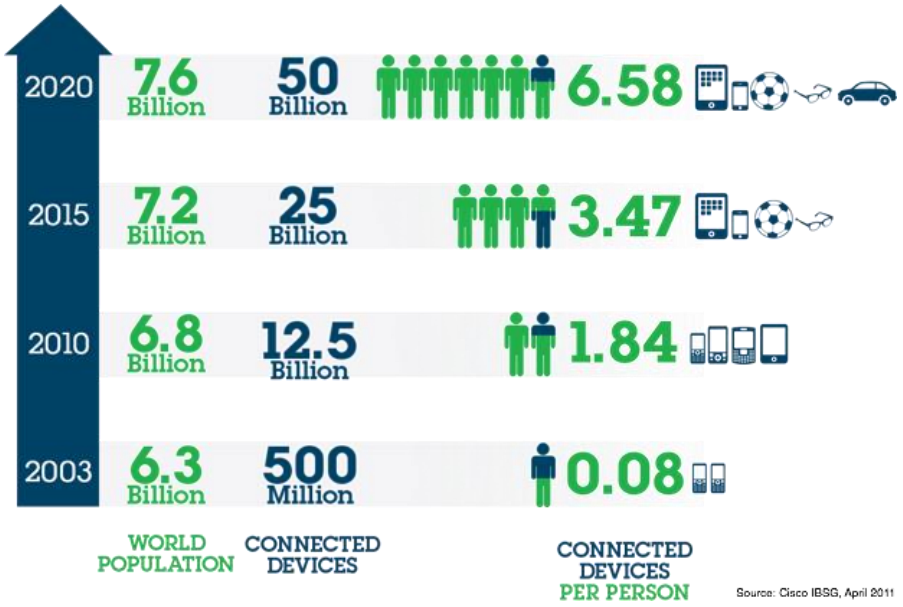

Figure 1.2 Global growth of IOT[6]

The figure presents global growth of devices connected to the network. From the scale it is indicated the Internet of things gadgets are growing significantly. Based on the current trends it is estimated the number of IOT will be around 7.6billion in 2020.

The image above illustrates the global growth of devices which are connected to the network compared to the population growth. The results are astonished presenting the significant growth of the devices from 500million in 2003 up to 25billion today. If the number of acquired devices is compared with the growth of world population the outcome claims there are more than 3 connected devices for each person on the world. Also the volume of created data is bigger every year.

Such process has impact on many various sectors including healthcare. The evolution of the e-health solutions moved far from the primary idea presenting now

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complex system which is used across many devices and technologies. One of the new e-health innovation is possibility to include the most popular device, namely smartphone as a part of the system [3, 7].

Amongst variability of devices which combine different technologies in to one, certainly modern smartphones are the one which noticed significant increase of attractiveness amongst society. There are many reasons behind such phenomenon. However one of the key point is a miniaturization of the powerful and rich in term of features gadget in to the size of pocket unit. It ensures users the device can always accompany the daily life routines making them faster and more convenient. Recent smart devices can basically support various tasks not only in ordinary but also in office and business environments [3, 8].

The research made by BI Intelligence took under the scope the global sale of Internet devices. Based on the historical data and current trends the investigation also presents the future forecasts for a particular device worldwide density. The outcomes of BI Intelligence study are presented in the image beneath.

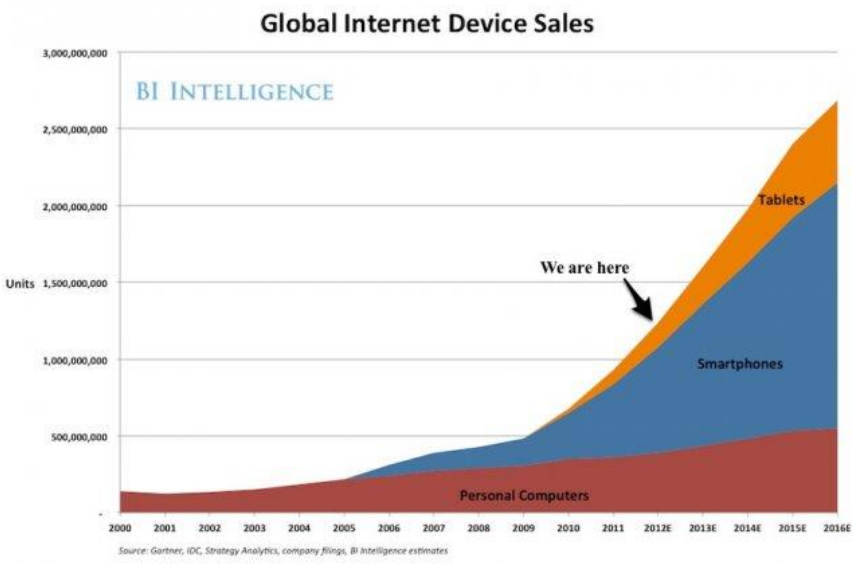

Figure 1.3 Number of global Internet devices[8]

The figure illustrates Global Internet devices from the sales perspective. From the graph above it is indicated the main Internet device nowadays is smartphone.

The picture above illustrates the trends of attaining three the most popular Internet devices. On the scale we can distinguish personal computers, smartphones and

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tablets. The research period starts from year 2000 up to forthcoming 2016. From the statistics above we can notice the personal computers increase steady up to 500millions in the throughout the whole period. The next two devices are smartphones and tablets. In this trend the increase was steady almost from the beginning in 2005 up to 2009 where the number of smartphones reached 500millions. Lately from 2009 up to 2016 significant growth appeared. According to the completed research expected amount of handle smart devices between 2009 and 2016 will rise almost five times, reaching 2,5billions in total. Comparing the number of units with the world population which is predictable to be over 7 billion, we can guess in the following year every third person on the world will hold a smartphone as a one of the main Internet device [8].

Elaborating further about predicted tendency we can also estimate the e-health systems functionality will rise in to more innovative level each year. The usage of the smartphones in clinical field is already widespread nowadays. The features like assessment of the injuries through the messaging a picture of it became ubiquitous among plastic surgeons. In addition the communication between hospital and staff has also benefited from the usage of smartphones. The push messages and variety of notification ensures that the information's are delivered as fast as it possible. The popularity of smart gadgets also induced the growth of designed application which might be used in the specific areas like for example orthopedic, anesthetic or epidemics specialties. Within the continuous evolution of medicine, technology and innovations also the new e-health solutions will become more advanced and precise [3, 9].

1.1.2 *Availability of ICT and potential for eHealth in developing countries*

So far, we have understood what is the concept of e-health and how the evolution of technology impacts the e-health progression. The concept was presented from the big overview in developed countries. However, the situation looks different from the insight of developing places. In this case we are seeing the developed parts of the world enjoys the positive impact in computer technology more than developing world. The reasons behind this are challenges in infrastructure and resources which are far behind in developing world. In addition, education to use and maintain the technology is often lacking as well.

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The figure 1.4 below shows the differences between developing and developed world. As it shown clearly that Africa and Asia are behind compare to the rest of the world. This is because people have mostly low or lower-middle income economies. [11]

If this situation needs to be changed, then there is a need for fairness with the prices where the people from developing countries can afford buy for the same things what we have in developed countries.

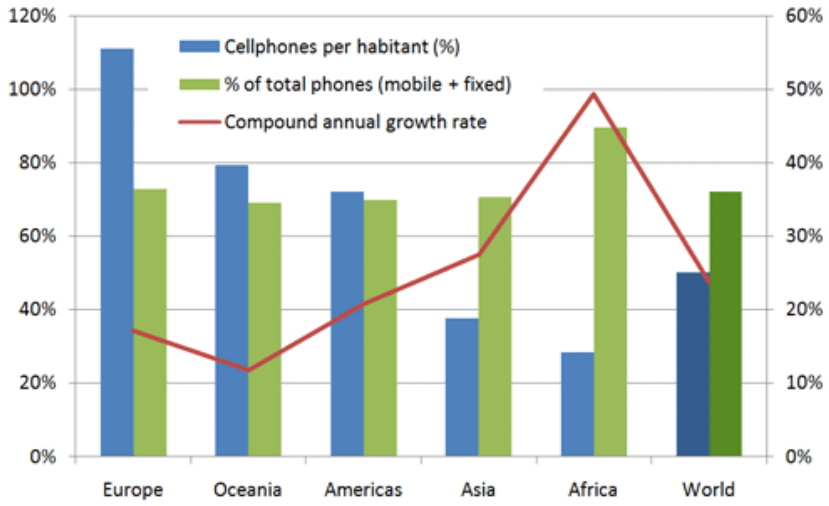

Figure 1.4 Worldwide Cell phone habits [11]

This figure illustrate cell phones habits in different part of the world. As it shows developing world such as Africa and Asia are behind compare to the rest of the world.

Since this project collaborates with the company Blue Town company, which is focusing on rural areas communication solution in developing countries. Our target will be one of the developing country Tanzania.

It is also relevant to look at the facts in East Africa about mobile phones and the use of them. The picture below shows some of the facts in East Africa in usage of mobile phones. Marked area by the yellow color indicates Tanzania and its statistics on the right side.

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Figure 1.5 Mobile stats in East Africa[12]

This figure present the trends of use of ICT in East Africa.

As shown in the figure 1.5 Tanzania's population is about 49 million, more than half of the population are mobile subscriber and only 11% of these are Internet users.[13] Here we are focusing in healthcare situation in selected country.

However, before we are going to illustrate Tanzania´s heath service, first let us look what Blue Town provides there. Blue Town has developed an end-to-end communication platform; this is a specially designed for the needs and conditions in rural villages. The solution comes with cost efficient standard technology with limited maintenance, which is easy and fast to deploy, includes their own power supply which is based on solar energy and rechargeable batteries [14]. In addition Blue Town also supports users with the Android based device in order to access the network.

The provided infrastructure and technology full fill basic needs in order to implement e-health in the focused region. Before that the analysis of e-health effectiveness must be studied in order to understand its importance in the health care quality improvement.

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1.1.3 *Adoption level and effectiveness of eHealth-Europe*

By taking under the scope Europe as mostly developed area and investigating adoption of the e-health in the all membership countries, strong and weak points of the solution can be revealed. In the official European Commission policy the e-health was part of agenda for more than a decade. The e-health technologies become more popular each year bringing benefits to the European healthcare system in various areas. The significance of e-health in the Europe is clearly visible and the latest e-health action plan created in 2012 is now included in the official Europe strategy plan which supposed to be achieved in 2020 [9].

In order to measure effectiveness, benefits and consequences of electronic healthcare system around the various EEU lands, big mount of data and many other circumstances need to be considered and investigated. However the first step of the research shows very promising results encouraging the EEU commission to move forward in order to get clearer picture of e-health usefulness. The latest research performed within the healthcare sector was targeting to examine the level of e-health services, performance and level of deployment. The data for analyzing was acquired through the surveys which have been sent to the Hospitals around the different countries. The results based on the analysis of attained data presents relevant findings which have been grouped in to four interrelated sectors [9]:

- Deployment and use of e-health in the European hospitals
- Further implementation of the electronic health record systems as a trigger for the e-health functionality development
- Exchanging of information
- Security and privacy of sensitive data used by the system

The main goal of the research was to benchmark the level of digital healthcare system and it's usage amongst different Hospitals distributed around the EEU. The potential benefits of implementation of technology in to healthcare industry has been noticed in various forms like for instance increase efficiency of care, operational and administration cost reductions, new modes of care. The actual studies performed by EEU Commission which will measure mentioned benefits are still in progress. Nevertheless, the first research which measure the e-health

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adoption has been already completed and it result is presented in the image below [9].

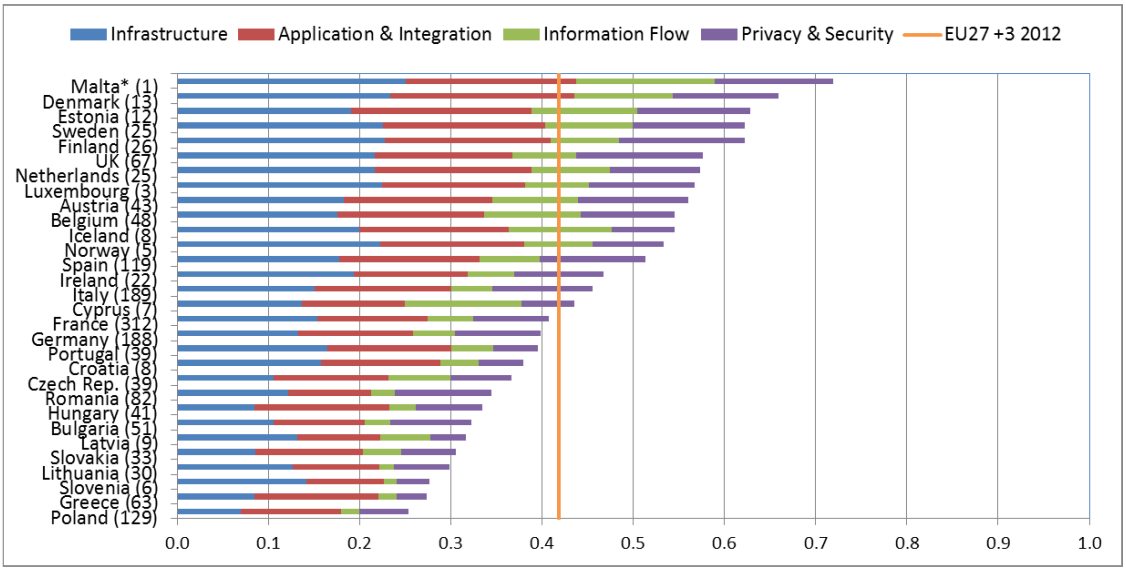

Figure 1.6 eHealth adoption in EEU hospitals[9]

The figure 1.6 presents the outcome results from the research conducted by EEU around different hospitals in the European countries. The red line indicates the average level of eHealth adoption based on data gathered from surveys.

The picture above presents an overview of the e-health adoption in four different dimensions like infrastructure, application and integration, information flow and privacy and security. The European Commission sent surveys to the Hospitals facilities in each member country in order to check the e-health implementation level amongst different nations. From the figures above it is evidently to notice the variability between EEU lands is significant. The orange line indicates the average level of e-health in the EEU zone based on the outcomes from analyzed samples of data. In this research 1,643 hospitals has been investigated indicating the predictable overall level of e-health adoption at 0.418[9].

As it is shown on the image above not every European country is at demanded level yet, however it is important to remember the results may be different if the greater number of hospitals would be examined. From the statistic overhead we can see the top ranks belong to Northern Europe. Unfortunately the country which stands at the first place provided insufficient value of data to analyze. As it is noted only one

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Hospital in Malta has been investigated, so the result presented on the graph may be differ from the actual value.

Therefore, the most populated countries like Germany, Spain, Italy and France provided greater sample of data to analyze, and consequently these countries are placed in the middle of scale. The eastern part of Europe has been positioned at the bottom of list and unfortunately none of east lands reached the average e-health adoption.

The research results show the significant differences between the EEU countries in terms of e-health adoption. There are many factors which contributes to that like for example different economic conditions, various level of technology or even number of population in particular country. Nevertheless the implementation of e-health is still progressing in the Europe. The EEU past research about economic impact of electronic health care system proved the potential benefits are actually there. The study was performed couple years ago in ten European Cities and it outcomes were presented in 2006. Further analysis of data gathered from on-going investigations about e-health might prove many valuable benefits for various sectors [9, 10].

1.1.4 *E-Health Standards*

In this section the e-health standardization and initiation for the standardization is presented. At the beginning the e-health description is showed from the Europe perspective. Furthermore, all relevant facts and on-going processes are described for the globally converged e-health to be developed based on the EEU e-health action plan.

In the second part of this chapter the structure of particular e-health components which need to be standardized is explained. Lately the standards which are being develop are indicated as well. At the conclusion the outcome highlights requirements which needs to be covered in order to develop globally standardized e-health solution.

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E-health in Europe

According to the phenomenon in Europe e-health popularity is growing significantly. The benefits which electronic healthcare is giving for the patients, doctors and economy, encourage European commission to focus on the standardization of the electronic health care as wide scale solution. Currently the major issue is lack of interoperability which effects each country have its own requirements related to the security and privacy [18].

The action plan created by European commission describes the e-health vision and its goal supposed to be achieved until 2020. The document specifies how the international e-health solution supposed to be shaped in order to full fill the European requirements in various fields. In addition the official EEU action plan also describes the EU role in the e-health shaping process and encourages various stakeholders in Member States to join forces toward common goal. From this we can see the e-health importance for Europe is one of the major priority. The global e-health solution is still in the process of standardization, however the challenges which needs to be faced are already identified. In order to provide wider e-health solution particular issues must be completed related with [18]:

- Lack of interoperability between particular eHealth solutions
- Absence of legal clarity for health and wellbeing mobile applications
- Patient privacy and information security
- Deficiency of transparency regarding the utilization of data collected by e-health apps
- Regional differences in accessing ICT services [18]

Electronic healthcare structure and standards

The organization named WHO(*world health organization*) defines e-health as a "the economical and secure use of ICT in support of health and health-related areas" From the definition it is clearly to notice e-health solution is built from various components and in each level different standards must be applied. The picture below presents the e-health structure according to WHO organization [18].

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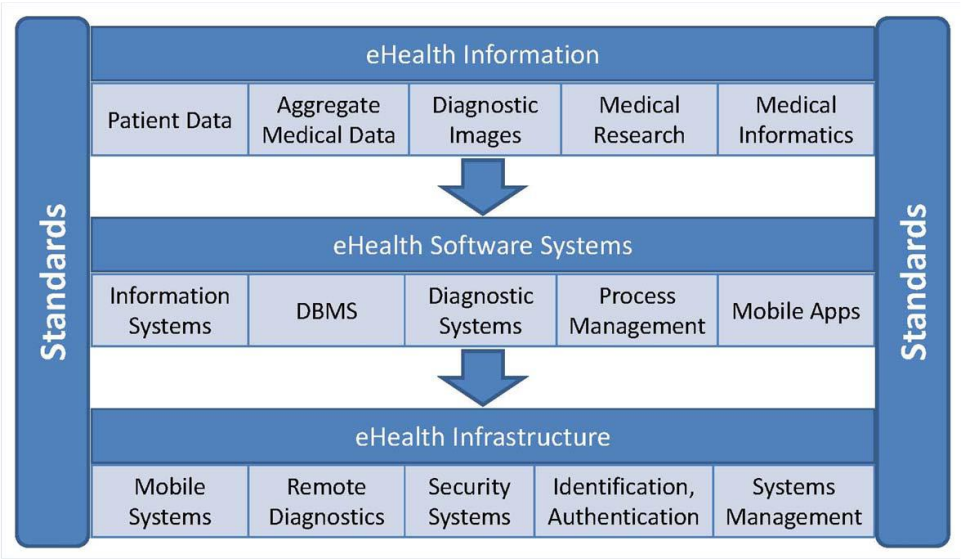

Figure 1.7 Structure of eHealth components for standardization[18]

The figure above shows three layers of e-health components which needs to be standardized in order to provide interoperable and secure e-health solution internationally

Picture above presents three layers of e-health structure specifying which components must be standardized in order to provide:

- Interoperability and minimize the risks related with development of new technologies
- Prevent single vendor lock-in
- Reduce costs by enabling market competition
- Eliminating the need for expensive and customized solutions
- Address specific concerns about privacy, security, and patient identification

If the proper standardization in each component will be available then the global secure and efficient e-health solution will be possible to develop [19].

In addition the main component of the e-health which is patient electronic medical record also must. The EMR contains various kind of clinical and administrative information's. Currently the information inside EMR are understood only by one system which has its own proprietary standard. The standardization process encounters this issue since the interoperability in this case cannot be achieved. The common format standard of EMR will allow to exchange information between different systems developed by various manufacturers. The scheme below presents which type of information are in the patient electronic record and how the EMR is structured [19].

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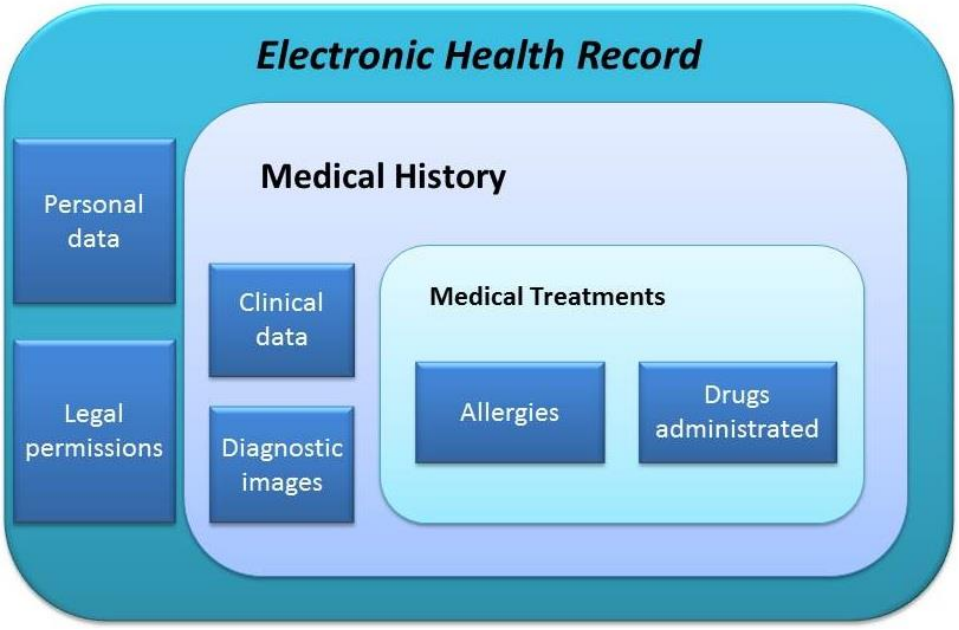

Figure 1.8 Structure of common EMR model

The figure above present three type of information which are indicated in the patient electronic medical record. Each layer requires different level of privacy and security protection

From the structure we can see the three type of information are presented. The first one which contains details about patient Personal data and legal permissions has the lowest level of confidentiality. The second kind of data is related with patient medical history where the various type of clinical data and diagnostic images are included. Medical history has information which are more sensitive and the confidentiality and security level in this case must be greater than in the first case. The most sensitive type of data is related to the treatments where particular information about allergies and types of administrated drugs are presented. Here the privacy, security and confidentiality plays key role [19].

Apparently there is still lot of work in terms of standards since the common EMR format rises many concerns is terms of privacy and security. From the privacy point of view there is of risk of discrimination in employment or insurance companies which can gain access to the patient Medical record. The often raised question is about extent to which particular stakeholder can gain access to the patient data. Another standpoint is the security part of common ERM. Here the system must full fill strict requirements about authentication and authorization. Furthermore also verification process needs to meet strict standards in order to monitor "who" can

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access "what". The protection of stored data on the servers and network as well needs to meet strict requirements which are crucial for the patient security [19].

The proper standards can provide a high quality and secure e-health service which can work internationally in terms of data exchange. Common ERM can bring many benefits not only for the patients but also for the doctors and economy as well. In addition there is already set of relevant standards which can be used in order to achieve this goal. The relevant standards are presented below [19].

- **DICOM(***Digital Imaging and Communications in Medicine*)

The DICOM standard is for exchanging medical images. It explains in which format picture supposed to be and how it need to be transmitted between imaging equipment which comes from different manufacturers. This standard is already used in the widely in the hospitals systems imaging equipment. The DICOM standard provides details and specification about:

- Network protocols
- Syntax and semantics of commands and associated information
- Media storage services, file formats, medical directory structure [19,20]

- **CEN/TC 251**(*The Comité Européen de Normalisation*)

CEN is an organization which includes 31 national members developing standards. This organization also has Health Informatics Technical Committee (TC 251) which is responsible for coordination of the development of standards for eHealth. The CEN/TC 251 focus point is on the technology at the content level and communication technologies to some extent. The organization is divided on the groups which works on the various tasks like for instance Group IV which is responsible on the information systems and interoperability of data amongst various devices[19,21].

- **HL7**(*Health Level Seven)*

Health Level Seven organization was established in the middle 1980's and primary goal for them was to develop standard for a hospital information systems. Currently HL7 is focused on the health care standards about electronic exchange

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and management of health information like for instance clinical data or administrative information. Like most of the organizations also HL7 is divided in to groups which are focused on the different issues. Amongst many tasks the member teams are working on electronic health records, infrastructure and messaging, and imaging integration
[19, 22].

One of the known standard in the e-health area which was developed by HL7 specifies Clinical document architecture servers as a XML based markup standard. The medical document structure, semantic and encoding parameters are developed according to the HL7 standard [19].

In addition one of the HL7 group also works on the standards related to the Genomic information. HL7 partners with other organizations like for instance ISO in order to develop common standards for e-health solution [19].

- **ISO/TC 215**(*ISO's Technical Committee 215*)

ISO/TC 215 focus area is primary on the electronic health records. Different group works on various fields related to the HER. The data structure, messaging and communication, business requirements and many other aspect are goals for the ISO/TC 215. Many of standards has been developed with collaboration between ISO/TC 215 and other organizations like for instance HL7 or IEEE. For instance standard, ISO/HL7 27931:2009, "Data Exchange Standards -- Health Level Seven Version 2.5" establishes an application protocol for electronic data exchange in healthcare environments [19, 23].

Currently ISO/TC 215 cooperates with WHO and the outcome of this collaboration produces technical report for e-health standardization in developing countries. The purpose of report will be to indicate how developing countries supposed to adapt universal standards for health informatics systems [19].

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- **ISO/IEEE 11073**

The ISO/IEEE standards are focused on the interoperability of medical devices. The standards are made by ISO, IEEE and CEN organizations. The standards includes personnel and end user and health devices like for instance blood pressure monitors or thermometers. The ISO/IEEE 11073 standards specifies messaging structures, however not the transport layer upon which messages are transmitted [19].

Conclusion

E-health solution is a complex system of various components and technologies so the standardization in this area is very complicated. Many different stakeholders is involved in to one solution like for example doctors, patients, hospitals etc. Every of the stakeholder has numbers of technologies, devices or information systems installed. Often the devices have proprietary specifications which makes the interoperability process difficult to achieve and standardization very complex at the same time.

Another challenge lays behind the security and privacy protection. The data used by the systems is very sensitive so many of important aspect needs to be taken under consideration. In addition the health sector is also heavily regulated in terms of law by national authorities. The new solutions or fresh technologies unfortunately might not meet the regulations requirements which will affect the adoption process in the negative way.

As it was presented above many standards of e-health is already in progress. However, there are different approaches in various countries in term of e-health standardization. This is another issue which might reflect on the efficiency of global e-health standardization. Furthermore standardization of health care devices which are sell globally might also suffer if the rules will be to strict [19].

There is no doubt the standardized international e-health with common digital data format can improve many segments of health care industry. Whether the universal standardization be developed by collaborations of private industries or through the government policies there are three major aspects which needs to be covered in

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order to make international e-health successful. The three main pillars which need to be accomplished are [19]:

- **Technical interoperability**

E-health in any form whether it will be remote diagnostic system or simple EMR will be successful only if the high level of interoperability will be supported. The exchanged data between various industries must be compatible amongst different facilities and medical devices [19].

- **Economic efficiency**

The potential investors will invest in the proposed e-health solution only in case if the proposed model will have long life cycle on the market. Also from the standardization perception the proposition must be solid and ensure investors there will not be more and more new standards in upcoming years. From the global point of view proper standardization might help economy to be more stable, create fields for new investment and increase level of competition amongst eHealth system developers and devices providers [19].

- **Public Accountability**

Over the challenges related to the technical standards or specification choices about the overall shape of the electronic health care, decisions which are taken under consideration by the e-health providers and relevant stakeholders should be made with some kind of public accountability. Various fields like individual privacy or access to the data used in e-health should be considered not only in the agreements between inside entities but also with respect of regular patient's requests. If the end user will not trust the system the global e-health development and adoption will suffer drastically resulting maybe even fail of the process [19].

1.2 Shift from regular healthcare to eHealth in Tanzania

Tanzania has developed a national health system since 1961 and decided to supply non-urban population who can access to health service. The health service in Tanzania is complex especially in rural area where the health care delivery is the lowest level in the country. Here they essentially deliver preventive service, which can be offered in homes. Normally the village government amongst the villagers

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choose two village health workers and give them a short training before they start providing services.

- **Primary care**

Governments employ at least two health workers for a village. This happens after a short training. A clinical assistant runs pharmacies. This clinical assistant is a secondary school graduate with two years of training in such as, hygiene, physiology, treatments of common illnesses etc. The clinical assistant supported by an enrolled nurse. Because of the lack of staffs, it is not abnormally to find pharmacies especially in rural area and hard to find districts having these facilities. Instead of this health worker may run the facility and this is without any professional training. Pharmacies provide guiding for protect against diseases and child health care, simple treatment for medical problems during pregnancy (e.g. anemia, help for normal deliveries). Although pharmacies provide these facilities, people from villages prefer to take care by them self; a good example could be delivery time for a pregnant woman.

We have seen the challenges in Primary care so fare in Tanzania especially in rural area. Below we describe the underlying challenges on the adoption of eHealth in Tanzania, which relates generally the use of ICT in healthcare services. The motivation here is aimed the knowledge gap of eHealth adoption for improved healthcare services in Tanzania. [16, 17].

- **E-health model for Tanzania as developing country**

Based on the analysis above there are known issues with current health care sector in Tanzania. The Tanzania as area of interest is developing place which means the technology and communication infrastructure is provided. At the first stage the e-health can be implemented in its preliminary stage which is focused on the patients primary care.

Blue Town company is one of the internet providers around the countryside areas in Tanzania. Another important aspect in order to full fill requirements for the e-health implementation is device for the end user which will be used in order to access the

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data and also sent the health related information's. The level of digitalization around the different hospital facilities is still not clear and further in this report it will be investigated. Even more the level of technology and new solution adoption also will be examined. This will help us to identify how fast potential patients might shift from the old fashioned solution in to more innovative one.

Presented e-health evolution scheme 1.1 in section 1.1.1 shows the changes overtime in the e-health concept. With current infrastructure, mobile devices capability and internet connection the basic e-health system can be implemented in Tanzania. The solution can provide more functionalities than simple EMR which was a milestone in the e-health foundation. In pair with the technology level in Tanzania also the health care system will benefit more, by providing patients additional functionality.

Unfortunately the smart e-health which is in its early stage can't be implemented in Tanzania since there is still many difficulties to implement it even in developed countries. However, continuous progress of electronic devices, applications and technologies in the future can start to use IOT in the higher level. The solutions which are in the test phase in developed countries now, soon can be ready to use and also can be applied in developing areas. Since in developing places technology and society progression is still on-going the implementation process will be faster. When it will happen the current e-health will not be just the solution which provides convenient exchange of data between different parties but also more advanced system with artificial intelligence in the backend.

- **E-health challenges and framework in Tanzania**

The Tanzania ministry of health and social welfare is focused on the e-health solutions as well. The Tanzania national e-health strategy specifies which challenges needs to be faced and how the necessary framework is shaped. Except the issues related to the regular health care like poverty, low level professionals education or ineffectiveness of traditional health care, there are also challenges in the ICT field[24].

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- *E-health challenges in the ICT field*

The ICT issues which needs to be overcome in order to provide electronic health care solution were identified through the consultations with a key stakeholders. The discussion was focused on the current ICT services and how advanced is the infrastructure in the country. Another aspect of discussion was about the health related data, how it will be collected and managed, referral ambiguities that can cause loss of patients monitoring ability. The discussion also included points about best monitoring and practices for patients monitoring and evaluation. The last point of interest was about the infrastructure and information pathway for a network of service providers [24].

Based on this debate the main issues were identified:

- Lack of coordination on ICT matters between various stakeholders
- Different percepction of e-health from various stakeholders
- Lack of ICT infrastructure
- Not sufficient number of ICT qualified workers

- *E-health framework in Tanzania*

The main goal of e-health implementation in Tanzania is to change traditional health care system in to more advanced by use of ICT technologies. Nevertheless, before the transformation can begin the current health care sector must understand how and what will be changed. In order to make it clear the Tanzania Ministry and health care stakeholders established the enterprise architecture as a development framework for e-health.

The Ministry developed a framework according to which electronic health care will be implemented. The goal of developed framework is to allow the Ministry itself and other stakeholders to accomplish particular goals:

- Understand what currently exist in health care system
- Understand the new compenents and see how they will fit in to current structures
- Define data structures in order to make it suitable for current needs
- Explain how the technology and other resources will be used

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The image below presents developed by Ministry and relevant for the healthcare stakeholders' framework of e-health implementation in Tanzania.

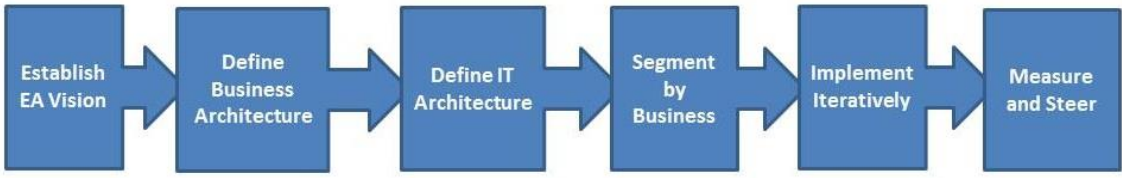

Figure 1.9 eHealth implementation framework

The figure presents the framework of e-health implementation. The framework contains 6 phases focused on the different goals

On the model above 6 stages is presented which needs to be completed. First stage objective is to establish rest of the blocks in order to successfully implement e-health. Second and third stage are focused on the defining and managing the finances, medicines HR at health facilities and IT architecture. In the fourth stage the e-health solution which will be developed based on the previous definitions is segmented by Business perspectives. In this stage relevant business stakeholders can understand what and how the solution will be made in order to invest on it. In the fifth stage the implementation phase is starting but iteratively, which means the solution is build step by step until it will be fully functional. The last phase is to measure effectiveness and steer the project. Also lack or issues are identified there which means during next iteration changes can be made. According to the official e-health action plan released by the Tanzania Ministry the whole project is estimated to be completed at the end of 2018[25].

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1.3 Problem definition

We have seen so far from the introduction to motivation and background, that there are big difference and challenges between developed countries and developing countries within eHealth. Some of the challenges are lack of infrastructure and resources far behind in developing countries, and education to use and maintain the technology is often lacking.

Therefore, this become motivation for us as engineer to research on how to enhance and improve the current health situation in rural area in Tanzania. Also, motivate people to use more doctors and clinics.

As we mentioned earlier this project collaborates with the company BlueTown, which is focusing 100% on rural area communication solution in one of the developing country Tanzania. In Tanzania BlueTown provides a solution with end-to-end communication with the people's needs. This solution is cost efficient, which uses standard technology which a limited level of maintenance. Since BlueTown already have a platform there, our initial idea of this project to improve the platform with additional new features, which is eHealth.

To illustrate more the situation, the figure below shows the overview of the problem definition, which is showed from the architectural perspective.

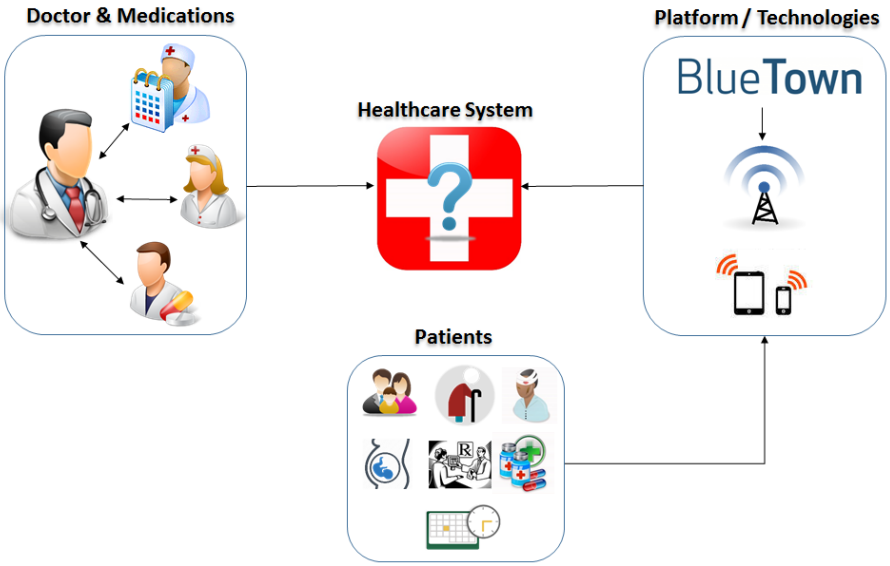

Figure 1.10 Problem definition

This figure illustrate the problem definition of this project

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At the left side box is the doctor who is taking care of patient's appointments and medications collaborate with pharmacist. From the middle "cross sign" indicates health system. The system interact with the platform, which is already provide by BlueTown to acquire real time information for the primary care. With this platform, patients can see when a doctor´s date and time are available, asking a doctor to extend the prescription via online and contact the doctor in case of emergency.

At the right side box is the platform with standard technology. This will be explained in chapter 4. This platform will be used to improve the current healthcare situation in rural are in Tanzania.

At the bottom box is the patient with different situation, whom shown as middle player. They interact to both standard technologies, healthcare and the doctors. As you can see, the arrows show the flow of the communication and the interaction between the entities.

Once the picture above is explained and by considering the objectives stated in above we have narrowed the research question for this project.

RQ: How should health care based on Portable mobile device should be designed in order to improve efficiency and quality of Primary care in rural area in Tanzania?

1. How to identify the current issues related to Primary care in rural area in Tanzania?
2. Any possibility to optimize the regular health sector and health service by introducing ICT solution?
3. What are the current ICT mobile-based solution in Tanzania?
4. How to introduce and encourage people to use eHealth?
5. How the existing infrastructure platform will support eHealth?

It is important to understand these challenges so that solution can be made which can help improving the health care situation in Tanzania.

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1.4 Project delimitation

The scope of this project is to build an eHealth application for people living in the rural areas of Tanzania. This task is achieved through the collaboration with BlueTown, which already has built a platform with BlueTown devices, infrastructures and internet. The application is not meant to be used in professional way since it is at the prototype level, so that is why the focus in the project will lay on mostly analysing and designing whereas implementation will be smaller part. The application will illustrate how the integration between doctor and patient's, patients' health records, ePrescription and awareness of diseases will be handled.

- **Project delimitation of this project**

  As it was mentioned in project scope above, the general idea of this project is to develop a prototype, which is providing a basis eHealth application service. Our project will focus on reusing the existing technologies and some relevant healthcare application for inspiration to build a new fresh health care system to be smarter, more efficient and improve quality of Primary care. Our decisions came from the points we have mentioned on the motivation, background, problem definition and then scenarios which presents various difficult situations related to the primary care.

  Below we are listing the points, which we will not cover in this project due to the recourses and time allocation.

Delimitation

- The eHealth application version beta, will not run into iOS, Windows or blackberry OS.
- We will not implement cloud based storage for this beta version
- From the business perspective we will not use any business theories or business model to illustrate EHS.
- We will not implement external server to run EHS database.
- We won't focus on privacy or security in patient healthcare records in the application.
- We will not implement the doctor and pharmacist site of application.

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CHAPTER 2

2. Methodology

Once we have outlined the topic for this project by discussion with BlueTown and by reviewing academic papers, statistics paper about eHealth in the previous part. This chapter will help us to identify in which strategies our research will be take on as well as identify the best development approach to be used. This technique describes the tool and the process that we are used to collect the necessary data according to our research which help is to formulate the problem area for this project and delimit to the specify area.

There are numerous ways to gathering accurate requirements for an engineering project. In the project, we are used, theoretical approach model in conjunction with the agile development methods. This is necessary for having a clear and structured way of project work, which helps in order to manage the time and work progress in the better manner.

The upcoming subchapters will explain why we have chosen these techniques and illustrate how we implemented them practically. We will start by presenting an introduction to our project planning in subchapter 2.1, followed by the theoretical approach model in subchapter 2.2. Here we will go through each stages in methodology and explain them. Thereafter we will go through the agile development model in subchapter 2.3, where we explain how and for what we are using this particular method.

2.1 Project planning

Theoretical approach model together with Unified process been used as a planning procedure. Agile development is used to planning process for the software development.

Project problems have been discussed and valuable input has been received by our project supervisor Kim Høegskilde and the supervisor from our university Samant Khajuria during the weekly meetings.

The Unified Process model is combined with the theoretical approach model, which used to break down the project into concrete tasks for the project. The milestone for this project can be found in *Appendix 2* and in *Appendix 5*, the detailed time schedule, which is the most fine grained of the planning tools can be found.

2.2 Theoretical approach

This subchapter presents the procedures, which was executed on how to deal with the issue within the problem area and develop the corresponding solution. The methods used for the design and implementation stage will be explicitly different from the research method.

The diagram below shows the workflow of our project development. Blue boxes are the phases in our workflow. Each phases has its own procedure, one phase could have more than one procedures.

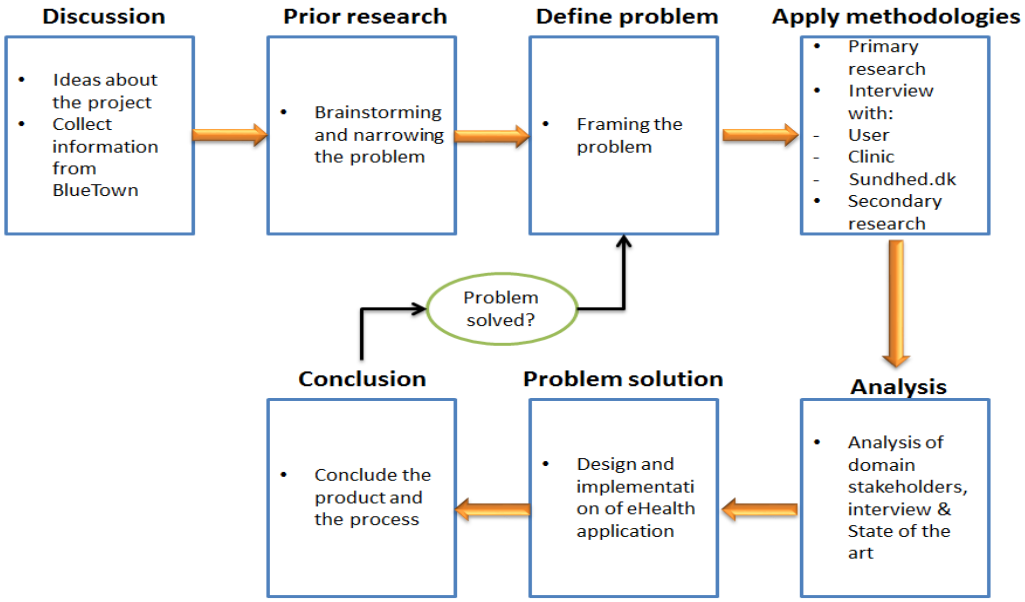

Figure 2.1 Methodology

Figure above illustrates the Methodology process divided between particular stages. Inside each stage the specific dealings are described

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- **Discussion**

  Since this project is collaborate with BlueTown, the workflow starts from the discussion stage. Here we need to collect the information about BlueTown such as,

  - What they are doing?
  - How they are doing?
  - Where they are doing?

  This will help us to find ideas to the topic for the project. Once we are done with discussion we are ready to move to next stage, which is Prior research. This is the phase where we need to perform brainstorming and then narrowing the problem.

- **Prior Research**

  After having number of discussions and ideas about the project with BlueTown, our main objective was to find a relevant topic and formulate a problem within the topic. Here we will work as one body in order to achieve desired goal. Throughout the next step we performed brainstorming which based on the discussion and pre-research within the area of interest. The outcome of the brainstorming was identification of the problems, which we are searching for our project. This will be the particular problem, which is going to be investigated further.

- **Define Problem**

  This stage we are framing the problem, which means the problem definition to set forward the project with many different areas such as what kind data are required for our researches and analysis in order to solve the problem with eHealth system. Since this the master project, we were motivated to examine different subjects from previous semesters and use them.

- **Apply methodologies**

  Since the problem, area is broad and it is very important to accumulate the necessary information to understand where to center our topic with the limited time. Here we decided to use quantitative (Secondary research) and qualitative (Primary research) methods in order to collect the data. As primary research, we conducted interviews with eHealth system in

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Denmark, a clinic representative and a user who already integrated with the BlueTown system. As secondary research, we used researches by investigating the available literature.

- **Analysis**
  The fifth stage is the Analysis part; here we are focusing on elaboration, which based on the State-of-the-art, interview data, and the problem definition and findings. The expected outcome of this stage will be the proposed software design, which based on the analysis system requirements. In this stage, it will be more reflect on our problem solution, which is the sixth stage where there will be design and implementation of eHealth application.

- **Problem solution**
  Once the analysis part is done, it is easier to design the concept for the implementation. In this stage, we are going to design the eHealth concept, when the design is completed; the next step is implement the design into prototype of eHealth application. When the prototype outcome is at demanded level then we are achieved our goal. The last stage is conclude the whole process and the product.

- **Conclusion**
  The final process of the project that can be seen in the diagram is the conclusions of our work on the product and the project process. Here an arrow going, back to our problem definition stage to review if we have answered and solved the problem and this closing the loop of the process.

2.3 Agile development model

There are many software development techniques available nowadays. Before we select the suitable method, as developers we must first consider other aspects e.g. market needs, user requirements or what technology can we use to develop.

For the problem solution stage, we decided to use agile development method. The agile development method for an iterative and incremental software development

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approach. It is a popular development methodology for small and medium size projects. Since development, part from this project is not a big part, the agile suits perfect for a prototype development. In addition, mostly software-based companies are using agile methodology for their workflow.

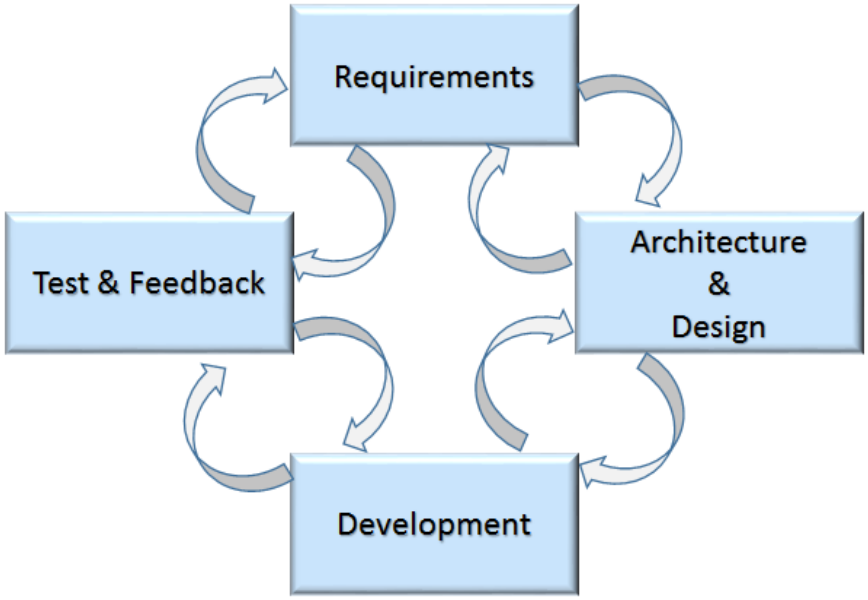

Figure 2.2 Agile model

Figure above presents software development methodology named Agile. The development process is divided between four main stages which are completed during each iteration

The figure above illustrates how the agile workflow is. It shows the process of the software development by the main four elements.

First phase is to gather user requirements, this help to create the system design and architecture. Now we can move to the development phase from the design. Once we are complete the development then the testing phase is executed. The feedbacks are from managers and users in collaboration, which ensure the quality of the product to be top level. By following these phase, the outcome prototype quality and features can be stratify both the users and the company who fulfil the user needs.

The Agile model will be used in order to deliver a testable product after each agile iteration to the users in order to get the feedback. The developed application will at the beginning present prototype version, which will provide basic functionality. After testing and getting feedback from the real users all the aspect which are missing or not accurate will be taken under the scope in order to be modified. The

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proposed application will be in the shaping process which will be strongly correlated with respect of users requirements. The use of Agile method can ensure us as a developers the development phase will be dynamic and vulnerable for the changes.

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CHAPTER 3

3. State of the Art

In this chapter, we will look at the relevant existing eHealth solutions based on portable mobile devices, which are currently available in developed countries. The idea is to indicate adoption of eHealth solutions from developed countries and later compare them to identify the suitable choices for the developing country Tanzania.

- **HealthMemo**

  It is a solution, which used to upload and maintain a user's health records electronically. This app is designed to fulfil the gap between hospital/clinics and patients. With HealthMemo app, a user can maintain all his/her digital documents (visiting a doctor for illness, prescriptions, medical bills, etc.) [26].

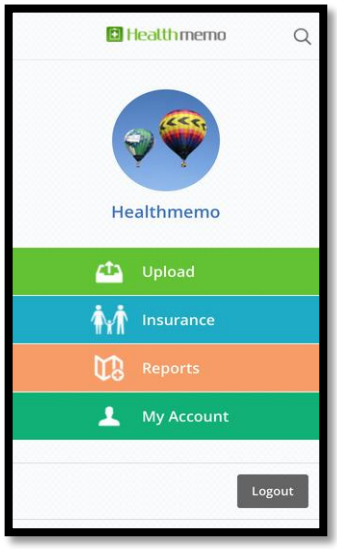

Figure 3.1 HealthMemo app [26]

Figure illustrates the main screen of mobile eHealth application named HealthMemo

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- With HealthMemo, users can access their health records (any hospital visit or emergency).
- With HealthMemo, users can access their medical records (add/delete or modify).
- With HealthMemo, users can capture and upload their health records using their phone's camera within the app or select form the phone´s gallery.
- Users maintain their health records with advance encryption technology.
- Users can mail the document to themselves or download to their mobile phones.
- They also can upload insurance records, policy number and other related notes.

- **iTriage**

  It is a healthcare anywhere, anytime free app. Users can search answer within health using iTriage health app. iTriage gives access to big databases such as healthcare and medical, then the users can find answers with their devices for medications, diseases and locations for medical. It will also help to find the most appropriate treatment, facility or doctor for the searched symptoms [27].

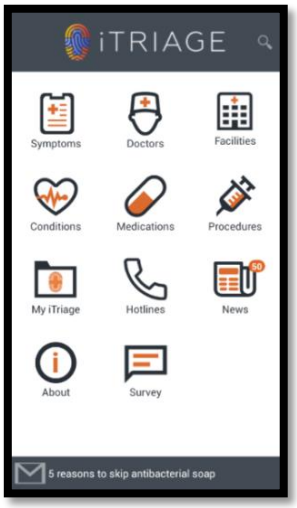

Figure 3.2 iTriage app [27]

This figure illustrates the main screen of iTriage mobile application which is one of the eHealth state of the art solution

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- With iTriage a user can find any doctor or physician quickly and easily
- With iTriage a user can find thousands of medical symptoms,
  - Diseases
  - Conditions
  - Medications
  - Drugs
- Find the nearest hospital, emergency room, pharmacy etc.
- With this app, a user´s waiting time for select hospital emergency room and urgent care facilities is average.
- A user can setup an appointment through iTriage (e.g. for a doctor, physician, nurse advice lines).
- A user can store his/her personal healthcare facilities, doctors, and diseases and so on.
- A user can view the stored personal record with Microsoft HealthVault.

- **Contact Doctor**

The solution is integrated platform which connects various medical services platforms together in order to provide patients primary care features through the mobile device. This solution main goal is to extend the on-line live video consultations between patients and the particular specialists.

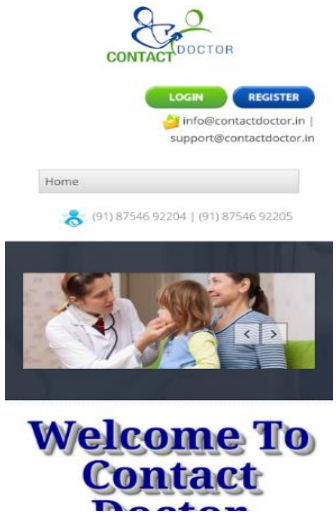

Figure 3.3 Contact Doctor app [28]

This figure displays the Contact Doctor home screen design

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Since the Contact Doctor mobile application integrates various platforms in to one, it provides many interesting features for the patients. The functionality helps users to increase frequency of the consultations between them and the Doctors. The core option is to provide extended video consultation instead of regular one helping patients to safe time [28]. Even more the application also supports other health related functionalities, which are allowing patients to:

- Book the appointment with the demanded specialist
- Order medicines and later deliver it directly to patient home
- Use the home care services which are included in the app
- Posting health related questions in order to receive feedback

- **NCORD's eHealth Card**

This application enables user to access his health related information's at any time when it is demanded. The information's are directly linked to the NCORD Global Health card system. The health related data easy accessibility ensures patients health status is all the time available.

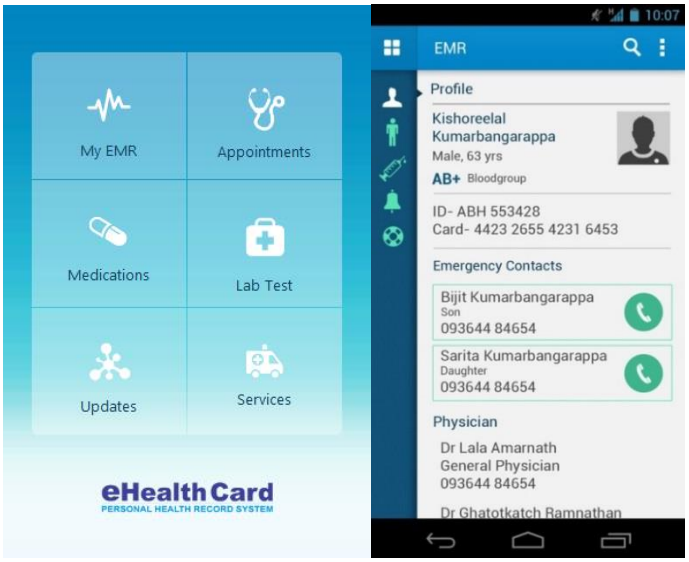

Figure 3.4 NCORD eHealth solution app [29]

The figure presents another eHealth application main screen and patient profile layout on the mobile device.

The application key functionalities support particular set of activities which are related to the primary care. The information's are taken directly from the healthcare system and then displayed on the patient mobile device. In addition

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the NCORD eHealth solution also provides more extended functionalities which in this case are: [29]

- Access to the list of Medication
- Possibility to book appointments with a Doctor via app
- Access pathology prescription
- Requests for blood banks and other services which are included

- **St. Luke's MedConnect**

The MedConnect solution is an easy to use application for mobile devices, which connects patients with St.Luke medical centre. The Centre provides services, which can be used via the application. The features are aimed in the primary care and the key functionalities include many interesting and also important options for the patients.

Figure 3.5 ST.Luke MedConnect app [30]

The figure presents St.Luke MedConnect eHealth application home screen.

The main functionalities of the MedConnect application allow patients to interconnect with a Clinic via mobile devices in order to: [30]

- Find a particular doctor
- Book the appointment with selected specialist
- Access the medical record
- Contact the St.Luke emergency service

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- **HealthOnPhone**

The application is a free platform where user can upload and later analyze his medical documents like records or prescriptions. In addition this solution also measure daily health records related to the level of blood sugar, body weight, Cholesterol, exercise etc. The results are displayed in the graph in order to be better understandable. The application also is supported by the selected hospitals and diagnostic centers. The application API can be used in order to allow user access his medical reports remotely simply by usage of mobile device. Also lab notes and results can be available through the app helping patients to save a time and be updated [31].

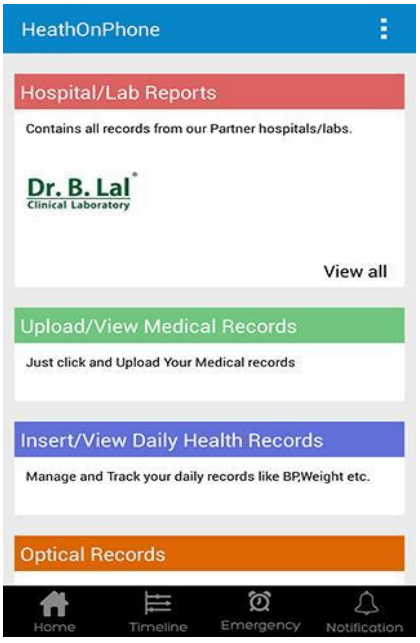

Figure 3.6 Health on the phone app [31]

The figure illustrates Health on the phone application displayed on the mobile device

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- **MedCitas Paciente**

Medicitas is the platform, which connects patients and doctors together. The MedCitas solution allows patients to book and customize the appointments at any time. This application is focused on the contacting patient's with specialists.

Figure 3.7 MedCitas paciente app [32]

The figure shows MedCitas eHealth solution. On the screenshots of the favourite doctors and appointments are presented

The MedCitas provides various functionalities based mostly on the primary care. The features allow patients to search for a Doctor based on the personalized criteria. Additionally the MedCitas solution supports more advanced features related to the appointments management like for instance alerts or possibility to rank a particular doctor after consultation. This app also helps to build a trust between patients and the specialists since the Doctors rankings are provided [32].

3.1 Comparison summary

App features / App name	HealthMemo	iTriage	Contact Doctor	NCORD´s eHealth Card	MedConnect	HealthOnPhone	MedCitas Paciente
Personal profile (EMR)	✓ Health records ✓ Medical records	✓ View personal records using Microsoft HealthVault	✓ Possibilities to login but no ERM support	✓ Medical records	✓ Medical records	✓ Medical records ✓ Health records	NA
Medication (prescription)	NA	NA	✓ Order medicines and then deliver to the patient home	✓ Access to the medication list	NA	NA	NA
Book appointment	NA	✓ Possibility to setup an appointment with a doctor	✓ Book an appointment with the demanded specialist	✓ Possibilities to book an appointment with a demanded specialist	✓ Possibilities to book an appointment with a demanded specialist	NA	✓ Possibilities to book an appointment with a demanded specialist
Emergency (call the doctor immediately)	✓ Upload pictures about illnesses	✓ Hotlines	✓ Ambulance services on emergencies	✓ Ambulance services on emergencies	✓ Emergency care	✓ Upload pictures about illnesses ✓ Emergency service	NA
Search diseases awareness	NA	✓ Possibility to search health related information	NA	NA	✓ Possibility to search health related information	NA	NA
Possibilities to find the nearest hospital/doctors/pharmacy	NA	✓ Possibilities to find medications locations for medical/pharmacy	NA	NA	✓ Possibilities to find a particular doctor	NA	✓ Possibilities to find a particular doctor
Other	✓ Upload insurance documents, policy numbers etc.	✓ News ✓ Insurance ✓ Saved allergies ✓ 3D human body illustrating	✓ Ask health related question and get feedback ✓ Online video consultations ✓ Diagnostic lab services at home	✓ Lab test ✓ Request for blood banks ✓ Other services	✓ Health tips	✓ Lab and other results ✓ Give feedback ✓ Notification (e.g. feedback)	✓ Ratings ✓ Online chat with the doctor

Table 1 Comparison of existing healthcare apps
The table illustrates relevant comparison of existing healthcare application.

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The comparison made in the table above has helped to identify which features in the current e-health solutions are mostly missing. From the results the missing functionalities are related to the user profile and possibility for the patient to have access to his electronic medical record (EMR). Another important lack is availability to have prescription in the electronic version from various type of specialists like for instance Adult or Pediatric.

Analysing further existing e-health mobile applications, discovered lacks were related to the patients' appointments handling. Some of the solutions don't give the feature which allows patient to book appointment or find the nearest hospital/doctor/pharmacy via app. Furthermore in many of the existing solutions the video consultations between doctors and patients are not supported as well.

Besides the Emergency and FQA features which will help patient to contact doctor directly or find the answer for demanded questions in case of life threat situation is missing in many applications. The last missing and important thing is functionality which will help patients to prevent particular sickness or viruses. The diseases awareness is often lacking resulting people to get sick more frequently since there is no practical information about how to protect them self's.

To summarize state of the art solutions the main lacks in e-health apps are pointed below:

- EMR
- Prescription (Adult and Pediatric)
- Book appointment
- Emergency
- Diseases awareness
- Possibilities to find the nearest hospital/doctors/pharmacy
- Video consultation
- FAQ
- Medication

In addition it is also important to mention the research included applications not only from Europe but from all around the world. The selected application were chosen based on the functionalities which supports primary care, but not due the location where it is used.

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CHAPTER 4

4. Technical background

This chapter presents the platform and the technologies, which will be used in order to implement the first version of eHealth android application. This application will be implemented by us in collaborates with BlueTown.

Below we decided to break the implementation of technology part into two parts. The first part describes the technology itself and the second part explains how each technologies will be used in our project.

- **Platform**

  The platform is the company BlueTown, which bridges our eHealth application to the users in rural area in Tanzania. BlueTown is an Innovative international technology company, which are located in Demark. There are focusing 100% on rural area communications solutions in developing countries.

  BlueTown's core offering is ultra-low cost end-to-end communication solution for delivering access to VoIP, internet and content. The communication platform is Wireless connection to Internet and mobile network via mobile phones without SIM card. This platform is based on cost efficient technology and includes their own power supply based on solar energy. The rural area people connect to the internet and access services, applications and content, video calls and VoIP through a BlueTown hotspot using Bluetooth or Wi-Fi [33].

  How the Platform is used in our project
  Since BlueTown already has a platform there, it is easier for us to deliver the eHealth app for the users.

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- **Android**

Android is an open source platform, which designed for mobile devices. It is the bridge to offer the users a richer, less expensive and better mobile experience. From the developers point of view Android provides all the tools and frameworks for developing mobile apps quickly and easily. All the developers need is Android SDK to start the developing process [39].

There are advantages of the Android but the same time there are also disadvantages of it. The main advantages in the Android system are multitasking, easy to implement notifications and support from many developers. Important aspect is also that the system is updated with close collaboration with the user who develops new updates making the Android more solid and interoperable.

However, the open source code is also the main disadvantage of the Google operating system. Since everyone can check how the system is structured it is easier to find a bugs and use it against the users. It is very important to continuously install new updates or latest versions of the Android apps in order to increase level of security.

How Android used in our project

Since BlueTown providing Android devices to their users, our implementation will be an Android based app. When users need a doctor appointment or extent medications prescription, they can use the developed app which will fulfill their needs.

- **Cloud technology**

The high level of virtualization was a main reason which allows to invent cloud computing. The concept behind cloud technology is to deliver various computer services through the Internet. The services itself might be used by individual users as well like a business one. The virtual software and hardware can be managed remotely by third parties vendors. The cloud services are still expanding allows to use more and more different features like for instance online file storage, webmail's or various online business applications.

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The main advantage behind cloud computing is possibility to access the services remotely from any place and anywhere. The requirement in order to access resources which cloud provide is to have active Internet connection. The solution also provides shared resources like for instance processing power or storage capacity. The cloud computing is divided in to three services models. The figure below presents particular service which can be used within the cloud.

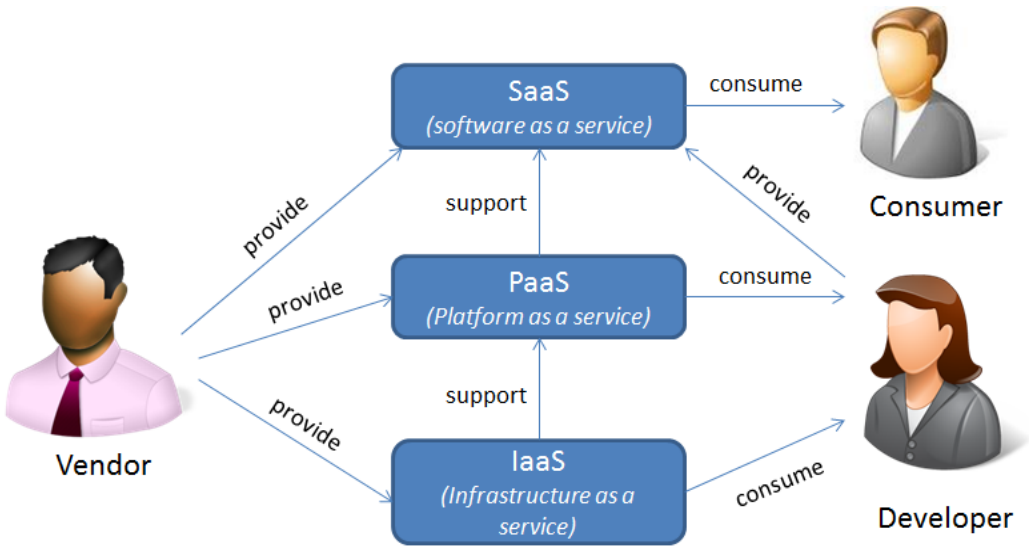

Figure 4.1 Cloud services

The figure above shows three type of cloud services. From the top there is Software as a Service which is delivered directly from vendor to the costumer. The next two presented services are Platform as a service and Infrastructure as a Service which supports the first service, but also can be used independent

As it is showed on the picture above the first solution is Software as a Service (SaaS) where pre-made applications along with demanded software and operating systems are provided. The second model is Platform as a Service (PaaS) and in this model user is allowed to install and develop his own software using virtual hardware as a platform where an operating system is provided. The third model provides just hardware and network and it is known as infrastructure as a service (IaaS) and network, so user develops or installs his own applications.

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By use of cloud many advantage can be gained by the user or even the whole industry. Being in the cloud helps to reduce physical costs which are required for IT software and hardware. Also more flexible scalability, reliability and efficiency are provided [34].

Nevertheless, amongst many benefits which cloud brings there are also some issues which are mainly related with privacy and security. The large volume of data which is traveling through the web and stored in different locations around the world brings many concerns not only for the users but also for the companies. The information's which are stored are often very sensitive so the trust for cloud computing in this case might be reduced [35].

How cloud can be used in our project

The cloud computing is important for the project because Blue Town platform will include their "own cloud" as a part of the system. From the company representatives it was explained that in the near future the most demanded data will be stored in the Blue Town own cloud whereby it will be possible to access it locally without need to have Internet connection.

Since in the rural areas in Tanzania there are problems with the coverage the own cloud might be used in order to store patient's electronic medical records. This ensures the patient data might be always accessed during the treatment no matter of internet availability at the moment.

- **MySQL**

This is the one of most popular open source database software. MySQL is developed supported and distributed by the Oracle industry. This database system allows to manage the whole system in the organized manner. The database concept represents structured collection of data in the tables. Nowadays every information might be stored in to databases. From the simple client information's up to collection of many various data which can be related to the other tables creating so called relational databases systems. These are more complex systems, however very effective because big mount of data is distributed amongst various tables. It makes it easier to understand more complex database system and also to edit and correct it.

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The advantage of MySQL system is the license which is open source. It means the application might be modified for the personal needs by everyone who use it. Also the MySQL server is reliable and fast so many processes are simple to complete like for instance scalability. The server also works as a client-server communication or might be implemented in more embedded systems as well. Because the continuous development of MySQL with close collaboration with users there is many additional features which are supported like for example different programming languages [36].

How MySQL is used in our project

MySQL is one of the most popular database management system. Because it is developed also by the users the extensive features and supports for a various programming languages are provided. The eHealth application will require relational database system which will collaborate with Android SDK and maybe in the future with more different API's. In addition the editing and expanding database is easy and efficient by use of MySQL. The important aspect is also that MySQL databases can be implemented easily in the cloud.

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CHAPTER 5

5. Problem analysis

With this chapter, we are going further with the problem we are investigating to improve efficiency and quality of Primary care in rural area in Tanzania.

In the beginning of the subchapter 5.1, we will describe the current health system in Tanzania; this will help us to identify the facts. Afterwards, we will discuss our findings from the interviews we have conducted in subchapter 5.2, which will help to illustrate some real life user scenarios in subchapter 5.3. We will reflect these findings and the facts on the system analysis on subchapter 5.4, which help to create the firs design of the eHealth system, which is Context diagram.

Once we have done with the system analysis, we can go through the process of specifying the requirements for our eHealth application prototype. At the end of the chapter 5.7, we will illustrate how the users can interact with the eHealth system in order to fulfil the particular of their needs using Use case diagram

5.1 Interview analysis

Here we are pointing out the findings from the interviews as one of the method in primary research. Using interviews is the best way for us to have a clear detailed answer for our research question as well. These interviews are done collaborates with our contact person and BlueTown's employee in Tanzania Kareen Limbe, who interviewed BlueTown users and illustrated a demo about the eHealth idea. She has also conducted an interview with a doctor about this idea.

There are two interviews conducted. The first interview with users, who are currently dealing with BlueTown device. The ide with the second interview was to find out from the doctor's point of view.

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5.1.1 *Interview with BlueTown users*

The section presents the conclusion of conducted by Kareen Limbe interview with potential users from Tanzania. The first part contains interview with the following users, Habiba Kassim, Rehema Selemani, Mohammed Juma, Mnafu Mmari, Kareen Limbe and Dr. Mbusso.

The second part presents the conclusion of the interviewed doctor point of view about applying eHealth solution. At the end the overall feedback from the conducted interviews is presented.

Q1: Are you familiar with usage of smartphone and do you know how to use an internet on the mobile device?

There are only about 6% of the population are smartphone users and 10% know how to use the internet on their mobile phones.

Q2: Is there reliable internet connection provided in your neighborhood?

There is no reliable internet, they are served from the 3G towers but with the slowest set up (edge) which makes it hard to even open a normal page thus the ones who got phones from BlueTown were really enjoying the service.

Q3: Are you using any mobile service like for example mobile payment? Is it difficult to learn how to use it?

Most of users are just using mobile payment services, which do not require the internet. E.g. M-pesa and Tigopesa.

Q4: In your opinion the mobile application should be represented more in the contextual level (pictures) or text based in order to be better understood for You?

The respond was, text is preferable, which makes it easier to follow the requirements.

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Q5: How often You are contacting your doctor?

Users contact with the Doctor is on a very minimal level, only when necessary, very few people call their doctors just to enquire on things, in fact even the Doctors do not give out their phone numbers to their patients unless necessary.

Q6: Are you contacting Your doctor more through the regular visit's or through the phone call?

Contact with the Doctor is mainly through visit, phone calls are on rare occasions.

Q7: What's are the main obstacles when contacting or visiting the doctor?

Main obstacles when contacting the Doctor is they hardly give out their numbers and when they do they hardly pick up because they are busy with other patients or sometimes people call for no particular reason or emergency, when it comes to visiting it is the availability of the Doctor or the Queue to get to see the Doctor.

Q8: Do you have access to your personal healthcare records and is it relevant for You?

They do not really have access to their records, most details are in the patient files in the hospital, and the copies given to patients easily get lost since they are not well kept. Records are very relevant for sometimes you need them for reference in other hospitals.

Q9: Is the process of getting medicine prescription is good enough? What are the issues?

The process of getting prescription isn't so bad as the Doctor prescribes when you visit but it is getting the medicine that is hard, chances are you would have to travel far to get medicine prescribed because maybe they are unavailable or finished in the dispensary.

Q10: Would You use Your smartphone and internet in order to book a visit with the Doctor if it will be faster?

Yes, they would definitely use smartphones and internet if that would make the visits faster.

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Q11: Would You prefer to receive medicine prescription in the electronic form, so the realization process will be simpler?

It is not a preference but it would be good to get prescription electronically for record keeping.

Q12: Do You often checking the updates about new viruses in order to know how to prevent your self? What are the main sources of accesing these information's?

They hardly check the updates on new viruses unless it has caught their attention or they have it and sources for information is usually the Doctor or nurses, very few read about it.

Q13: What other options might be helpful in order to make healthcare process simpler?

Health Tips Eg. Bad symptoms for Pregnant women, How to prevent from HIV, find out alternative medications for the prescribed one.

Q14: If the process of prescription, doctor visits and emergency situation will be more efficient and faster by use of smartphone and internet would this will encourage you to use mobile device to do so?

It would so encourage people to use their mobile phones as that is an important aspect in life and it would help reduce health ignorance, which goes on now just to avoid hospital issues.

5.1.2 *Doctor Mbusso's opinion about the idea*

Our contact person, Kareen presented the initial idea of our project to Dr. Mbusso. He believes this eHealth application be very useful in their area, especially since people are neglected to attend the hospital for avoiding inconveniences. Later they are go with bigger problems that could have been discovered at an early stage.

Overall feedback

After those interviews conducted and we asked Kareen about how was these interviews and how people´s reaction for the eHealth application. She said overall our idea was well received, their suggestion was only that application made as simple as possible so that even the most uneducated person can be able to use it.

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5.2 Scenarios

With these scenarios below, we are elaborating the consequence of inadequate of current healthcare system in rural area in Tanzania by introducing the real scenarios, which are facing the patients in their daily lives. When we were looking in depth by analyzing the interview data and research articles about healthcare in Tanzania, the current healthcare system fare behind compared to developed countries.

The causes are challenges in ICT infrastructures and lack of resources, in addition education to use and maintain the technology is often lacking. We have seen from the interview data that, doctor and patient's communication is on very minimal level, the patients only contacting when it is necessary, very few people call their doctors just to ask about things. Doctors do not give their phone numbers to their patients, only when is important.

Doctor needs to well maintain their patients and the same way the patients need to communicate with the doctors flexibly. Furthermore, we have seen it is hard to get medicine, patients need to travel far to get prescribed medicine, cause they are unavailable or finished in the dispensary.

The scenarios below illustrates, challenges in doctor-patient communication, challenges in prescribed medicines situation, challenges in keep the health records safe, challenges in symptoms/illnesses awareness.

5.2.1 *Scenario 1: Irene uses her mobile phone for contacting her doctor*

Figure 5.1 Scenario1-Patient and doctor communication
The figure above visualizes the concept of lack of patient-doctor communication

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Irene is a housewife who lives with her husband and three children in a village in Tanzania. She is a self-confident person, mostly she taking care of house stuff by self while her husband working lot to take care of the family. Since she is a self-confident, even when she is ill or her children is ill, she wants to always take care of by self. Irene not thinking directly to go to doctor only when it is really needed.

Sometime she has painful stomach pain but it soon goes over, but one day Irene has a painful stomach pain again but it stays for a while, she could not handle by herself anymore. Since she is not visiting doctor so often, she does not know how to handle it now. She tries to call her doctor but the line was busy. Since she could not reach him, and does not know about if he is available or not.

Irene arrives at the hospital with her stomach pain, and needs wait in the waiting room until the doctor is available, she feels a little anxious of her stomach problem and what the doctor going to say about it. Eventually her time comes in and she go in and tell the doctor about the first reason she came for. The doctor asks the question, which she was nervous about, even she, is quite a confident person at home but strangely she could not front of her doctor, she does not feel able to speak directly, but she answered for what the doctor asked about her stomach pain, the doctor listening and typing things on his computer. The doctor warns her and tells her to contact him directly when she feels like this again and gives her his number and a prescribed medicine to her.

She leaves with her prescription and thinking not to make the mistake again and hopes in the future the doctor communication will be changed to a better solution. Where she can make an appointment already from home not make the appointment directly at the hospital, which makes wait long in the waiting room or emergency call when she needs directly.

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5.2.2 *Scenario 2: James wants to access his health records from home*

Figure 5.2 Scenario2-Patient wants to access health records
The figure above visualizes the concept missing accessibility of patient health records

James is 50 years old man lives in a small village with son and daughter in Tanzania. His weakness is, his illness, often he forgets things. James children taking care of him, when he forgets things. He is in regular treatment and medications. There is no real options to keep track of things in a proper way according to his health records.

Also in the hospital, they give him copies of his health records as physically, which means he needs to bring it with him sometimes, since he forgets very often, he forgets his health records or sometime he looing it somewhere.

Other issues are since he forgets things often; he also forgets where he lives or if some emergency when he is outside and needs help at the same time his son or daughter are not nearby him which makes things more complicated until he comes back to his normal again. Even if other people wants to help him, they also do not know whom they must contact.

James needs his health records and his other contact data in one place where he can always access. If he forgets things then other people can helping using his contact data to call his son or daughter.

5.2.3 *Scenario 3: Grace wants to acquire her prescribed medicines*

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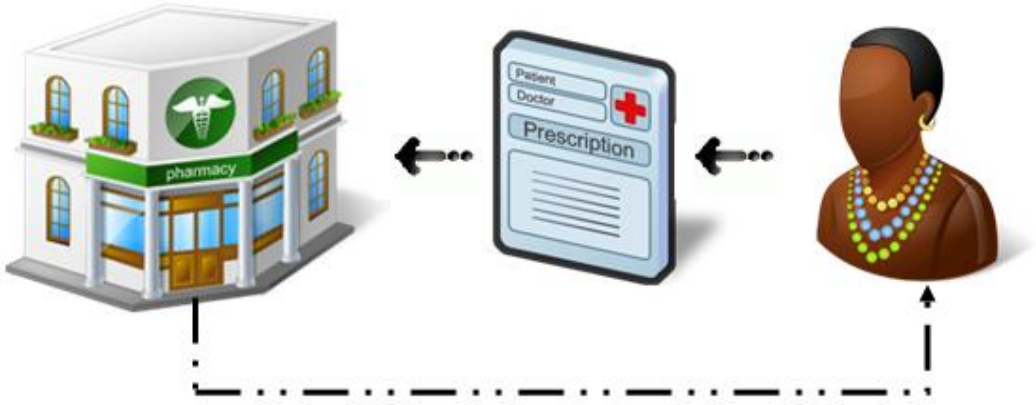

Figure 5.3 Scenario3-Patient wants to acquire prescribed medicines
The figure above visualizes the absence of electronic prescription

Grace is a 35 years old woman living with her husband in a village in Tanzania. They both work hard and save the money to travel sometimes. One day they decided to travel their neighbour country Kenya for a week. They both had a nice trip and came back home after one week.

Then Grace starts to feel high fever, so she went directly to the hospital with her husband. After the doctor checked her up and said she needs medication immediately and the doctor could not say anything about how long it is going to take. Since she needs to take the medicine for a while, she needs long period prescription. However, she cannot have it once, she must visit the doctor every second week to renew the prescription.

This is not the big problem, but getting the medicine is hard, because sometime she needs to travel far to get the prescribed medicine, because it is finished in the dispensary. She finds it will be nice if there is a way to keep the prescriptions in one place also no needs to go to doctor for extant new prescription.

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5.2.4 *Scenario 4: Kennedy wants to access information about malaria*

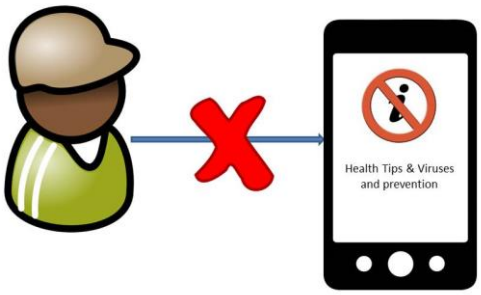

Figure 5.4 Scenario4-Patient wants to access information about diseases

The figure above visualizes the lack of access the relevant information about diseases

Kennedy is 27 years old young and energetic person. He is working as a guard in one of the local factory. Kennedy is having a wife and two daughters and the family is the most precious thing in his life. The husband works hard in order to provide means to live for his wife and two daughters. The factory were Kennedy is working is located far from his home, so every day He is traveling for over 2 hours by bike in order to be on time. Work is tough and because of the travel distance also the time length is extended around 4hours additionally.

Every evening after coming back from home the wife is preparing a supper where family during the eating enjoy each other company while Kennedy is having conversation with wife about every day routines. Almost traditionally after supper tired father is having some free time which can be spent on play with his kids. At late evening the family is getting ready for sleep since next day again brings an effort in order to earn money. Kennedy often feels deep inside he is happy person and his family is everything for him. All the problems suddenly disappear when the exhausted husband lay down next to his wife and falling asleep.

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Later at night suddenly Kennedy started to hear a children cry. Because of tiredness he is still not going out of bed since his mind is still between dream and reality. When the light turned on in his bedroom the child scream became more clear and loud. When Kennedy heard his name shouted by his wife he woke up and in front of his eyes He sees a wife carrying terribly crying child. It was Caramel, the younger daughter of Kennedy, his precious pearl. Wife was panicking also crying with her daughter.

The kid had a terrible fever, red eyes and during coughing the blood was coming out of her small mouth. Both parents in the panic don't know what to do in such case. Suddenly like a star on the black sky one thought came in to Kennedy's mind. It might be Malaria! He hard at his work place the virus is more active in this season than before and even his work mate wife got sick last week. In all fear and shock Kennedy totally lost his all focus.

Now this focus which needs to be present in order to know what to do disappeared in dark fog of fear and tears. Kennedy can't remember what to do and how to recognize if the symptoms actually indicate worst case scenario. There is no way to get information's since Kennedy and his family lives in the rural area. The desperate family doesn't have phone number to any doctor and don't know how to diagnose sick child and what can be done to reduce a fever. Finally after over an hour Kennedy decided to give child some natural weeds which helped to reduce a fever. The child went to sleep and next morning the whole family went to visit a doctor. On the way Kennedy was still thinking how much pain, fear and tears can be spared if there will be a way to access demanded information's about the sickness.

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5.2.5 *Scenario 5: Dr. Mbusso needs to control his patients more frequent*

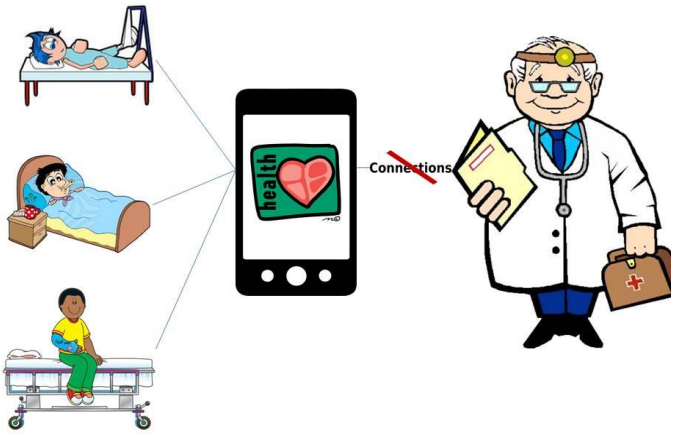

Figure 5.5 Scenario5-No patient monitoring

The figure above visualizes missing possibilities of patient controlling

Another sunny day was bringing positive humor to the people working in the local Hospital. Shinning sun except warming an early morning air was also warming people bodies preparing them for another long day on duty. Early in the morning when Hospital doors squeak and then became wide open by the Doctor, yesterday air flew away bringing the memories from the last day. When Doctor Mbusso crossed the hospital entrance the whole stuff knew another working day started for good. Everyone who knows an old surgeon respects him and admires him not only as a Doctor but also as a person.

When Doctor entered to his office immediately Jeminna who is a lead nurse followed him carrying patients cards which Doctor needs to review during morning coffee. With a smile on her face nurse put the records on the desk and started to prepare coffee for Dr.Mbusso. After short conversation the Doctor remained alone in the office with documents to review. After going through the patients documents one picture kept attention of the Doctor. The image presented a big wound on the left arm. After checking name of the patient the Doctor decided to tell nurse the patient needs to be located as soon as possible. The lead

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nurse started to find ways how to contact a patient. Except the name there was no more information about the patient. After trying various ways the nurse was not able to locate and contact a man. She decided to inform Dr.Mbusso about the situation. When she went to his office doctor had a consultations with one of the patient. After a while when the person left Doctor's office the nurse entered and explained she simply can't locate a patient with wound on his arm. The only way now was just to wait until the injured man will come by himself to the Hospital for consultation. The problem is that an infection of the wound is in very advanced stage so concern Doctor knows soon the arm need to be amputated.

While sitting next to the old wooden desk Dr.Mbusso was feeling sad and disappointed. Almost every day the situation is repeating. The patients who can be saved can't be contacted at any way because usually they are leaving in the rural areas. They can't be found unless they will show up in the Hospital by them self's, but the problem is that it's often too late. The Doctor started to think if there could be any possibility to consult the patient remotely the health monitoring and patients consultation would be more frequent. By this kind of solution many people can be saved.

5.3 System overview

The main purpose of the proposed solution is to provide electronic healthcare system which will help to increase quality of regular healthcare in the rural areas in Tanzania. From the previous sections of this report we discovered many issues related to the healthcare in the areas which are far from the City center. We believe by support of technology which is available in Tanzania the healthcare system can be more advanced and efficient at the same time. Many issues can be reduced if the existing technologies would be combined with the traditional healthcare. Current healthcare solution in Tanzania is outdated and the tools which are necessary to make the improvement are already there.

In order to start the evolution process first of all the necessary technologies are needed. In this case it is required to have reliable Internet connection on the rural areas. Since the Blue Town Company provides Internet around the villages the connection and access to the information is now available. Another important facet is to deliver devices through which end users will be accessing worldwide network.

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Blue Town except providing reliable Internet connection also delivers mobile devices based on the Android operating system. The e-health app will be implemented on those devices providing the end users particular features which support primary care.

As it is shown the basic platform for the eHealth is available. The existing infrastructure now needs to be used in order to connect patients with doctor by use of Blue Town Android based mobile device. In order to make this real eHealth application need to be developed. Furthermore the data which needs to be used must be in the digital form and stored in the database. The cloud technology allows to use virtual servers where the outsourced data can be kept in order to be delivered to the particular parties. The scheme below presents proposed electronic healthcare infrastructure.

Figure 5.6 eHealth solution based on the available infrastructure

The figure above visualizes the overall system architecture for Tanzania. The architecture displays interaction between specialists and patients through the eHealth app. In the figure the gathered data is sent through the various internet connections to the database

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The data in the digital form which will be generated by the hospital specialists will be sent to the database which in the future can be implemented in the cloud. Produced data will include information about patient and his treatment. Even more this kind of electronic medical record will also include information about medications which are taken by the patient and his sickness history as well. The data will be delivered to the cloud by usage of Blue Town infrastructure.

The patients will hold mobile devices which will be connected to the network through the Blue Town platform. Installed eHealth application on the device will provide some certain functionality for the patients. The solution will allow patient to check his health record via app. Also booking appointment with doctor will be now possible without need to go physically to the Hospital in order to arrange consultation. Another important feature gives possibility to receive e-prescription and also check availability of the medicine around the different pharmacies. From the app menu patient will also have practical information's about various sickness and health related tips. The app will depend on the Internet connection since all data will be stored in the external database so in case of the connection problem the message and coverage map with Blue Town closets antennas will be displayed on the screen.

In the other hand from the doctor point of view electronic healthcare system will give possibility to control patient more frequent, contact him in more easy way and provide care on better and more organized manner. By providing e-health solution the Blue Town Company brings new values for the users and ensures also the country development process will increase noticeable since healthcare industry has currently many lacks.

5.4 Context diagram

Once we have analysed applying EHS (eHealth System) in system analysis in subchapter 5.4, we have found the stakeholders who are involving in EHS. However, we do not know how they will interact with EHS. In this section we needed to figure out how they interacting with the EHS.

The context diagram is a first step of the whole design process and the outcome of this diagram will be system requirements. Hereafter, Use case diagram created,

which based on the system requirements. Part of the use case diagram is use cases, which is important tool for the developing process later.

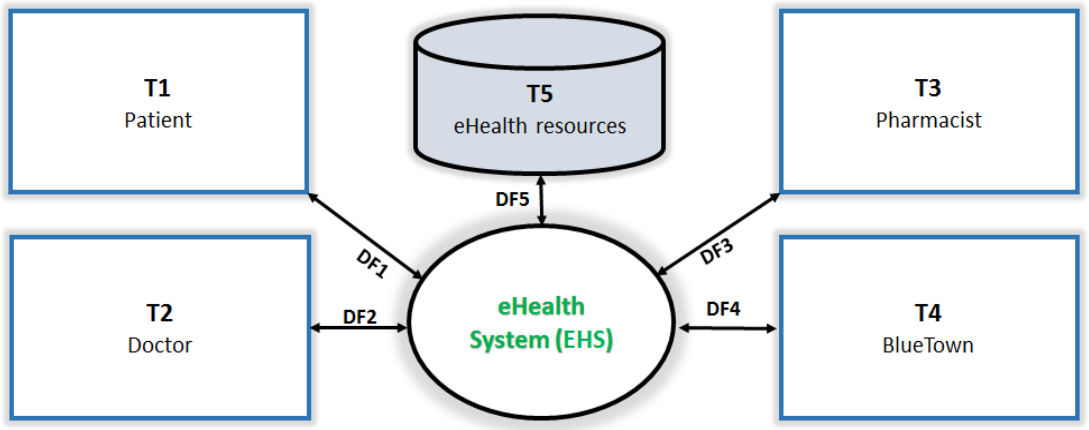

Diagram 1 Context diagram of eHealth system

This is the context diagram of eHealth system the outcome of the system analysis. It is illustrates the different stakeholders of the eHealth system. As we can see, there are five stakeholders, which are Patient, Doctor, Pharmacist, BlueTown and eHealth resources. They represents as terminators who interacts with the system. Each terminator can have its own data flows and control flows. The description of these terminators and their data flows and control flows can be found in the table below. E.g. the terminator one (T1) is a model of Patient, which provides information for instance about what type of patient interact with the system.

The context diagram above illustrates the proposed eHealth solution with the system stakeholders as terminators (T1 to T5). The communications between stakeholders described as data flow (DF).

- The terminator one (T1) is a model of Patient, which provides information about for instance what type of patient interact with the system. The description of T1 can be found in table with row T1 and its data flows found in table row DF1. These rows provide information for instance about how the Patient can be part of the system and the patient´s communication between the system and the patient itself.
- The second terminator (T2) represents the Doctor, similar to the first terminator the description and data flows, which found in the tables below.
- The third terminator (T3) illustrates the Pharmacist, who will update patients 'prescription status in the system where the doctor can always

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check. All the details about this terminator described as data flows in the table row DF3.

- The fourth terminator (T4) is a model of BlueTown, similar to other terminators the description and the communication described as in the table row DF4. BlueTown provides information such as health tips collaborates with the doctor in to the system and updates to the system to keep maintain.
- The last and fifth terminator (T5) illustrates database, which will contain all necessary data such as patients health records, electronic prescriptions, health tips and other necessary data used by the system in order to give better structure and quality in healthcare.

The description above illustrates the full eHealth system solution. For the project there will be selected only few features, which are going to be presented in the prototype version.

The presented table below explains more in details the stakeholders´ interactions, type of data and the role of the various terminators in the system.

Terminators	
T1	• Terminator shall represent a patient who is also a user of the system • Terminator request and receive booking information from the doctor • Terminator shall search available date for an appointment • Terminator can use the system to check the health records • Terminator can use the system to keep electronic prescriptions • Terminator can use the system to search information about illnesses and health tips
T2	• Terminator shall represent a doctor who is also a user of the system • Terminator shall confirm the booking date for the appointment • Terminator can create electronic prescription to the patient • Terminator can reschedule the booked meeting • Terminator can update health records
T3	• Terminator shall represent a pharmacist who is also a user of the system • Terminator identifies the prescription using the patient´s phone number and name.

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	• Terminator update the system about prescription status for a patient after delivered the medicines.
T4	• Terminator shall represent as a service provider • Terminator can provide health tips and other diseases information to the user collaborates with the doctors. • Terminator shall maintain the system

T5	• Terminator shall represent a database, which contains information from
	  ○ Doctor
	  ○ Pharmacist
	  ○ Service provider (BlueTown)
	• Terminator shall response with requested information by users/doctors/pharmacist

Table 1 Terminator of EHS system

The table above describes the different terminators of EHS.

Data flows	

DF1	• Appointment date
	  ○ Available date
	  ○ Problem description
	• Notification data
	  ○ Confirmation from doctor
	  ○ New health tips information
	• Electronic health records
	  ○ Name
	  ○ Treatments
	  ○ Medications
	• Electronic prescription
	  ○ Prescriber
	  ○ Name of the medicine
	  ○ Date
	  ○ Dosage/doses
	  ○ Extant prescription online
	• Identification information
	  ○ Using phone number in the pharmacy
	• Information provided by the system

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	○ Read information about health tips ○ Read and watch about illnesses
DF2	• Confirm the appointment date • Electronic prescription ○ Prescribes to the patient ○ Extant prescription
DF3	• Identifying the patient ○ Using phone number and name • Prescribed medicines ○ Inform the patient about where to get the medicines if it is sold out.
DF4	• Provides information ○ Updates about the hospitals ○ Information about diseases ○ Information about alternative medication for particular sickness. ○ Information about new updates for the app ▪ Size ▪ Date ▪ Brief description about the updates
DF5	• Response information ○ Health records ○ Appointment information (date and time) ○ Prescription status ○ Patient information ▪ Name, address, phone number, contact person ○ Doctor contact information ○ Pharmacist contact information ○ Information from BlueTown ▪ About updates for the system ▪ Health tips ▪ Awareness about illnesses

Table 2 Data flows of EHS system

The table above describes the different data flows between the system and the particular terminator

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5.5 Use case diagram

Once we have the big overview of the system, in the next step a number of use cases were created. Use cases are short written sequential stories, which illustrates the interaction between user and the system. For the software development process Use case diagram is one of the key point. At this stage by designing the use case diagram, it will lead to identify the functional requirements. This diagram is the outcome of the EHS context diagram.

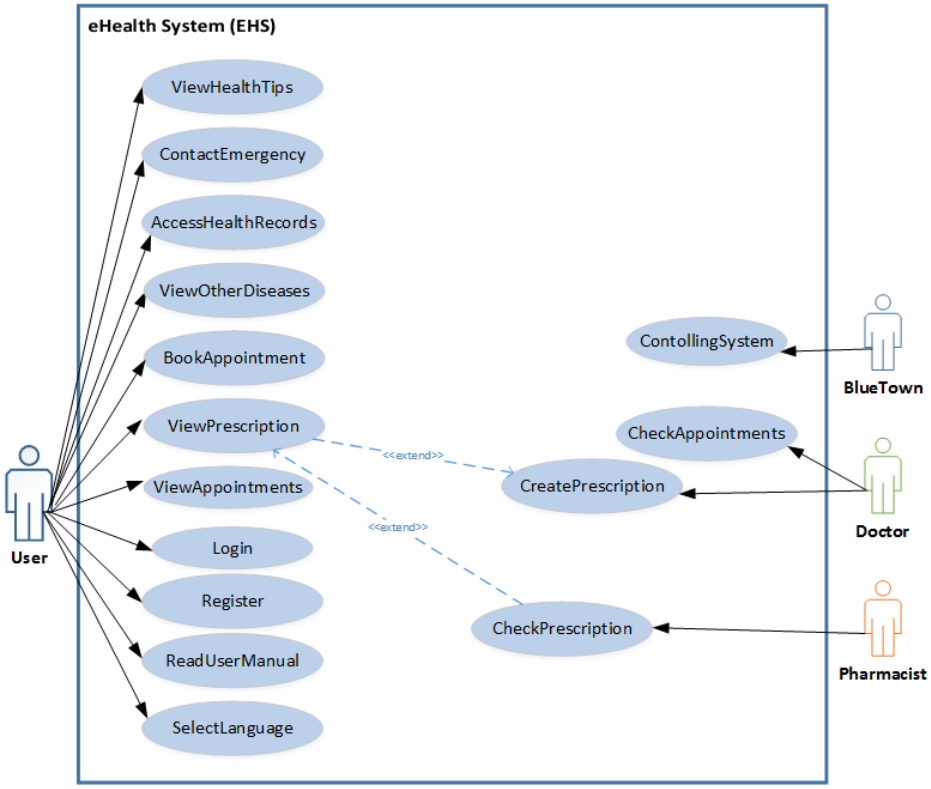

Diagram 2 Use case diagram of EHS

Use case diagram above presents how the user and stakeholders are interact with the system. Use cases can be found below in subchapter 5.5.1; these use cases are mostly focused from the user (patient) perspective, how a user interact with the EHS

The diagram 5.5.1 above illustrates eHealth system, actors and their interaction between them and the system. The big blue box illustrates eHealth system, which is the central point of the Context diagram.

From the left side there is only one actor, which is the user (patient) of the system who interaction with the system for different purposes. E.g., a user (patient) wants to book an appointment to the doctor.

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The right side we have the other actor, who also interact with the system. These actors interacting with the system to help the user (patient). The actor BlueTown is to be above the regular and the other users in the hierarchy, which simply means BlueTown is responsible for, maintain high level of the system quality and functionality. Further details will be described in the use case tables below.

5.5.1 *Use case specification*

The following three use cases are intended to user as an example of the stories that were devised. Below tables shows more detailed description of the selected use cases of eHealth system from user perspective. The detailed use cases have been omitted, but these use cases can be found in *Appendix 4*. We begin by showing user case number 2 (UC2), which illustrates the case when user register into the system for the first time.

Use Case	Register
ID	UC2
Brief description	The user needs to identify by the system, so that is why the user must be registered in the system.
Primary actors	User
Secondary actors	None
Preconditions	1. User connected to the internet. 2. Registration is available if the User is not part of the system.
Main flow	1. The use case begins when the User selects "Sign up". 2. While the User details are invalid a. The system asks the User to enter details comprising user Id, password and password again for confirmation. b. The system validates the User details. 3. Once the membership completes, the system creates the User in the system.
Post conditions	1. A new User has been created 2. User can now login to the system
Alternative flows	Invalid email address Invalid password Cancel

Table 3 Use case about user registration

The table above describes the second use case about user registering in the system.

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Use case "Register" describes that user must register on the system before login. To register on the system, there are some preconditions needs to be fulfil as shown in the table above. After the registration, the user can login.

Next, we will consider the case of the user login, in order to user the system.

Use Case	Login
ID	UC3
Brief description	The system allows user to login to the system by using the login details.
Primary actors	User
Secondary actors	None
Preconditions	UC2
Main flow	1. The use case begins with when the User fills the login details and select "Login". 2. Once the User logged in successfully, the system shows EHS main screen. 3. The User can log out.
Post conditions	1. The system has displayed main screen.
Alternative flows	1. If the User does not have internet connection, then the system will request user to check the connection. 2. If the login fails, the system will request to check the user's login details.

Table 4 Use case about user login

The table above describes user login into the system

Use case "Login" describes that User must login into the system in order to use the system. To login there is one precondition need to be fulfil, which is UC2. User needs to able to access the internet in order to use the different service from the system.

The last we will consider here is the case of user book the appointment to the doctor.

Use Case	BookAppointment
ID	UC7
Brief description	The system allows the User to create new appointment.
Primary actors	User
Secondary actors	None
Preconditions	UC3
Main flow	1. The use case starts when the User selects "book

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	appointment". 2. The system displays a mobile screen showing the fields for book a new appointment. 3. The User fills in and send to the system for reviewing by the Doctor.
Post conditions	1. A new appointment is created. 2. User get notification about the appointment. 3. User can view this appointment on his or her upcoming appointment list.
Alternative flows	None

Table 5 Use case about book appointment

The table above describes book appointment by the user

Use case "BookAppointment" describes that User can book an appointment. To book an appointment, there are some preconditions need to be fulfilled, which is login. Once the appointment is confirmed from the doctor, the user will get notification.

5.6 System Requirements

In this section System requirements based on the problem analysis with detailed interviews resulted creation of Context and Use case diagram. These diagrams present particular flows between system and the various entities. Based on these diagrams the requirements now can be identified.

5.6.1 *Functional*

The first set of requirements is the functional requirements. These are the requirements which need to be implemented in order to satisfy user demands for the system. The table below presents particular requirements with detailed description of each feature in the middle column. The last row of the table contains a letter which stands for a priority of each requirement. Prioritization is made according to the "MoSCoW" method which describes every requirement and its importance. For the prototype only the features noted by letter "M" will be implemented since it is "Must".

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	Functional requirements	Priority
F1	Patient must login into the system by using user id and password	M
F2	Doctor can login in to system by using his unique id and the password	C
F3	Patient must access his electronic medical records	M
F4	Patient can download his electronic medical record to the device	C
F5	Doctor must update patient electronic medical record	C
F6	Patient can find a nearest available doctor	C
F7	Patient must book the appointment with the doctor	M
F8	Patient can request to edit the booked appointment	C
F9	Doctor can send the confirmation of appointment to the patient	C
F10	Doctor can request a patient for consultation	C
F11	Patient can check medicine prescription online using the app	M
F12	Patient can check medicine availability in the dispensary	C
F13	Patient can receive notification about doctor request for consultation	C
F14	System must provide health related tips	M
F15	System must provide information about alternative treatment and medicines	C
F16	Patient must contact emergency services in dangerous for health cases	M
F17	System must notify patient if the Internet connection is lost	W
F18	System must provide with video information about diseases	M
F19	System must contain tutorial which teach patient how to use particular feature	C
F20	System can send a reminder for the booked appointment	C
F21	Patient can rank particular hospital facilities	C
F22	System provides FAQ	C
F23	All data which is necessary for the system need to be stored in the external hospital servers.	M
F24	System must distinguish particular user and provide different features depend on the profile	C
F25	System can be platform independent	C
F26	Data stored in the external hospital server must be protected to	W

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	be accessed by non-authorized user	
F27	Patient has access to the booking information about the appointment	M
F28	Patient has access to his profile	M
F29	BlueTown can update/add information about the hospitals location	C
F30	BlueTown can send information to the users about upcoming system maintenance	W
F31	The system can contain selection of the menu to be more user friendly	W
F32	Pharmacist can update information about medicine availability in particular dispensary	C
F33	Pharmacist deliver the prescribed medicines to the patient after check the system	C
F34	The doctor can create medicine prescription and deliver it through the app	C

Table 6 Functional requirements of the eHealth application

The table above presents identified functional requirements for the eHealth app. The First column contains number of the requirement whereas the second description of it. Last column presents priority of particular requirement

Selected requirements - rational	
User Requirements	**F1** – essential in order to recognize particular user of the system and provide security.
	F3 – essential in order to give patient possibility to check his health status and follow the progress during the treatment.
	F7 – essential in order to make the appointment process more easy and faster. Also the patient monitoring will be performed at the better manner than before.

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	F11 – essential in order to make the prescription process more faster and easier for the patient. Electronic prescription can be accessed in the dispensary more faster through the Internet.
	F27 – essential in order to provide booking information for the patient. In addition essential in order to reschedule the already books appointment.
	F28 – essential in order to provide access for the patients to his personal EMR and relevant data which is important for the treatment procedures.
System Requirements	**F14** – essential in order to increase level of awareness of the patients and also help them to prevent and diagnose particular sickness. The access to the information might be limited in some areas so the application will deliver the most important information about popular and dangerous sickness.
	F18 – essential in order to provide users practical information about the current viruses and diseases. Often the resources where this kind of information can be found are limited so the app will give patients relevant educational videos.
	F23 – essential in order provide security and data privacy protection. Since the patient data will be stored in the hospital servers the facility is responsible for it.

Table 7 Rationality behind selected requirements

The table above contains selected functional requirements and explains also rationality behind each requirement and why it is necessary to implement it. The requirements are presented from the user and system perspective

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5.6.2 *Non-functional*

The second set of requirements presents the procedures, user interactions and details about the implementation. These are non – functional requirements, however these requirements importance and level of cover reflect on the quality of the system and user experience level.

Non - functional requirements		Priority
NF1	MySQL database support	M
NF2	Application developed in Java Android	M
NF3	Database implemented in virtual server (Cloud)	C
NF4	Device required to have Internet connection	M
NF5	Interface design must be at demanded and understandable level, well organized and easy to use	M
NF6	The Internet connection speed must be stable in order to provide good quality of service	M
NF7	Mobile device need to operate on the Android 4.2 or higher	M
NF8	The patient need to give permission to store and access his data in the system database by the specialists	M
NF9	Application source code must be well organized and explained by the comments in order to make further development easier	C

Table 8 Non-functional requirements

The table 8 shows number of non - functional requirements. The requirements are noted by the letter M in the last column. These are the requirements which need to be covered in order to provide proper functionality and user experience

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CHAPTER **6**

6. Problem solution

This chapter contains the detailed design and implementation documentation of the developed prototype. The proposed product is described based on the problem analysis chapter. The chapter 6 is divided into four main parts.

The first part is about software design where all the design is presented with detailed description. The second part is focused on the software implementation. In the second part some of the relevant methods together application layouts are presented. The third part of problem solution chapter is about way of testing the developed application. In this part the relevant testing methods are presented together with outcome results. The last part presents the User interface and here the visual hierarchy can be found.

6.1 Software design

This section is concentrated on the software design process for the prototype which is based on the previous analysis of the problem area. Later based on the proposed design the implementation part is performed. Outcome of the software development process is the functional working prototype. The implemented application functionalities has been chosen according to the MoSCoW technique.

The following subchapters of the chapter 6.1 start with wireframes presentation. This is the first design phase of the software design. Wireframes shows the paper layout of the developed application. This process help to avoid the waste of time during the development stage. It is visualizing the proposed design of user interface of the system.

The next subchapter 6.1.2 presents database design. It is a preliminary database design concept for the prototype. The next following subchapter 6.1.3 shows the class diagram, which describes the structure of the application classes and relations

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between them and the database. The last subchapter contains sequence diagram of the system. This part explains the workflows between the patient and the system.

6.1.1 *Wireframes*

Wire-framing is the process of building and developing application interface layouts from the scratch, which illustrate how the system will look like. Normally there will spent lot of time and resources to build a mobile app. That is why it is very important part in app programming to make plan for the implementation of the functionality. In this phase we should consider the time with complete respect of the user requirements at the first place. The development stage can be in progress and the developers by close cooperation with users can correct the issues after each Agile iteration. It is best way to understand user needs and use their help to correct the GUI design of the app.

In this process the layouts been created for each application's view in details. It can be pure drawing or sketching, but there are also other ways of performing wireframes. Many designers will spend lot of time for the extra steps, however this depends on the designers and project pre-planning process.

For this project we have done certain detailed wireframes and presented them in this subchapter which is focus on different application screens.

Designing of the wireframes is based on the different scenarios, context diagram, functional requirements and use cases. The sketches below will help to visualize how the EHS GUI should look like. In addition the time for redesign the layouts during the developing process can be saved as well.

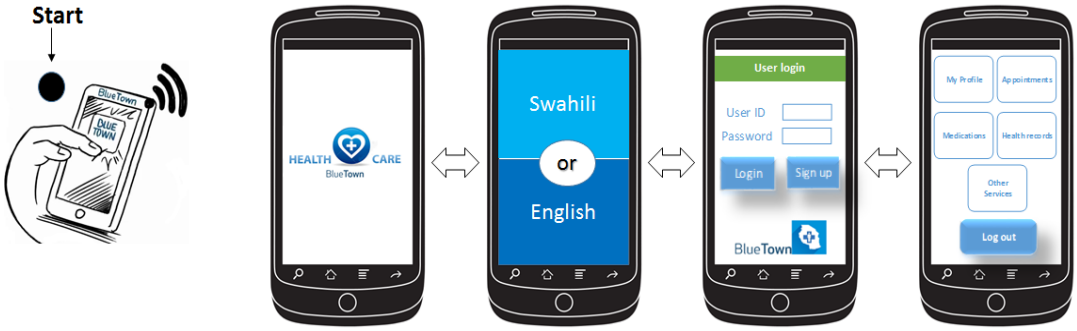

Figure 6.1 Wireframes of start activity to main screen activity

The figure shows, once the user clicks e-health app from the mobile phone, it is taking from splash screen to main screen.

The activities description

When a user decided to use the e-health application, the first step is select the language. Here the user can choose between two option which are Swahili or English. Once the user has selected the language, the system needs to identify the user with login details. During the login stage the user must provide User Id and password. If the user is not part of the system yet, then the he needs to register first place. Once the user has logged in successfully, then he can use features which are displayed on the main screen. The features are:

- My profile
- Appointments
- Medications
- Health records
- Other services

The layouts description

The application starts with screen where the logo of the application is displayed. Thereafter it leads the user to the language selection where two big buttons are available. Light blue indicates “Swahili” and dark blue indicates “English”.

Next user login screen with some labels for name fields such as, title, User id, and password is displayed. The login and signup buttons are on the middle of the screen. Login button will navigates users to the main screen and the signup button

navigates the user to another screen where it requires user information to create login for the fresh user.

In the main screen, the user can see four different features, these features are in forms of buttons. Each button will navigate the user to the different activities. When the user is done, the logout button can be used in order to quit the application.

Figure 6.2 Wireframes of different activities from main screen

The figure shows, the different activities from the system, which helps the user and fulfil the needs (e.g. book an appointment to the doctor).

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The activities description

Once the user has logged in successfully, then the user is in the main screen. Here the user has different options:

- User can check the profile by clicking "My profile" to see if it is up to date.
- User can check what medicines he has been taking by clicking "Medications"
- User can book an appointment using by clicking "Appointment" and check the upcoming appointments.
- User can check some general health records by clicking "Health records"
- By clicking "Other services", user has different other options.

The layouts description

Each screen has labels and button. At the top of the screen, title label is displayed. The user can navigate to different activity from the main screen. Each activity contains various content. From appointments, activity leads user to another activity, which is book an appointment. It has text box and buttons where user can type the information and use the confirm button to submit request. Using "Other services" button leads the user to another screen with other different services.

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Figure 6.3 Wireframes of different activities from Other services screen

The figure shows, the different activities in other services, which are useful resources for the user and fulfil the needs (e.g. getting weekly health tips or learn more about other diseases).

The activities description

When the user continue to "Other services", he has other useful options.

- User can check the weekly "Health tips".
- User can use "Emergency call", when it is needed.
- User can check the "Other diseases" to learn about diseases and how to take care of that.
- User can use "Contact us" in order to solve application problems or check for new updates.

The layouts description

The layouts are the same like in the main screen activities. "Other diseases" activity has video references to YouTube, which will open YouTube app or in the browser will present the video about the other diseases.

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6.1.2 *EHS database design*

There is a lot of relationship between various data; the best choice for this project will be a Database Management System (DBMS). It is simply the technology of storing user data and retrieving them. According to the non-functional requirement two (NF2), the system should support a MySQL database. Since it is a prototype, the EHS database will be implemented in local server. In this database user information and other health related data are stored. This section presents E-R model to relational database design of eHealth system.

E-R model of EHS

With E-R model, the conceptual view of EHS database is defined. It shows real-world entities and the relations among them. Once we have agreed on what kind of data is used during the problem analysis the next step is to visualize the concept. E-R model of EHS contains Entities, Attributes, Primary keys, Relationship and Mapping cardinalities. This can be done represents the E-R model by use of E-R diagram.

- An entity represented by means of rectangle with named.

Figure 6.4 Entities from E-R diagram

EHS E-R diagram contains six entities; this figure presents three of them, which are Profile, Health records and Patient.

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- An attribute is the property of an entity. It represented by means of ellipse and directly connected to its entity.

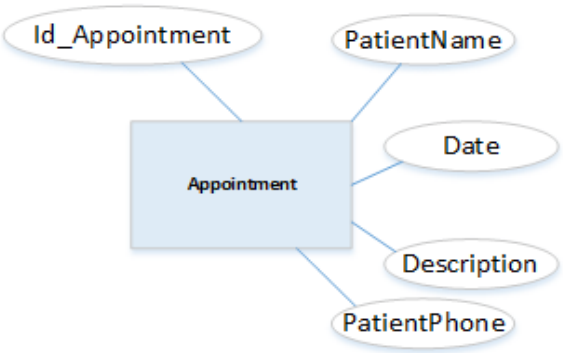

Figure 6.5 Appointment and its attributes from E-R diagram

In figure presents Appointment entity with its attributes, such as Patient name, Date, Description, Patient phone and appointment id.

- The relationship is indicated by diamond-shaped box with name of the relationship. Below entities are presented in a relationship by solid line. There are different type of relationship, e.g. one-to-one (1:1), one-to-many (1:N) or many-to-many (N:N).

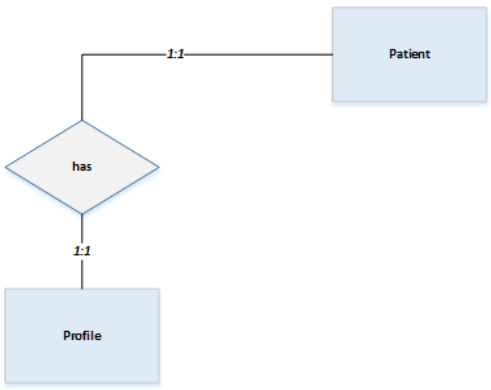

Figure 6.6 Patient and Profile relationship from E-R diagram

In figure presents Patient's relationship with the Profile. The relationship is 1:1, which means one patient can have one profile.

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- Below figure presents the entire E-R diagram of EHS. The E-R diagram will lead to relational database design.

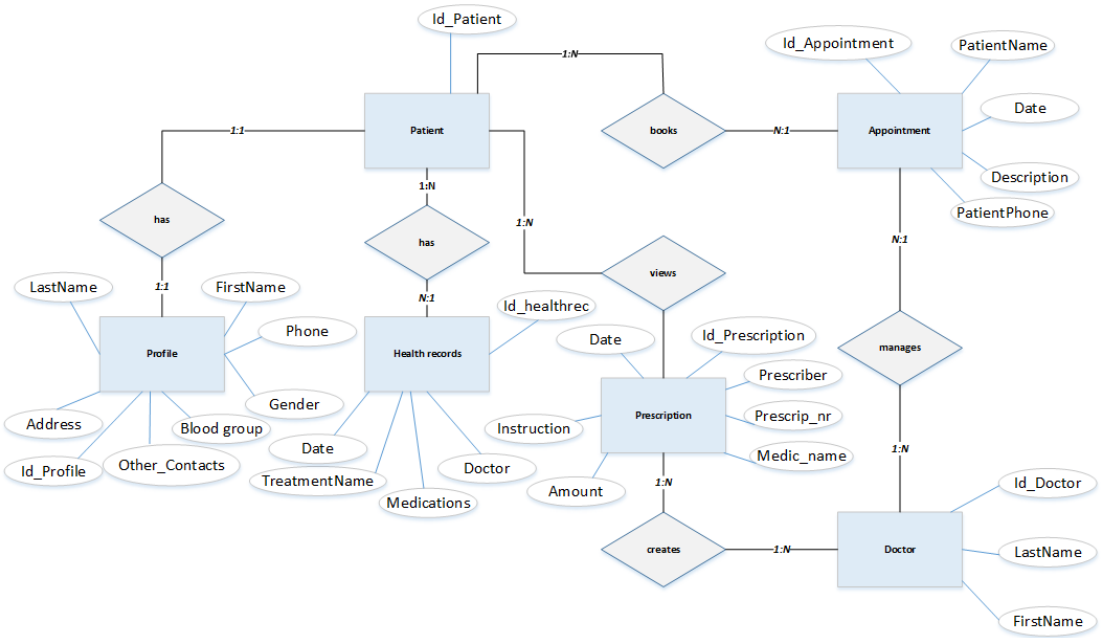

Figure 6.7 eHealth application E-R diagram

The figure illustrates EHS E-R diagram. Entities such as, Patient, Profile, Health records, Prescription, Appointment and Doctor have their own attributes and relationships.

Relational database design of EHS

Before we have completed the conceptual view in the E-R diagram. With the designed E-R diagram now the relational database design can be achieved through the mapping process.

The basic mapping process

- Table for each entity are created.
- Attributes of each entities became fields of the tables with their correct data types.
- Primary keys are declared for each tables.
- Tables for those relationships are created.
- Foreign keys are declared.
- Entities are connected using the foreign keys.
- The last step is implement the EHS database.

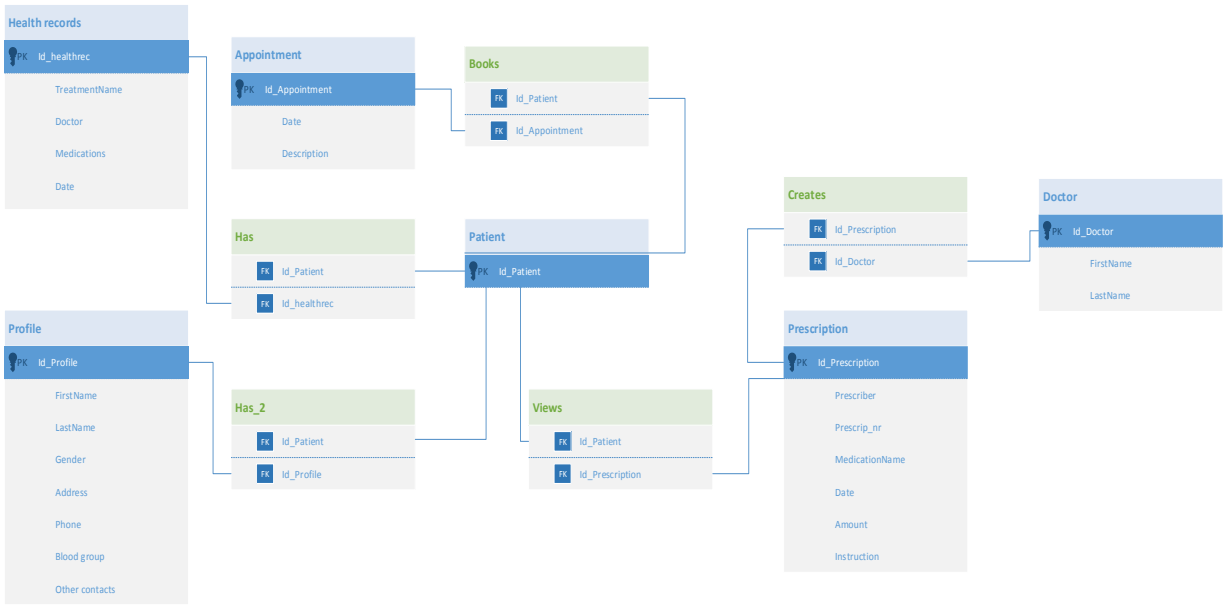

Figure 6.8 Relational database design of eHealth application

The figure illustrates Relational database design of EHS. As it can see, from the figure, Tables are in blue and relationship tables are in green. Relationship tables connect two or more other tables.

The figure 6.8 above illustrates preliminary database design concept of EHS prototype. There are six tables with different attributes. The relationship also have tables, which connects the tables.

- **Patient table**

  The patient table will contain each patient IDs. This table connected with all other tables in rational way. The `Id_Patient` is the primary key for this table.

- **Profile table**

  The profile table will contain all patient related attributes, such as basic personal data and contact information for each patients. The `Id_Profile` is the primary key for this table.

- **Health records table**

  The health record table will contain all patient related health record attributes, basic information such as, treatment name, who handled the

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treatment, what was the medication and when was it happened. The `Id_healthrec` is the primary key for this table.

- **Appointment table**
  The appointment table will contain all patients' appointment dates. The `Id_Appointment` is the primary key for this table.

- **Prescription table**
  The prescription table will contain all prescription details for each patients. The `Id_Prescription` is the primary key for this table.

- **Doctor table**
  The doctor table will contain details about doctors´ first name and last name. The `Id_Doctor` is the primary key for this table.

6.1.3 *Block diagram of eHealth application*

Once the wireframes and database design been created. The next step will be visualize the whole concept using block diagram. The block diagram is high level structured diagram and presents an overview of key process participants of the eHealth conceptual view.

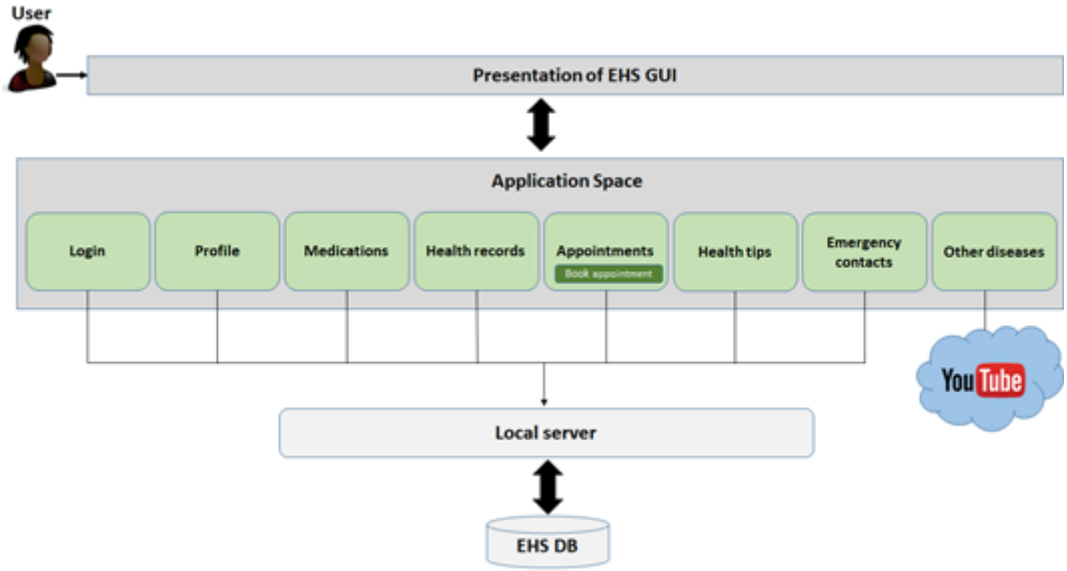

Diagram 3 Block diagram of eHealth application

Diagram illustrates high level structured overview of the concept eHealth application

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The diagram shows eHealth application prototype represented with blocks and connected by lines that shows the relationships of the blocks. It shows layers of eHealth application. The block diagram above has three layers. The first layer is the "Presentation of EHS GUI", the second layer is "Application space" and the third layer is "Local server". When the user using first layer which holds the GUI and select wished features and these features handled by the second layer. The third layer been used in order to complete the process when it's needed.

For example,

1. The user selects "Health records" to access and check the previous treatments/medications.
2. The second layer handle the health record process and to complete the process it needs support from the third layer.
3. The third layer dealing with database access in order to retrieve the health record information.
4. The last step is displays the retrieved information.

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6.1.4 *Class diagram*

The main objective when proposing application class diagram is to present each class of the system as a separate element. Every class is shown as a square which is divided in to three different sections which generates complete element. First section presents name of each class in the system. The middle square shows attributes of the particular class whereas the last part explains which methods are used in specific class.

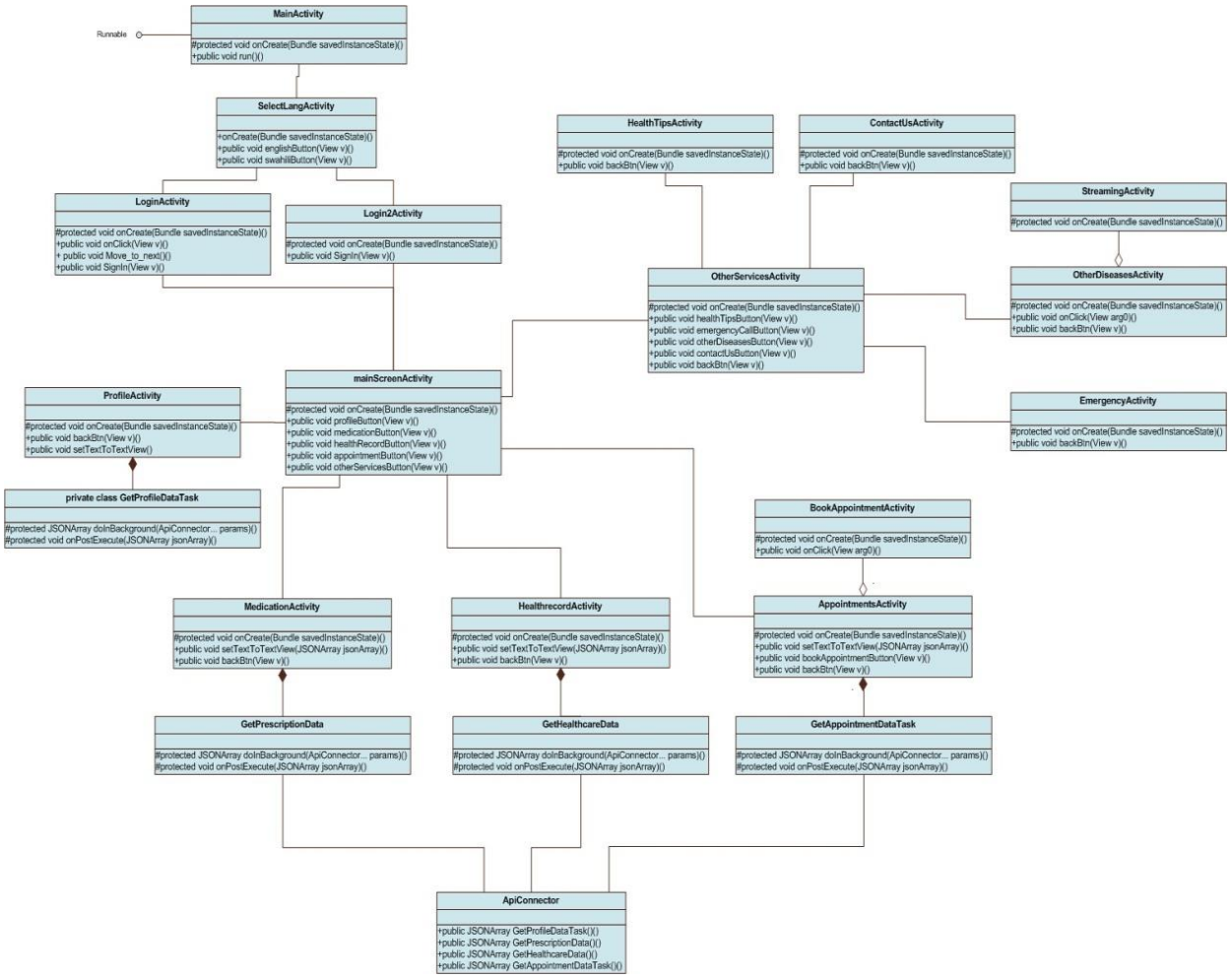

Diagram 4 Class diagram of eHealth application

The diagram shows class diagram of e-health application. Each square represents class and describes attributes and methods in particular section.

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The diagram above shows e-health app prototype classes structure and relations between them. The first class which starts the app is MainActivity class. From this class another class is initialized where the user is required to select the language in which the application should be displayed. By the user selection the methods which are inside SelectLangActivity class starts another classes where the login is required. The methods inside Login/Login2 Activity classes verifies the user credentials and then the mainScreenActivity is invoked giving user particular features which are indicated on the diagram above.

Each user selection initialized different classes where the particular methods invokes demanded functionality. For example from mainScreenActivity user can select the option which will display information about his profile through the methods inside ProfileActivity class. In addition the Profile class also requires to use composed GetProvileDataTask class in order to retrieve the user information from the external database. This is example of composition and it is marked as a relation with solid diamond-end which is directed to the mother class. On the figure overhead more compositions between particular classes is indicated. In case where the composition is presented it means the subclass is a part of container class. When the main class is destroyed also class which is composed no longer exists.

Moreover, all composed classes are "private" which means only the methods within the same main class can use it. It is not allowed to invoke methods inside the composed class by other class which is outside the mother class. Furthermore, on the above class diagram also some methods are "protected" and marked by the"#" symbol on the left side. This also means the method can be used within the main class and any external class cannot invoke it. Rest of the methods which are "public" can be invoked by other classes in order to reuse the existing components. The public methods are marked by the "+" symbol.

6.1.5 *Sequence diagram*

The system requirements will be used to in order to design sequence diagram. The presented sequence diagram shows how the user (patient) interact with the system and how the particular components are interacting between each other during the process call. The sequence diagram below presents how the particular user

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requirements are invoked. Since it is a prototype, we have agreed to illustrate how the booking appointment process is performed from the user perspective.

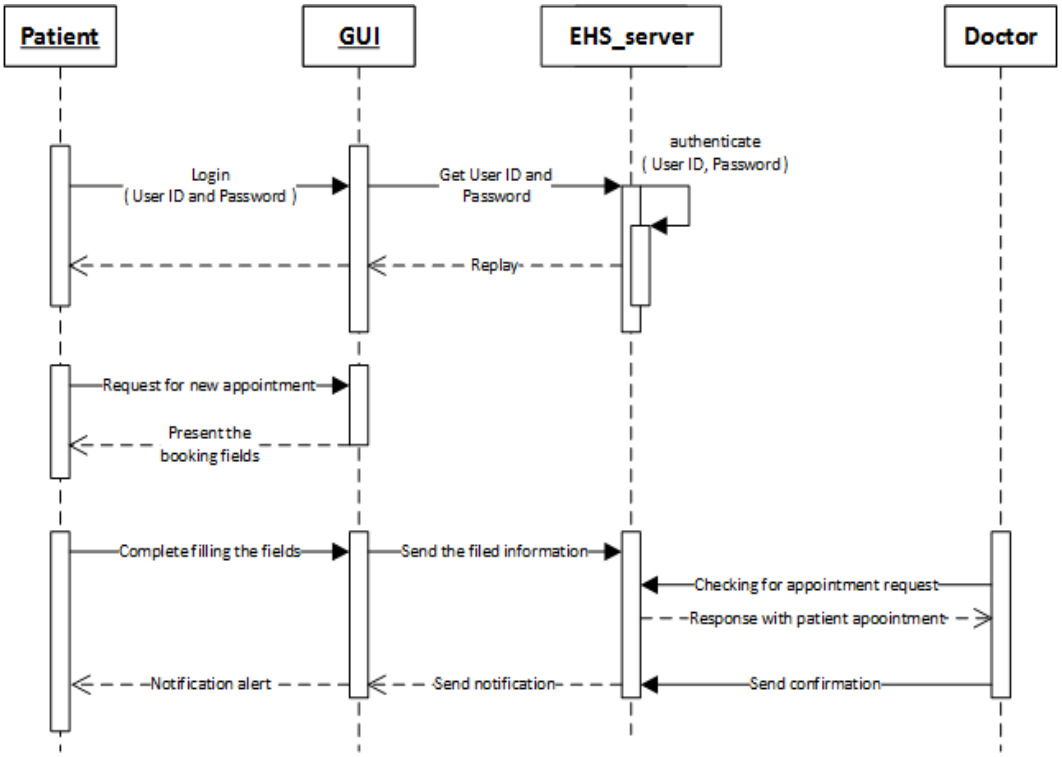

Diagram 5 Sequence diagram of booking process

The diagram above illustrates booking process from the patient.

The first process is user login, during the process there are two components (Patient and EHS_Server) interact with each other. When the user logged in successfully, the next process is request for new appointment, this process require two components (Patient and GUI) interaction in order to present the booking field information. The last process require three components (Patient, EHS_Server and Doctor) interaction in order to complete the request. Once the patient has sent the booking request to the system, the doctor will review it and the respond will be sent with the booking confirmation.

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6.2 Software implementation

The software design looks at the conceptual and structural decisions, where in this chapter will be focus on the practical implementation part of the eHealth app prototype. Namely, the programming code will be analysed which was created to support those different decisions. However, in this chapter only most important aspects are presented. In particular, here are the explanations and methods about five distinct aspects, such as user authentication, prescription, book appointment, other diseases video streaming and HTTP connection. Furthermore, the included CD contains the whole source code in the "E-health app" folder.

6.2.1 *User authentication*

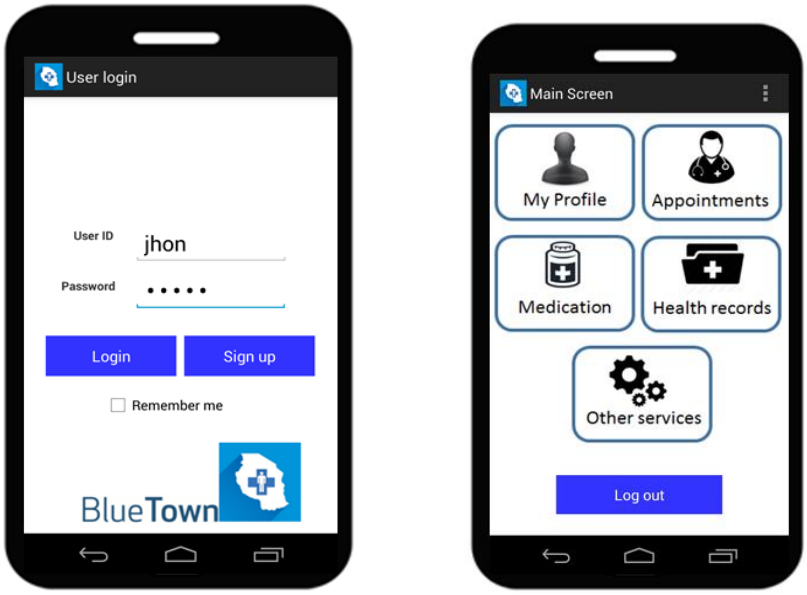

Figure 6.9 Patient login screen and main screen
The figure presents Patient's login screen and main screen. Here the patient either login or signup.

Since this a prototype, user authentication is not high priority, but still needs to be illustrated because it is a part of the process EHS process. Therefore, the login process is hardcoded however, it fulfil the functional requirement one (F1), which is the "Patient must login into the system by using user id and password".

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The following code illustrates how the login activity class works. It starts by locating the login button in the xml file and adding onClick method for login "`android:onClick=signIn`", which wait for the click event. When a patient types the login details and then click the login button, the login method will check the conditions, if it is true then it will goes to patient's main screen.

```
public void SignIn(View v) {
 String userID = "jhon";
 String pass = "12345";
 if (username.getText().toString().equals(userID)
         && password.getText().toString().equals(pass)) {
     Intent intent = new Intent(LoginActivity.this,
             mainScreenActivity.class);
     startActivity(intent);
 } else {
     AlertDialog.Builder dlgAlert = new AlertDialog.Builder(this);
     dlgAlert.setMessage("Invalid UserID or Password ");
     dlgAlert.setTitle("ERROR");
     dlgAlert.setPositiveButton("OK", null);
     dlgAlert.setCancelable(true);
     dlgAlert.create().show();
     dlgAlert.setPositiveButton("Ok",
             new DialogInterface.OnClickListener() {
                 public void onClick(DialogInterface dialog, int which) {
                 }
             });
 }

}
```

Figure 6.10 Login method

*The following source code snipped from login method form **LoginActivity** class.*

Since the login process is hardcoded, the user ID and password are fixed. As it can see from the figure, 6.10 above the user ID declared as "john" and the password is "12345". The if statement comparing the username and the password with what the patient types in, if it is true then it moves to next activity which is "mainScreenActivity". Otherwise, it displays an alert message with invalid login.

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6.2.2 *Prescription*

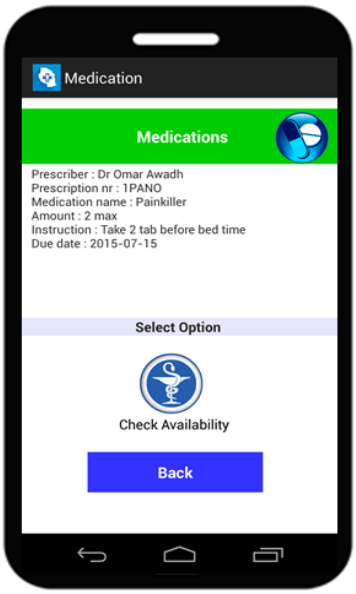

Figure 6.11 Prescription screen

The figure shows prescription screen. Here the patient's current medicine details been displayed.

The user can use the application to check the current medicine details. Thereby it fulfil the functional requirement eleven (F11), which is "Patient can check medicine prescription online using the app".

The following code illustrates how the user access the medicine details and displayed. It starts by locating the medication button in the xml file of main screen and thereafter adding onClick method for medication "`android:onClick=medicationButton`", which is waits for the click event. When the patient clicks the medication button, then it creates an Intent to start MedicationActivity.

MedicationActivity using ApiConnector class to connect the local server, which create HTTP GET for the URL. This URL pointing to the PHP script in local server, which communicating the MySQL database to retrieve the prescription data and displayed on the patient's screen in medication activity.

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```
public void setTextToTextView(JSONArray jsonArray)
{
   String s = "";
   for(int i=0; i<jsonArray.length();i++){

      JSONObject json = null;
      try {
         json = jsonArray.getJSONObject(i);
         s = s +
                 "Prescriber : "+json.getString("prescriber")+"\n"+
                 "Prescription nr : "+json.getString("prescripNr")+"\n"+
                 "Medication name : "+json.getString("medicName")+"\n"+
                 "Amount : "+json.getString("amount")+"\n"+
                 "Instruction : "+json.getString("instruction")+"\n"+
                "Due date : "+json.getString("date_");
      } catch (JSONException e) {
         e.printStackTrace();
      }

   }

   this.result.setText(s);

}
```

Figure 6.12 Method for set the data into view

*The following source code snipped from setTextToTextView method from **MedicationActivity** class.*

The method above in figure 6.12 get each fields from EHS database and displays in text view. The **prescription.php** script control which data needs to be retrieved. This PHP file plays the role of accepting request and giving JSON responses using background Asynctask thread. Once we got JSON from prescription.php, we parsed into JSON object and displayed in the text view. This PHP script for prescription is presented below.

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```php
/**
 * Retrieve prescription data
 */
<?php
    $host='localhost';
    $uname='gatha';
    $pwd='12345';
    $db="ehealth";
    $con = mysql_connect($host,$uname,$pwd);

$con = mysql_connect("$host","$uname",$pwd);
if (!$con)
{
die('Could not connect: ' . mysql_error());
}
mysql_select_db($db, $con);
$result = mysql_query("SELECT * FROM prescription");

while($row = mysql_fetch_assoc($result))
  {
    $output[]=$row;
  }

print(json_encode($output));

mysql_close($con);
?>
```

Figure 6.13 Retrieve prescription fields from database

The following PHP script for retrieve prescription data from Prescription table in ehealth database.

The figure 6.13 above shows the backend coding detail of how the prescription data retrieves from ehealth database. The line 5 to 8 are the database configuration. Since it is a prototype the server running in locally. Line 11 is MySQL connection to the database `$db="ehealth"`, if the connection fails it will alter the error message in line 14. Once the connection is successfully made the database will selected in line 16 and thereafter request with MySQL select query "Select * from prescription" in line 17. The output will come out in JSON format in line 24. The last step will close the MySQL connection.

6.2.3 *Book appointment*

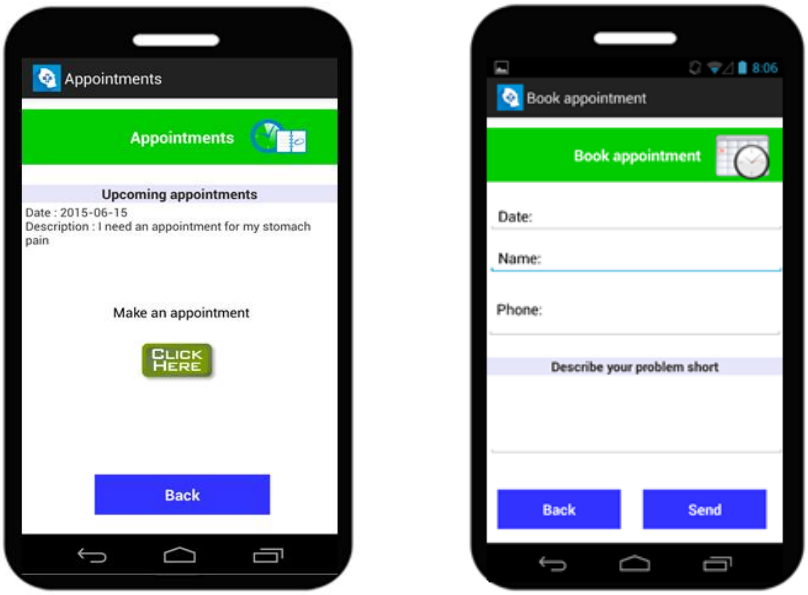

Figure 6.14 Appointments and book appointment screens

The figure presents appointments and book appointment screens. Here the patient can check upcoming appointments and book new appointment by filling the fields such as date, name phone and description of the problem.

The user can use the application to either check the upcoming appointments or book an appointment. Thereby it fulfil the functional requirement seven (F7) and functional requirement twenty-seven (F27), which are "Patient must book the appointment with doctor" and "Patient can check the booking information about the appointment".

The following code illustrates how the user books the appointment. It starts by locating the book appointment button in the xml file of appointment screen and thereafter adding onClick method for appointment "`android:onClick=appointmentButton`", which is waits for the click event. When the patient clicks the appointment button, then it creates an Intent to start AppointmentsActivity.

Here the patient can view the upcoming appointments. If the patient needs make one more appointment, then click the "CLICK HERE" button, which creates an Intent to start BookAppointmentActivity. Here the patient needs to fill the required fields in order to make an appointment. Once the fields are filled in then by click the

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"Send" button, the request been sent to the EHS database, which can be seen by the doctor later.

Here HTTP POST been used to send the typed data to the system. The URL also pointing to the PHP script in local server, which communicating the MySQL database to insert the appointment data.

```
                                        [. . .]
      public void onClick(View arg0){

          String name = ""+username.getText().toString();
          String date = ""+reqdate.getText().toString();
          String phone = ""+userphone.getText().toString();
          String description = ""+userdescription.getText().toString();

          List<NameValuePair> nameValuePairs = new ArrayList<NameValuePair>(1);
          nameValuePairs.add(new BasicNameValuePair("patientName",name));
          nameValuePairs.add(new BasicNameValuePair("date",date));
          nameValuePairs.add(new BasicNameValuePair("phone",phone));
          nameValuePairs.add(new BasicNameValuePair("description",description));

}
                                        [. . .]
```

Figure 6.15 onClick method for send

The following source code snipped from onClick method from ***BookAppointmentActivity*** *class.*

The method above in figure 6.15 set each fields with typed information from booking screen. The conditions are here to control the **nameValuePairs** are correct before it sends to the database.

The **bookappoint.php** script control which data needs to be send to EHS database. This PHP script for book appointment is presented below.

```php
<?php
    $host='localhost';
    $uname='gatha';
    $pwd='12345';
    $db="ehealth";

    $con = mysql_connect($host,$uname,$pwd) or die("connection failed");
    mysql_select_db($db,$con) or die("db selection failed");

    $name=mysql_real_escape_string($_POST['patientName']);
    $phone=preg_replace('/[^0-9]/', '', $_POST['phone']);
    $date=preg_replace('/[^0-9]/', '', $_POST['date']);
    $desc=mysql_real_escape_string($_POST['description']);

    $res = mysql_query("INSERT INTO `appointment` (patientName, patientPhone, description, date_) VALUES('$name','$phone','$desc', $date)");
?>
```

Figure 6.16 Insert appointment data into database

The following PHP script for insert appointment data into appointment table from ehealth database.

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The figure 6.2.3.3 above shows the backend coding detail of how the appointment data inserts in ehealth database. The line 2 to 5 are the database configuration. Line 7 is MySQL connection to the database `$db="ehealth"`, if the connection fails it will alter the error message. Once the connection is successfully made the database will selected in line 8 and thereafter execute with MySQL insert query `"Insert into * appointment (patientName, patientPhone, description, date_) Values ('$name', '$phone'. '$desc', '$date')"` in line 15 with filled information from the appointment screen.

6.2.4 *Other diseases video streaming*

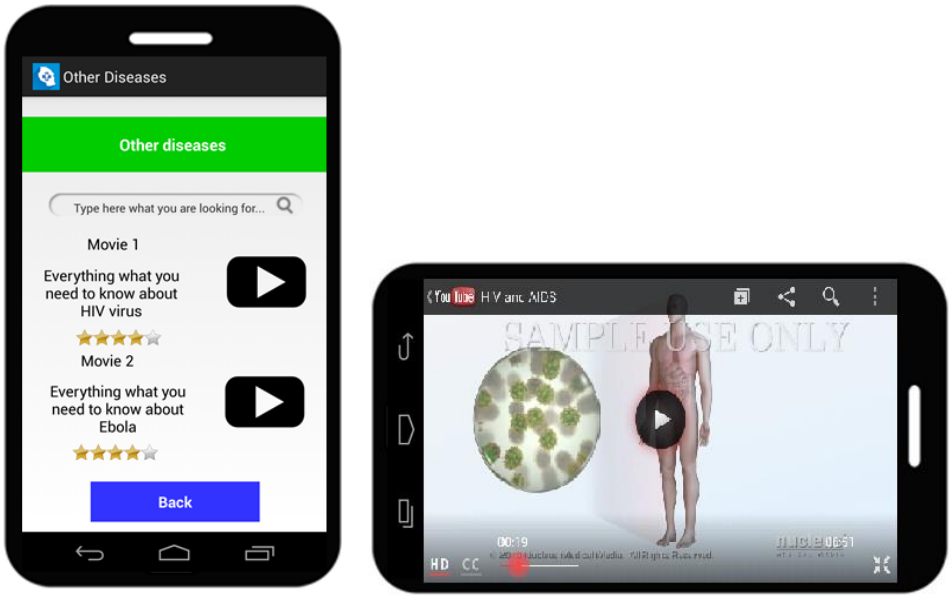

Figure 6.17 Other diseases screen and video streaming view

Figure shows the Other Diseases and video streaming view. Here the patient can find important information about viruses and diseases in the video form which is streamed directly through the mobile device

The patient can use the e-health application to find video materials about diseases which are in form of streamed videos. This functionality fulfils functional requirements number 18 which says "System must display videos about current diseases and viruses". This functionality provide users information how to diagnose and prevent particular sickness.

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The source code presented below shows how the user can access videos and stream it on his mobile device. The process starts by choosing an button which is in form of play icon next to the title of the movie. The button is in the xml file of other diseases screen. When the button has been selected then the onClick method for this activity set the event after click intent. When the button has been clicked the intent initialize StreamingActivity.class; The method which starts another activity after clicking a button is: "`Intent intent = new Intent(context, StreamingActivity.class);`"

After the StreamingActivity is started by the click event the selected by the user movie is streamed from the YouTube service. The code shows a method which is used in order to deliver streaming service for the users.

```
public class StreamingActivity extends ActionBarActivity {

  private WebView webView;

  @Override
  protected void onCreate(Bundle savedInstanceState) {
      super.onCreate(savedInstanceState);
      setContentView(R.layout.activity_streaming);
      webView = (WebView) findViewById(R.id.webView);
      webView.getSettings().setJavaScriptEnabled(true);
      webView.loadUrl("https://www.youtube.com/watch?v=rv0yIICeg-E");

  }
}
```

Figure 6.18 Streaming Activity source code

Figure shows the StreamingActivity class method which is used in order to deliver streaming content for the users. The materials are focused on the practical information about diseases and viruses

On the figure above the source code shows a method which is used in the StreamingAvtivity. After click event the Streaming service starts to display demanded movie in the "webView" which is in the XML file. The "webView" is set to support Java Scripts in order to display web content properly. Unfortunately the Flash technology is not supported so the app is asking before movie starts if it should be displayed in the Android integrated YouTube app. When the user will select it then the content under "loadUrl" begins to play on the mobile device.

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6.2.5 *HTTP connection*

The implemented e-health application prototype is extracting and sending the data to the external MySQL database which is implemented in the server. Since it is a still first version of the solution the database is implemented in the local machine.
In order to fetch and sent the data from the app the HTTP connection method is used. In addition the backend in php on the server side also needed to be developed. The source code under explains how the HTTP connection method is used.

```
public JSONArray GetHealthcareData(){

  String url = "http://172.30.216.73:8080/android/healthrecords.php";

  // Get HttpResponse Object from url.
  // Get HttpEntity from Http Response Object

  HttpEntity httpEntity = null;

  try
  {

      DefaultHttpClient httpClient = new DefaultHttpClient();  // Default
HttpClient
      HttpGet httpGet = new HttpGet(url);

      HttpResponse httpResponse = httpClient.execute(httpGet);

      httpEntity = httpResponse.getEntity();


  } catch (ClientProtocolException e) {

      e.printStackTrace();
  } catch (IOException e) {
      e.printStackTrace();
  }
```

Figure 6.19 Example of HTTP connection method

Figure shows the HTTP connection which is used in order to GET and POST the data to the database. The response later is converted in to JSON format.

At the figure above the URL of the backend PHP file is defined. Later the default HTTP client is used in order to use a "HttpGet" or "HttpPost" method to retrieve or sent the data to the database through the php script which is pointed in the above URL. At the example above the "httpGet" method is executed. The stack with

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retrieved values is printed out and needs to be converted from "HttpEntity" in to Json format in order to be displayed properly on the mobile device. The below picture shows how the values delivered through the "`HttpResponse httpResponse = httpClient.execute(httpGet)`" method are converted in to proper for the mobile device format.

```
// Convert HttpEntity into JSON Array
  JSONArray jsonArray = null;

  if (httpEntity != null) {
      try {
          String entityResponse = EntityUtils.toString(httpEntity);

          Log.e("Entity Response  : ", entityResponse);

          jsonArray = new JSONArray(entityResponse);

      } catch (JSONException e) {
          e.printStackTrace();
      } catch (IOException e) {
          e.printStackTrace();
      }
  }

  return jsonArray;
}
```

Figure 6.20 HTTP response to JSON transformation

Figure shows the method, which converts the HTTP entity format in to Json. The converted values are later inserted in to new Json array and printed out in the proper for mobile device format

The Http Entity are converted to the string by the "`String entityResponse = EntityUtils.toString(httpEntity)`" method. Later the new JSON array is created by the "`jsonArray = new JSONArray(entityResponse)`" method and the converted entity is passed in to it. At the end the result is printed as a "jsonArray" which is displayed by the e-health application inside the text view through the "`setTextToTextView(JSONArray jsonArray)`" method, and values are retrieved through the "`json = jsonArray.getJSONObject(i)`" instructions.

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6.3 Software and system testing

The testing phase is the last step in development process and here it is very important to test every developed part by performing various techniques. With these various techniques, the developers can check for bugs, inconsistences, or other kind of errors in software or source code, which need to be fixed. It is also make ensure developers the product quality is at demanded level. For the developed prototype, we agreed the most corresponding test methods will be Unit test and User acceptance test.

Due to time restrictions, integration test part is not carried out, but there will be an explanation about integration test, how it will used in our project and there will be also one example of Unit test will presented. This is just a limited part of the full testing process, which contains many others test methods, nevertheless by considering the specific and the time limitation for this project we believe selected methods give a decent feedback and understanding about the testing methods.

6.3.1 *Unit test*

In this section Unit test will be presented. The main goal of the test method is verify the smallest part of the application source code (units), which can be testable and then perform test on it. That way, each unit is being tested separately and by checking the test results the bugs can be detected and fixed immediately. This test method is be very suitable for our prototype, since it is a proof of concept application. According to the developers' expectation with this test, it can be checked if every piece of software behaves, as it should.

- **Unit test for login activity**

The purpose of the unit test in our project show and example of creating a test case and how to implement the test case. This process will continue to help to create other unit test cases. Such testing helps support management of the application over time by ensuring that changes we make do not affect other parts of the system.

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Following test cases is created for the user login process. Normally such test case is useful to check when the test is created and who is implemented the test. With these test information developers scan always go back, if something goes wrong in the future and to check how the method was tested.
For the following test case, the relevant information are:

- Scope
- Preconditions
- Test procedures
- Results

Application name:	E-Health app	**Version:**	V.0.1
Unit test ID:	ID1_User Login activity		
Scope:	This test procedure verifies that the layouts and the login process of EHS is implemented properly. It tests the user's login information request is sent to the EHS, that the system responds with the login details response.		
Written by:	Gatha	**Tested on:**	26-05-2015
Preconditions:	Make sure the stimulator is started.		

Step	**Test Procedure**	**Result**
1	Create test class for login activity and import the ActivityInstrumentationTestCase2.	PASSED
2	To create a functional test on the login activity the test class should extend ActivityInstrumentationTestCase2.	PASSED
3	Add missing the constructor	PASSED
4	Configure setUp() for preconditions such as declare button and edit text views from the login activity.	PASSED
5	Setup teardown() for clean up before it moves to next test.	PASSED
6	Create test for views in login activity	PASSED
7	Create test for login process and validate the username and password	PASSED

Table 9 Unit test case for Login activity

The unit test case for the login activity with the results.

The test case created into rows and columns and it is divided into two parts. The upper part (before light blue) contains information such as the name of the application, version number, who has written the test and the preconditions. The

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lower part (after light blue) are the test procedures into steps and result columns show if it is passed or failed. Developers using the results to decide if there is a need to re-run the test from the beginning or not, if it is necessary then the document needs to be updated.

6.3.1.3 Unit test implementation

```
public class LoginActivityTest extends
ActivityInstrumentationTestCase2<LoginActivity> {

  Button login;
  EditText username, password;

  LoginActivity activity;
  public LoginActivityTest() {
      super(LoginActivity.class);
  }

  @Override
  protected void setUp() throws Exception {
      super.setUp();
      activity = getActivity();
      login = (Button)activity.findViewById(R.id.signInButton);
      username = (EditText)activity.findViewById(R.id.username);
      password = (EditText)activity.findViewById(R.id.password);
  }
  protected void tearDown() throws Exception {
      super.tearDown();
  }
  @SmallTest
  public void testViewsCreated() {
      assertNotNull(getActivity());
      assertNotNull(login);
      assertNotNull(username);
      assertNotNull(password);
  }
  @SmallTest
  public void testLogin() {
      username.clearComposingText();
      password.clearComposingText();

      TouchUtils.tapView(this, username);
      sendKeys("jhon");
      TouchUtils.tapView(this, password);
      sendKeys("12345");

      getActivity().runOnUiThread(new Runnable() {
          public void run() {
              login.performClick();
          }
      });
  }
}
```

Figure 6.21 Source code of unit test for Login activity

The unit test implementation of login activity.

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The figure 6.21 above shows LoginActivityTest class. This class has to methods; the first method `testViewCreated()`, is for to test the different views, such as edit texts and button. The second method is `testlogin()`, is for to test the login process. This method is checking the login user Id and the password.

6.3.1.5 Unit test results

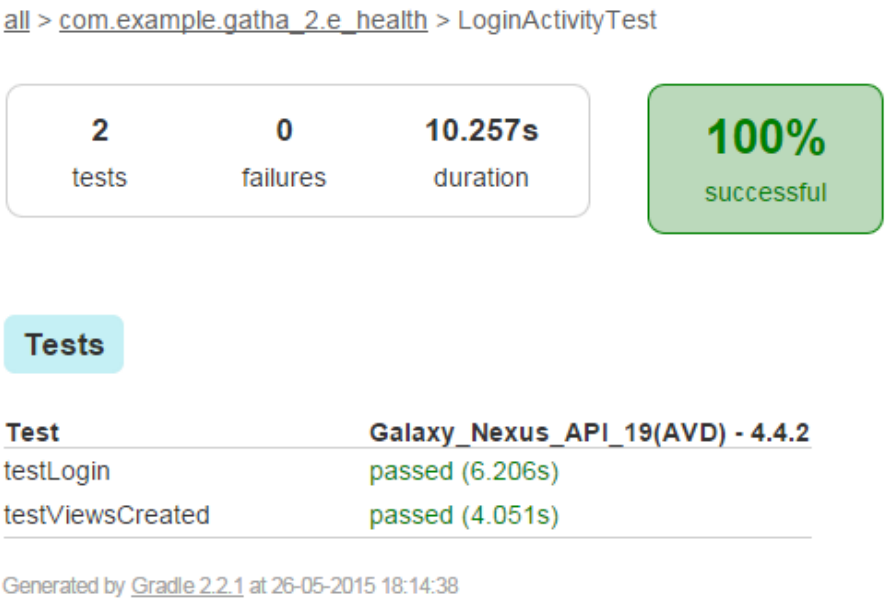

Figure 6.22 Unit test result for login activity
The figure present the unit test result from login activity.

The figure 6.22 above shows the test result of login activity. When the test case is implemented, it needs to be run in order to verify the results. This can be done in the terminal window by typing `gradlew.bat connectedAndroidTest`. Once the process is completed, the results can be displayed in `index.htm` file, this file can be found in `build/outputs/reports/androidTests`.

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6.3.2 *Integration test*

After the first completed Unit testing method another stage would be to perform integration testing. This method is an stretched version of the Unit testing which aims to test each possible to test part and then perform the test cases on it. In the Integration test the relationship between classes are tested verifying the application classes integrity. The reason why the integration test also supposed to be completed is the structure of proposed app. In the developed app many classes and method which invokes particular classes are implemented. That is why this the integration test method also should be completed ensuring developers the classes correlations are at demanded level.

The main objective of the Integration test method would be to see if the system overall integrity is at the required level. The expected tests results should indicate the bugs or any kind of faults in the application integrity. The developed prototype already uses many classes with various relations between them, so the test would be a time consuming if the valid results needs to be produced [37].

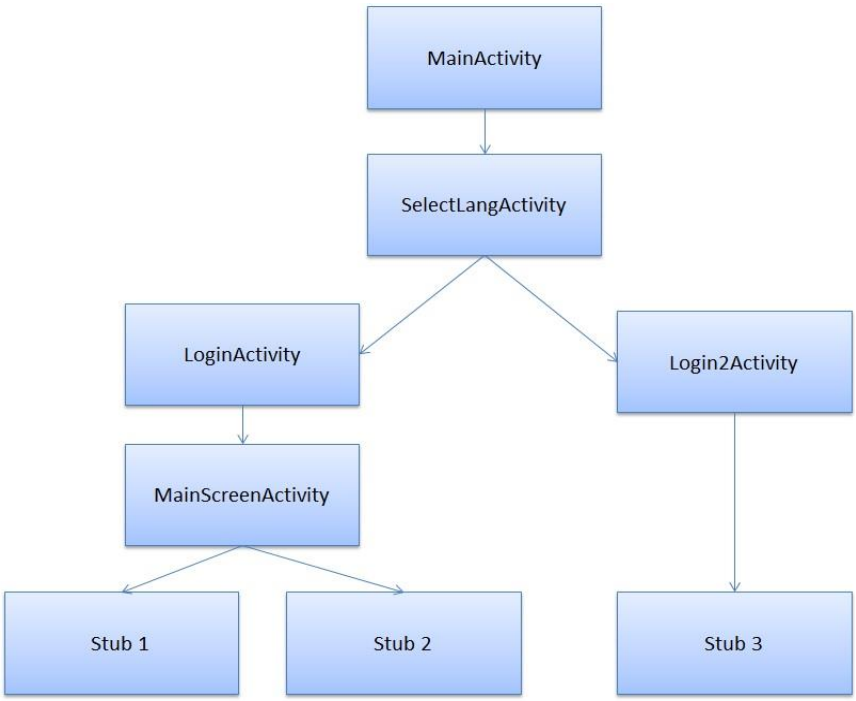

Diagram 6 Integration testing scheme

The figure above shows the top-down integration test scheme for the developed application

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The figure above explains how the integration testing procedure can be performed for the proposed prototype. This testing method is a key facet before the user acceptance test can be performed. The technique should be performed by use of top-down approach. The integration testing method tests the classes from the high level and in the next phases moving down in the hierarchy flow. The test helps to check if the data flow and system logics are performing correctly as expected by use of "stubs" which are indicated on the above figure. The stubs are the modules with methods which temporary replaces the called modules giving the same output as a product real modules.

The integration testing method can be fully completed by use of Android studio by use of Jenkins plugin. Unfortunately, due to project time limitations integration testing will not be performed physically since there are already two different testing methods accomplished. The outcomes from previously performed methods can give already a certain level overview of the application quality. Since the app needs to be developed further in the next Agile iteration the integration testing can be performed in order to make sure the prototype version fulfill the requirements and the demo versions can be released [38].

6.3.3 *User acceptance test*

This is the third test of the product, which is user acceptance test. Since the prototype was in the development phase and due to time restrictions, we have decided to send the final layouts from the eHealth application to the potential users. The goal of this test was to get users feedback related to the usability of the developed product. The conclusion of the feedback gathered by Kareen Limbe, which is our contact person from Tanzania are presented below:

- First of all the app looks very easy to use. In additions users claims the application shouldn't be complicated.
- Overall opinion about the design was positive. The users prefer more colourful layouts.
- The users claim the information displayed in the app are not too personal. Their personal information looks similar to the records kept in the hospitals. Login requirement ensured them that unauthorized access will be denied.

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- Users would be tend to use the application because it would help to save lots of time wasted during waiting to see the doctor. In additions, there will be less ignorance due hospital visits and treatment.
- In overall, the application will be helpful providing users' access to the medical services, health info and medical records. It will help to save lot of time since the regular paper based document are often lost, requiring patients to make other time consuming appointment

The next development phase will bring more functionality, which then again will be tested by the potential users. The conducted test showed the users are looking forward to test the actual app.

6.4 User interface

Normally an important role the context plays the user interface, which should be easy to use from the user perspective. For this reason, the following section is dedicated to describing the visual hierarchy, which were help to support the user requirements.

6.4.1 *Visual hierarchy*

In this section the visual hierarchy of the proposed eHealth application is presented. Having decent hierarchy model is important part of the design process. The model visualizes what things and particular elements going to be displayed on the device screen. Hierarchical model gives readers the basic understanding of the application flows and visual cues. Below the proposition of the hierarchical model explains few chosen application layouts, selected colours and icons and font's type.

- *Selected colors*

The color selection is based on the light colors, however the contrast is clear and each element is visible clearly. Since the mobile devices screens are limited in term of available space that is why the number of used colors is limited to four. Rest is filled by the labels and icons creating vivid and easy to use application in term of human - machine interaction.

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Figure 6.23 Application colours

The figure above displays the colors which are used in the application. Under each color there is a hexical value of it.

- *Application icons*

The proposed icons were chosen based on the simplicity and understanding. Each icon represents different concept or action. From the samples below the icons with the text are showed as well like regular icons which represent general concepts like for instance update icon or play video icon. In order to make the application more understandable the icon selection was based also on the popularity of various symbols which are represented by particular icon.

Figure 6.24 Some of the application's icons

The figure above shows the selected icons which are used in the developed app. Icons above are just a sample and the rest of them might be found in the application itself.

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- *Application fonts*

For the application the default android font type has been selected. The font type is "Roboto" and the size and style is selected individually for each activity. The default android font provides clear and readable text. The style of selected font is:

- ✓ Header and back button - text size 19sp "bold", color white
- ✓ Rest of the content – from 8sp to 20sp, color black "bold" and "normal"

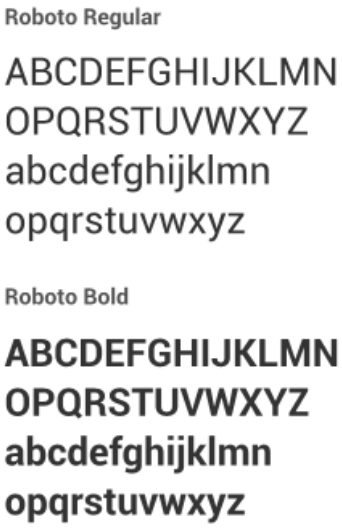

Figure 6.25 Application fonts

The figure above shows selected font type for the application. The family font is default android font type named "Roboto".

- *Contact us - layout*

The first selected application layout presents "Contact Us" screen. The layout contains two main headers labeled Contact Us and App information. The type of layout is a absolute layout which allows easy to customize position of each element on the screen. Under first section the customer support information's are displayed for the user. The second section provides information about the version of app and possibility to update if newer version is available.

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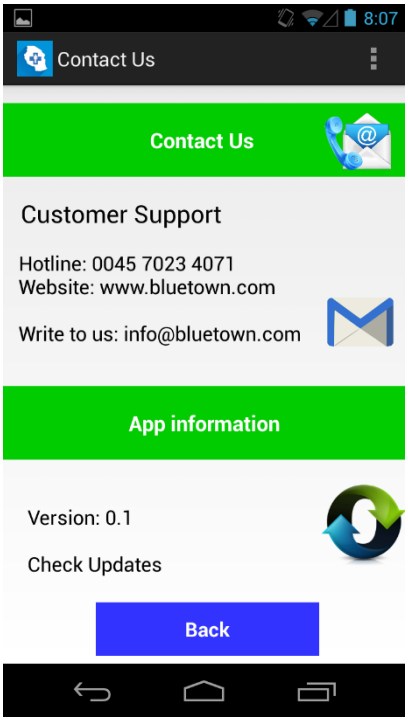

Figure 6.26 Customer support layout

The figure above presents contact us application screen with a details about costumer support info's and application information's. There is also possibility to update app directly from this screen.

- *Health record - layout*

The second selected layout presents a health records. The same like previous layout also this one is absolute layout. Under the main header the patient treatment information are displayed. Each treatment is in separate block in order to make it more readable. On the right site the tabs allows patients to check more detailed information's about particular treatment.

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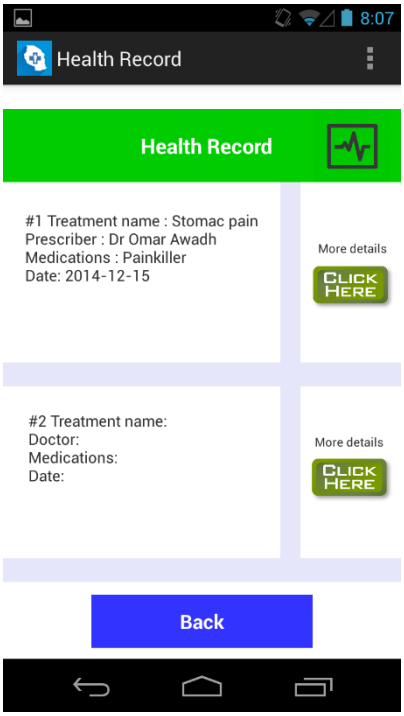

Figure 6.27 Health record layout

The figure above presents health records application screen with information about the treatments The left tab allows to get more details about particular treatment process.

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CHAPTER 7

7. Discussion

This chapter presents a relevant discussions regarding the appropriate things related to the project. The chapter 7 is divided in to two main subchapters. The first part contains a relevant findings which were identified during the research and development process. The second part presents a future perspective of the developed prototype as a full scale solution which might be developed based upon the proposed application.

7.1 Findings

Before finalizing the project it is important to close the loops. So we went through the relevant chapters of the project in order to check what extent we have solved for the raised questions.

Our main goal was to introduce ICT solution for healthcare in rural area in Tanzania, which will improve efficiency and quality of Primary care. Further analysing the current healthcare system in analysing part, we came up with the main problem question which was:
"How to involve portable mobile devices to improve efficiency and quality of Primary care in rural area in Tanzania"
especially in:

- Book appointment
- Online prescription
- Basic patient health records
- Awareness about diseases (visualize and explanation)

1. In chapter one we have managed to find lot of usefully references from reliable sources which related to healthcare and smart phone growth in developing countries. These reliable sources are ICTlogy, WhiteAfrican and ministry of health and social welfare many other, which gave us clear picture

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on healthcare current situation and usage of smart phones in Tanzania. The references point out especially in rural area in Tanzania for the lowest level in healthcare.

2. In chapter three state of the art we have managed to identity some relevant mobile application which already in the market. These applications are from different location such as India, US, Portugal and Philippines. We did comparison with the applications and found some relevant key features were missed. From the compare result the missing functionalities are
   - User profile
   - Accessing patient electronic medical record (EMR)
   - Availability of electronic prescription (Adult or Paediatric)

3. In chapter five we have furthermore analysed the problem of this project. Mainly our analysis were based on the conducted interviews with potential users and a doctor from Tanzania. These interviews showed us clearly the current situation of Primary care in Tanzania. So this will be challenges for us engineers who are working on the consumer site application, because here we are planning to integrate different healthcare stakeholders into one place.

   To illustrate more the challenges, we have created different scenarios. The outcome of this the system overview with such as context diagram and use case diagram, which brought us to the functional requirements. Let's look back into previous chapter one, the company BlueTown which is already providing internet and smart phones to the users in rural area in Tanzania and we also found out usage of smart phones over there.

   This motivated us because we don't need to worry about how to reach the users and what kind of phone they are using since this project collaborates with BlueTown. But the challenge we found is how to use this BlueTown as bridge in order to deliver the users a better solution in healthcare in rural area in Tanzania.

4. In chapter six, which is problem solution part, we have worked on eHealth mobile application as proof of concept. Before the implementation part we have done wireframes which gave us a good overview of the different frames

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and their relationships. What we did first is presented those wireframes to some users in Tanzania to make sure the wireframes are too advanced or it's simple and understandable.

This is also one way to keep close the user and their feedback which will be used to modify the wireframes. The wireframes satisfied both us and the users, which mean we can go ahead with the implementation. The eHealth application covered some key points form the requirements part such as

- User profile
- Book appointment
- Basic patient health records
- Electronic prescription
- Awareness about diseases
- Weekly health tips

From the user tests it showed us their satisfaction with the product. It can be found in the subchapter 6.3.3.

To close the loop we believe this academic report has covered the essential key areas we have raised as research questions. The EHS design has shown all the stakeholders such as Patients, Doctors, Pharmacists, Service provider (BlueTown) and technologies. For instance the stakeholders interact with EHS in order to,

- The patient will have booked appointment before going to the hospital. This will avoid waste of time and make things easier between doctor and the patient.

- The electronic prescription makes avoidance with the physical prescription form the doctors. This make easy work for the pharmacist and the patient. The patient can't lose the prescription and always can check the previous ones.

- Using the EHS, the doctor can monitoring patients from the system, which help to give the overview and responds the requested appointments. And also extant the prescription in online without

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involve the patients to come whole the way from their home to the hospital.

- The technology such hospital servers will be used to store all health related and users information. By this it responses with real time information about the users and their health related information.

7.2 Future improvements

According to the conducted research about the shape of future eHealth solution it is indicated the system complexity will be at very high level. The EEU action plan which specifies the eHealth development explains how and what steps needs to be taken in order to provide fully functional large scale system. As it was clarified in the official Action Plan for the eHealth development the electronic healthcare system is build based on the other systems which have to be standardized. Every element of e-health is significant and what is more important the technical specification is dissimilar for each of them.

There is still many issues related to the e-health which were declared in this report however, if all the concerns will be covered then there is bright future on the horizon for the eHealth. The developed first standalone version of the application can be in the future part of complex eHealth structure which will provide information exchange on the larger scale. The major advantage of use of ICT in the healthcare system is the possibility to "act and react" much faster and accrued what helps to safe people life. The figure below presents the future concept of eHealth and proposed in the report application can be first step of the large scale eHealth development in Tanzania.

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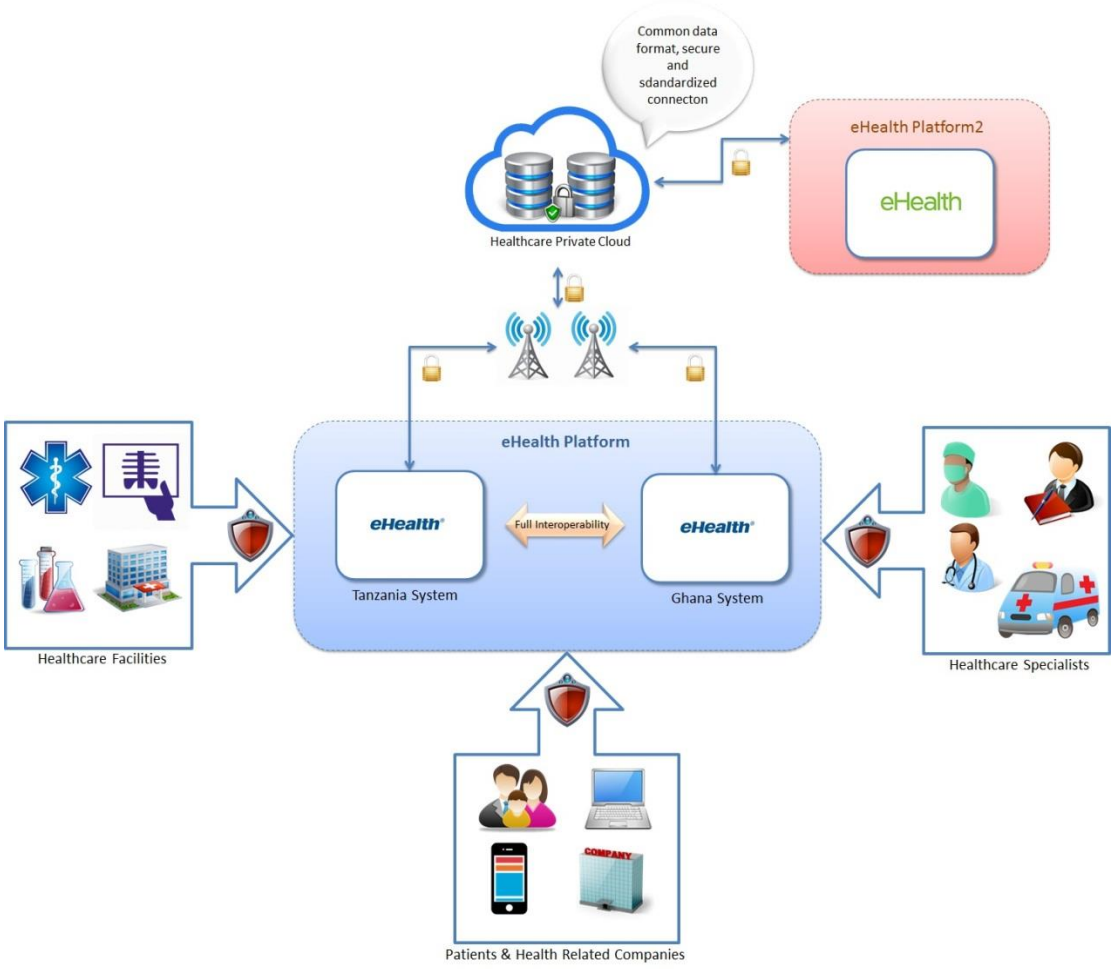

Figure 7.1 Future perspective of eHealth in Tanzania

Figure above illustrates the future vision of eHealth system. The standardized solution will involve various stakeholders which will interact with the system. Also in the future perception the interoperability between different eHealth systems will be supported

The figure above presents future outlook of the eHealth in Tanzania. On the scheme various entities which are interacting with the system are showed. Each data exchange between entities and system must be secured at the demanded level. Furthermore in the center two different eHealth solutions are displayed as a one platform which allows them to cooperate if the common standards will be applied. All the data can be transferred to the Tanzania healthcare private cloud through the secure network connection. In the cloud various type of sensitive data must be segregate according to the confidentiality and security level. In addition the data which will be stored in the common format and security standards can be accessed by other eHealth platform which is developed on the same standards.

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The proposed above solution can be implemented in Tanzania according to the existing electronic healthcare development framework established by the Tanzania Ministry of Health and Social Welfare. Since already many organizations is working on the standardization of eHealth components the produced specifications can be applied in Tanzania eHealth solution. By applying common requirements and specifications the solution can be compatible with European systems bringing many benefits for various parties and economy.

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CHAPTER 8

8. Conclusion

In this project we have identified the potential of eHealth as a support for a regular healthcare quality enhancement and its possibility to be developed in Tanzania. The main focus point was to provide primary care e-health solution with opportunity to use it in the countryside areas in selected region.

Going deeper in to analysis we investigated how the e-health impacts on the healthcare in developed countries. The process of e-health development is still in progress as well like researches which will show the true measures of e-health effectiveness in developed regions. However, the actions taken by European Union shows there is a big attention around electronic healthcare and its positive benefits. Many actions and initiatives is currently ongoing in order to make the electronic healthcare solution common, safe and interoperable.

The e-health evolution is progressing fast, every time shaping new concept which brings more innovative features for the patients, hospitals, doctors and other health related stakeholders. From performed analysis this project also highlighted the major issues which first needs to be solved in order to make the e-health functional in a greater scale. Many limitations of currently known healthcare e-solutions is caused by obstacles related to the lack in standardization field.

Furthermore, by understanding the eHealth importance in the near future perspective and matters related to its development the investigation about the possibility of eHealth implementation in Tanzania was conducted. The results showed current problems in the Tanzania health care sector as well like possibilities which can be facilitate in order to implement the primary model of eHealth. Moreover, the gathered and analyzed data was also collected directly from Tanzania by support of BlueTown company which collaborates with this project. The outcomes of the research helped us to achieve main objective of this project.

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From the perspective of engineers we introduced the Android based e-health application which uses ICT technologies. The solutions can be used in Tanzania countryside areas if the basic system requirement like Internet access and Android device will be provided. In order to reach the objective the main problem definition together with relevant sub-problems needed to be investigated.

How health care based on Portable mobile device should be designed in order to improve efficiency and quality of primary care in rural area in Tanzania?

Based on the research, interviews with potential patients and later feedbacks from the testing, we have discovered the application supposed to be easy to interact and minimalistic in terms of labels and displayed information. The potential users prefers to have text instead of picture based design. According to them the text explanation will be more clear. In addition the idea of more colourful layout also kept the attention of the users giving a positive reaction. The results also showed the information which are accessed through the application are not to personal according to users point of view. Provided basic functionality should fulfills patients requirements related to:.

- Possibility check his EMR(*electronic medical record*)
- Book appointment with a doctor
- Receive e-prescription
- Access health related tips and information

The interviews and testing effects also showed the potential users are really satisfied with the proposed functionality and design. The conclusion pointed out that if the primary care will be supported by the ICT solution, then the quality of healthcare will be at higher level.

How to identify the current issues related to Primary care in rural area in Tanzania?

According to the desktop research and also through the analyzing Tanzania patients interviews we have discovered many problems related to the current healthcare system. The major issue is related with the lacks of hospitals and qualified specialists within the hospitals. The countryside areas are usually far from the hospital or dispensary so often people have very limited contact with the doctors or

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even totally ignores them. Frequently people decide to go to hospital only when it is really necessary.

Another issue was related with possibilities to call the doctor since they are very busy and often not even giving away their phone numbers. When people decide to go directly to the hospital usually there is a very long queue. This makes the patients to perceive the doctor visits as a necessity. From the prescription point of view patients claims often there is a problem with knowledge about availability of particular pills. Sometimes they need to travel far to the dispensary just to discover the medicine is not available. This result a loss of time and seeing the healthcare sector as a not well organized.

Moreover, the access to the health related to information is also very limited. The patients hardly can find some relevant details about the diseases, bad symptoms of pregnancy or alternative medications. The possibility to get such an information is usually possible through the doctor or nurse which are usually far away.

Any possibility to optimize the regular health sector and health service by introducing ICT solution*?*

There is many lacks in traditional healthcare system in Tanzania which can be minimized by use of ICT based solution. Provided in Tanzania technology can support proposed primary care eHealth application. However, based on the Tanzania users output the level of available technology and devices is still pretty low. The same response was given where the users have been asked about reliable internet connection which in most cases is not there. The users usually are served from 3g towers with the slowest set-up which makes the usage of internet very slow.

Nevertheless, it is important to know the Tanzania is an developing country so the level of technology and available devices is growing continuously. The Tanzania ministry already created the official framework for the e-health development. This shows the government also see the potential of bringing innovation in to old fashioned healthcare system. According to the official Tanzania Action Plan the e-health will play an important role as a part of traditional healthcare.

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Even more, the proposed e-health application is just a first stage which can evolve in pair with the progression of technology. For the time being the proposed application can be implemented as a small-scale solution with limitations in terms of accessibility. This will help people to adopt it and see the benefits of such solution in the progressed manner. Later in time if level of supported technology will grow also the e-health can expanded on wider scale. According to the official Tanzania e-health action plan the project will be supported by various healthcare related stakeholders and government.

What are the current ICT mobile-based solution in Tanzania?

We have raised this question to see the level of adoption in mobile based services. From this we will know if they are able to operate our eHealth application. Problem analysis in Chapter 5 presents conducted interview with the BlueTown users. There we have asked the users about if they are familiar with any ICT mobile based solution. Most of the users from there are just using mobile payment services, such as M-pesa and Tigopesa. This level showed enough to adopt eHealth application.

How to introduce and encourage people to use eHealth?

To introduce a product will be a challenge, even more if the product is new in the market. Here you must make them sure what are the benefits from the product and what will make the life easier. So for this we need to know what the users are thinking of it. From the conducted user interview in Chapter 5, we have asked if they will user their smartphone for healthcare, e.g. for booking appointments, electronic prescription and access health records.

The answers were positive from their point of view, which gave us also more confident. Before we developed the product we gave the users a pre-introduction (presented with conducted user interviews). We created a presentation with a demo for the idea of eHealth application. This was very good idea because figures and animation tell more about the idea than text. After the good feedback we moved the development part and complete it and did user test from the developed product point of view. From the user test in Chapter 6.3.3 showed us overall the application looks very easy to use and looks promising. From their point of view it will be very helpful in healthcare. Encourage people to use a new product even challenging than

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introducing, but since from the beginning the users saw this solution with positives eyes and the user test feedback, we are not doubting this is the first step will change the Primary care life style in rural area in Tanzania.

How the existing infrastructure platform will support eHealth?

Once we know what we are going to investigate and what kind of solution to build. The next step will find the bridge, which can connect the users to us. This bridge was BlueTown, through them we can reach their users to present our idea of eHealth application. Since BlueTown already has a Platform in rural area in Tanzania, our work became easier. As we have mentioned in the beginning BlueTown providing internet and smartphones to the users. This helped us to build an application around it and deliver the product the users, at the same time make the job easier within Primary care.

Process assessment

To conclude the project process and topic selection which was based on the interest within selected area, we needed to consider available resources and time limitation which can be spent on particular sections. One of the main procedure was related to shift from wide perception of the research area in to particular field within, which we needed to solve the chosen problem successfully.

Furthermore, another important aspect which brought a good results in term of project structure and finding a good research field was support from the BlueTown. The meetings which we were participate helped us to follow the right track and gather the relevant data for the analysis and specifying the requirements. With a support of the company we were able also to establish cooperation with Kareen Limbe which help us to collect the relevant information.

The process of the project research and development phase provided us many valuable information and practical experience, which we can apply in the future work. During the process many challenges which needed to be faced were solved by support of BlueTown and AAU supervision.

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Appendices

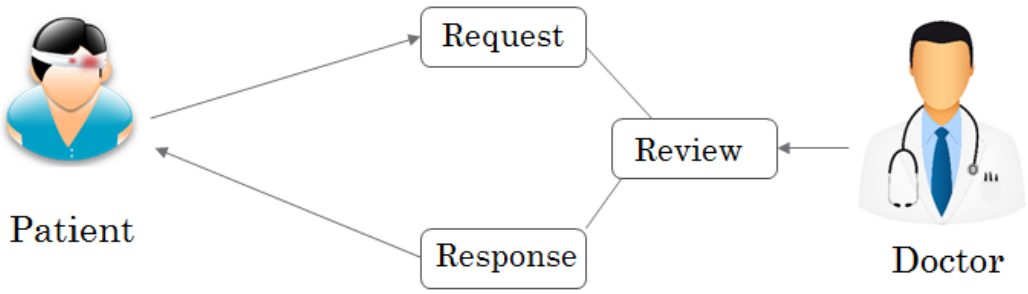
Appendix 1. Project description

The scope of this project is focused on the e-health solution for rural areas in Tanzania. The proposed e-health application is made for the BlueTown Company, which is supplying less developed areas of the world in term of ICT.

The main idea of the e-health is to combine the usage of electronics and information communication technologies in the healthcare. The technology used in the e-health solutions supports particular processes based on education, research and administration. Amongst many benefits of such solutions the main advantage is scalability. The technologies which are used in the e-health can be converged together not only in the one city, but also across the different continents.

Proposed application for the healthcare industry will support functionalities for the patients, doctors and pharmacies. The particular features will be divided between three main categories:

- *Primary care* – will focus on the administrative and research e-health perspectives. This functionality will help patients to be connected with the doctors in order to have better quality treatment. In the other hand the doctors will also have improved possibility to monitor and interfere with the patient during the handling. Even more the appointment between doctor and patient also can be made through the application. This can improve the treatment procedure and makes them more convenient for both parties.



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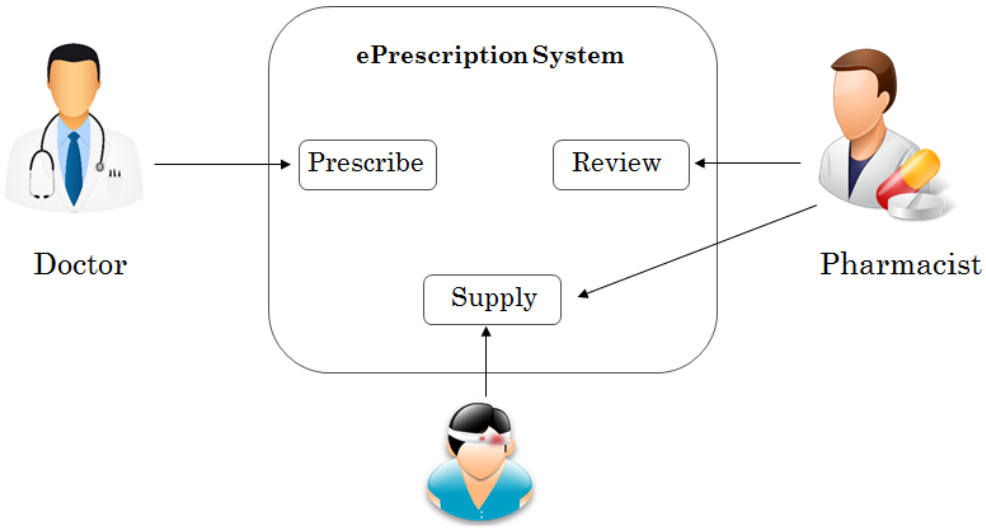
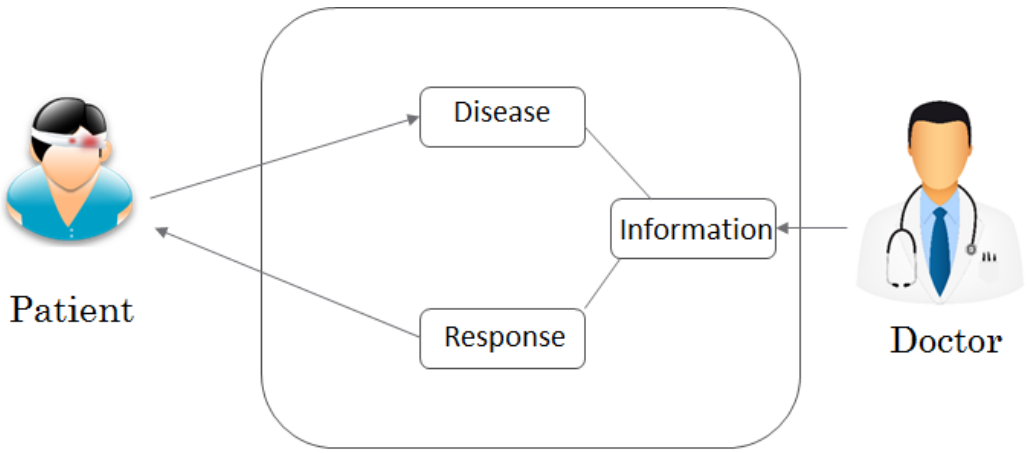
- *Pharmacy* – allows the pharmacy to acquire e-prescription made by the doctor without involving the patient role. The virtual prescription can be realized faster than regular improving administration process effectiveness.



- *Additional materials* - this feature will tackle the educational perspective of the E-health. Under this section the facts about the diseases can be found as well like information how to diagnose, prevent and heal certain illness.



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Moreover, the application will also contain a map, which will represent particular area of Wi-Fi coverage. The network towers covers specific part of the land and in many cases obstacles can affect the connection.

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Appendix 2. Milestone plan

This is the milestone plan for the Master project e-Health system for Tanzania collaborate with BlueTown. Milestone plan was compiled to organize the goals to be achieved before deadline. Each milestone plan has its own goals and document delivering for review. This detailed milestone plan helps us with following the progress in each milestone and to complete the tasks.

Milestone 1 – Brainstorming and finding problem area	**Deadline: 06-03-2015**

This is the first milestone, which is the kick-off of the master project. The focus here is to find a topic collaborate with BlueTown for the project. Some documentation will be done in this phase of the project.

Milestone Goal

1. Methodology
    a. The topic for the project collaborate with BlueTown is done
    b. Pre-Research about the project done
2. Done with final brainstorming.
3. The supervisor approves the project.
4. Milestone plan is created
5. The time schedule is created
6. Project description is created collaborate with BlueTown.
7. 1st draft of the report ready for review

Document delivering

- Project description is delivered
- Methodology is delivered
- 1st Introduction is delivered
- 1st draft of the motivation and the background
- 1st draft of the problem definition
- Milestone plan is delivered
- Detailed time schedule

Milestone 2 – Requirements and analysis	**Deadline: 03-04-2015**

This is the second milestone, which is the requirement and analysis phase of the project. Once the final problem definition defined, and then is possible to move into, a good understanding about e-Health with State of the Art. Hereafter, problem analysis about lack e-Health system in Tanzania. The focus also will be interview questions, to collect data for the analyse part. A lot documentation will be done in the phase.

Milestone Goal

1. **State of the Art**
    a. Investigate about the current Healthcare solutions
    b. Comparison
2. **Analysis**

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a. Scenarios
b. Interview with a research clinic representative
c. Context diagram

3. **UML process**
   a. Use case diagram and cases
   b. Requirements specifications
      i. Functional - what behavior the system should offer
      ii. Non-functional – a specific property or conditions on the system

Document delivering

- Final problem definition of the project is delivered
- Final motivation and background is delivered
- State of the art is delivered
- Context diagram is delivered
- Scenarios are delivered
- Requirement specifications are delivered
- Use case diagram and the cases are delivered
- Interview data been analyzed and the document are delivered
- 2nd draft of the report ready for review

Milestone 3 – Design and Implementation **Deadline: 15-05-2015**

This is the third milestone. It is the design and implementation phase of the project. This phase consists of all design and almost of all entirely implementation. There will also documentation in this phase, but very small documentation since it is design and implementation phase.

Milestone Goal

1. **Designs for the application**
   a. Wireframes
   b. Layouts
   c. Figure selection
   d. Visual hierarchy
2. **UML process**
   a. Class diagram is created
   b. Sequential diagrams are created
3. **Application development**
   a. Primary care
      i. Request and response an appointment between a doctor and a patient
      ii. Missing Medicines (patient checks and request to the doctor)
      iii. Doctor prescribes the medicines
   b. Pharmacy
      i. ePrescription
   c. Additional material
      i. Aware About diseases

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d. Better signal
    i. Showing a map with where to find better signal.
    ii. Signal lost and what to do.
e. Instruction about how to use the application
    i. Explain how the different features work.

Document delivering

- All wireframes and design are documented
- All UML documentation are delivered
- Description about the application is delivered
- 3rd draft of the report ready for review

Milestone 4 – Testing and Final report **Deadline: 10-06-2015**

It is the last milestone of this master project. Which means it is the final testing phase. In this phase, some important tests are implemented and tested. Find the bugs and correct them or discovered bugs must be documented. Conclusion documented by the group. The final report reviewed by the group.

Milestone Goal

1. **Create test cases and run**
    - User acceptance test
    - Unit test
    - Integration test
2. **Correct or document all discovered bugs**
3. **Test the final product**
4. **Create a guideline for the product**
    - How to use the application
5. **All written documents are reviewed**

Document delivering

- Test cased are delivered
- Test methods and test case results are delivered
- Conclusion are delivered
    - Product oriented
    - Process oriented
- Final report is handed in.

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Appendix 3. Interview questions

Interview questions about ehealth application for the user

1. Are You familiar with usage of smartphone and do You know how to use an internet on the mobile device?
2. Is there reliable internet connection provided in your neighborhood?
3. Are you using any mobile service like for example mobile payment? Is it difficult to learn how to use it?
4. In your opinion the mobile application should be represented more in the contextual level (pictures) or text based in order to be better understood for You?
5. How often You are contacting your doctor?
6. Are you contacting Your doctor more through the regular visit's or through the phone call?
7. What's are the main obstacles when contacting or visiting the doctor?
8. Do you have access to your personal healthcare records and is it relevant for You?
9. Is the process of getting medicine prescription is good enough? What are the issues?
10. Would You use Your smartphone and internet in order to book a visit with the Doctor if it will be faster?
11. Would You prefer to receive medicine prescription in the electronic form, so the realization process will be simpler?
12. Do You often checking the updates about new viruses in order to know how to prevent yourself? What are the main sources of accessing these information's?
13. What other options might be helpful in order to make healthcare process more simple?
14. If the process of prescription, doctor visit's and emergency situation will be more efficient and faster by use of smartphone and internet would this will encourage you to use mobile device to do so?

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Appendix 4. Use cases

Use Case	SelectLanguage
ID	UC1
Brief description	The system allows User to select language between English and Swahili.
Primary actors	User
Secondary actors	None
Preconditions	None
Main flow	1. The system shows language selection 2. The User can select wished language
Post conditions	1. The User has selected wished language. 2. User can login with login details 3. User can register into the system
Alternative flows	None

Use Case	ReadUserManual
ID	UC4
Brief description	The system displays user manual to the User
Primary actors	User
Secondary actors	None
Preconditions	UC3
Main flow	1. The use case begins with User selects instruction 2. The system displays a mobile screen showing the user manual in details. 3. While the User is browsing the user manual a. User can plays video demos.
Post conditions	1. The system has displayed user manual. 2. The User can select video demos
Alternative flows	None

Use Case	ViewPrescription
ID	UC5
Brief description	The system displays his or her current prescription details to the User.
Primary actors	User
Secondary actors	None

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Preconditions	UC3
Main flow	1. The use case starts when the User selects "view prescription". 2. The system displays a mobile screen showing the prescription in details. 3. The system provides to check other options of pharmacies in order to get the medicines faster or if the medicines are sold out in the current pharmacy then the user can go to another pharmacy, which has the medicines.
Post conditions	1. The system has displayed detailed prescription.
Alternative flows	None

Use Case	ViewAppointments
ID	UC6
Brief description	The system displays his or her upcoming appointments details to the User.
Primary actors	User
Secondary actors	None
Preconditions	UC3
Main flow	1. The use case starts when the User selects "view appointment". 2. The system displays a mobile screen showing the appointment in details. 3. The system provides another feature, which is book a new appointment
Post conditions	1. The system has displayed detailed appointment
Alternative flows	None

Use Case	AccessHealthRecords
ID	UC8
Brief description	The system displays his or her basic health records to the User.
Primary actors	User
Secondary actors	None
Preconditions	UC3
Main flow	1. The use case starts when the User selects "access health records". 2. The system displays a mobile screen showing the health records in details.

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Post conditions	1. The system has displayed detailed health records
Alternative flows	None

Use Case	ContactEmergency
ID	UC8
Brief description	The system displays emergency contacts to the User.
Primary actors	User
Secondary actors	None
Preconditions	UC3
Main flow	1. The use case starts when the User selects "contact emergency". 2. The system displays a mobile screen showing the emergency contact details. 3. The User can use the different emergency options.
Post conditions	1. The system has displayed detailed emergency contacts.
Alternative flows	None

Use Case	ViewHealthTips
ID	UC9
Brief description	The system displays weekly health tips to the User.
Primary actors	User
Secondary actors	None
Preconditions	UC3
Main flow	1. The use case starts when the User selects "view health tips". 2. The system displays a mobile screen showing the weekly health tips. 3. The system also displays previous health tips.
Post conditions	1. The system has displayed detailed weekly health tips.
Alternative flows	None

Use Case	ViewOtherDiseases
ID	UC10
Brief description	The system displays options of other diseases to the User.

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Primary actors	User
Secondary actors	None
Preconditions	UC3
Main flow	1. The use case starts when the User selects "view other diseases". 2. The system displays a mobile screen showing videos about other diseases. 3. The user can rate the videos.
Post conditions	1. The system has displayed videos about other diseases. 2. The user has selected one and watched thereafter rated it.
Alternative flows	None

Use Case	CheckAppointments
ID	UC11
Brief description	The system displays requested appointments from users.
Primary actors	Doctor
Secondary actors	None
Preconditions	1. The doctor needs to be logged into the system to check the appointments.
Main flow	1. The use case starts when the Doctor selects "check appointments" after login process. 2. The system displays a web page showing appointments details.
Post conditions	1. The system has displayed detailed appointments. 2. The doctor responded the appointments.
Alternative flows	1. If the Doctor does not have internet connection, then the system will request the Doctor to check the connection. 2. If the login fails, the system will request to check the Doctor´s login details.

Use Case	CreatePrescription
ID	UC12
Brief description	The system allows the Doctor to create a new prescription for the User.
Primary actors	Doctor
Secondary actors	None

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Preconditions	1. The Doctor needs to be logged into the system to create a prescription.
Main flow	1. The use case starts when the Doctor selects "create prescription". 2. The system displays a web page showing the fields for to create a new prescription. 3. The Doctor fills in for the specific User and send to the system.
Post conditions	1. A new prescription is created. 2. User get notification about the new created prescription. User can view this prescription on his or her prescription list.
Alternative flows	None

Use Case	CheckPrescription
ID	UC13
Brief description	The system displays prescription details from the user-
Primary actors	Pharmacist
Secondary actors	None
Preconditions	1. The Pharmacist needs to be logged into the system to check the prescription
Main flow	1. The use case starts when the Pharmacist selects "check prescription". 2. The system displays a web page showing prescription details.
Post conditions	1. The system has displayed detailed prescription. 2. Delivered to the User.
Alternative flows	1. Pharmacist does not have internet access, and then the system will request Pharmacist to connect to the internet. 2. If the Pharmacist does not have internet connection, then the system will request the Pharmacist to check the connection and valid login

Use Case	ControllingSystem
ID	UC14
Brief description	This actor controls the system.
Primary actors	BlueTown

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Secondary actors	None
Preconditions	1. The user must be logged-in as Admin
Main flow	1. The use case starts when the Admin selects "controlling system". 2. They system displays web page-showing overview of different departments (e.g. normal users, doctors and pharmacists). 3. The system provides monitoring: a. Connection, b. Memory usage c. Capacity usage d. Invalid logins e. Login attempts f. Committed transaction
Post conditions	1. Displayed detailed overview of the system 2. If any failure in any departments the admin is presented with an error message.
Alternative flows	1. Admin does not have internet access, and then the system will request admin to connect to the internet.

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Appendix 5. Detailed time schedule

# Task	Description	Area	Start Date	Due Date	Responsibility	Status
MILESTONE 1 – Brainstorming and finding problem area | Deadline 06-03-2015 |						
1	Discussion with BlueTown about the project	DISCUSSION	28-01-2015	16-02-2015	Group	CLOSED
2	Brainstorming	DISCUSSION	28-01-2015	16-02-2015	Group	CLOSED
3	Round up brainstorm and choose the topic	DISCUSSION	16-02-2015	16-02-2015	Group	CLOSED
4	Finalize the project topic with the Supervisor	MEETING	16-02-2015	16-02-2015	Group	CLOSED
5	Project description about eHealth solution to Tanzania	DOC	17-02-2015	17-02-2015	Michal	CLOSED
6	Milestone plan	DOC	16-02-2015	17-02-2015	Gatha	CLOSED
7	Write detail time plan with milestone goals 1st draft	DOC	17-02-2015	18-02-2015	Gatha	CLOSED
8	Methodology	DOC	18-02-2015	18-02-2015	Gatha	CLOSED
9	Introduction 1st draft	DOC	19-02-2015	26-02-2015	Michal	CLOSED
10	Motivation and background 1st draft	DOC	19-02-2015	26-02-2015	Group	CLOSED
11	Problem definition 1st draft	DOC	26-02-2015	03-03-2015	Group	CLOSED
12	Review all documents	REVIEW	04-03-2015	06-03-2015	Group	CLOSED
13	1st draft of the report is ready	DOC	05-03-2015	06-03-2015		CLOSED
MILESTONE 2 – Requirements and analysis | Deadline 03-04-2015 |						
14	State of the Art	DOC	07-03-2015	15-03-2015	Group	CLOSED
15	Create questionnaire for the users	DOC	13-03-2015	13-03-2015	Group	CLOSED
16	Interview with users/patients in Tanzania	INTERVIEW	16-03-2015	16-03-2015	Group	CLOSED
17	Final problem definition of eHealth solution for Tanzania	DOC	18-03-2015	18-03-2015	Gatha	CLOSED

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18	Final motivation and background	DOC	18-03-2015	19-03-2015	Michal	CLOSED
19	Literature reviews	DOC	18-03-2015	20-03-2015	Group	CLOSED
20	Document the interview data from users/patients	DOC	20-03-2015	22-03-2015	Gatha	CLOSED
21	Scenarios of eHealth system compare to current system • Scenario 1: Using smartphone to contact a doctor (Gatha) • Scenario 2: Wants to get access the health record (Gatha) • Scenario 3: Acquire the prescribed medicines (Gatha) • Scenario 4: Wants to know about malaria symptoms (Michal) • Scenario 5: Doctor needs to control patients more frequent (Michal)	DOC	18-03-2015	25-03-2015	Group	CLOSED
22	Project delimitation	DOC	26-03-2015	27-03-2015	Gatha	CLOSED
23	System analysis	DOC	28-03-2015	29-03-2015	Michal	CLOSED
24	Context diagram of eHealth system for Tanzania	DOC	26-03-2015	28-03-2015	Gatha	CLOSED
25	Requirement specifications • Functional requirement • Non-functional requirement	DOC	26-03-2015	27-03-2015	Michal	CLOSED
26	Use case diagram of eHealth system for Tanzania	DOC	29-03-2015	03-04-2015	Gatha	CLOSED
27	Use cases	DOC	29-03-2015	03-04-2015	Gatha	CLOSED
28	Background theories and how they are relevant for our project • Platform (Gatha) • Android (Gatha) • Cloud technology (Michal) • MySQL (Michal)	DOC	28-03-2015	03-04-2015	Group	CLOSED

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29	Final milestone plan + detailed time schedule	DOC	03-04-2015	03-04-2015	Gatha	CLOSED
30	2nd draft of the report is ready		03-04-2015	03-04-2015		CLOSED
	MILESTONE 3 – Design and Implementation | Deadline 15-05-2015 |					
31	Design for the application • Wireframes • Figure selection	DOC	04-04-2015	05-04-2015	Gatha	CLOSED
32	Description of Wireframes	DOC	05-04-2015	06-04-2015	Gatha	CLOSED
33	ER-diagram	DOC	07-04-2015	07-04-2015	Gatha	CLOSED
34	Relational database design	DOC	08-04-2015	08-04-2015	Gatha	CLOSED
35	Block diagram of eHealth application	DOC	09-04-2015	09-04-2015	Gatha	CLOSED
36	Database configuration		08-04-2015	08-04-2015	Gatha	CLOSED

37	Create layouts (GUI)
	• Splash screen (Gatha)
	• Language selection screen (Gatha)
	• User login screen (Gatha)
	• Main screen (Gatha)
	• My profile screen (Michal)
	• Prescription screen (Michal)
	• Book appointment screen (Gatha)
	• Health records screen (Gatha)
	• Other services screen (Gatha)
	  ○ Health tips screen (Michal)
	  ○ Emergency call screen (Michal)
	  ○ Customer service screen (Gatha)
	  ○ Other diseases (Gatha)
		ANDROID	07-04-2015	10-04-2015	Group	CLOSED

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38	Visual hierarchy description	DOC	11-04-2015	12-04-2015	Michal	CLOSED
39	Database creation	SQL	12-04-2015	13-04-2015	Gatha	CLOSED
40	Methods • User Login – hardcoded (Gatha) • Splash screen (Gatha) • Language selection (Gatha) • User profile – fetching user data from DB (Gatha) • Book appointment – writing data into DB(Gatha) • Fetching health records and displayed (Gatha) • Service ○ Other diseases (Michal) • Prescription created in the system (Gatha)	JAVA/SQL	14-04-2015	12-05-2015	Group	CLOSED
41	Class diagram	DOC	13-05-2015	14-05-2015	Michal	CLOSED
42	Sequential diagram	DOC	14-05-2015	14-05-2015	Gatha	CLOSED
43	Database documentation	DOC	15-05-2015	17-05-2015	Gatha	CLOSED
44	Description about relevant programming parts • User login (Gatha) • Book appointment (Gatha) • User profile (Gatha) • Other diseases video streaming (Michal) • HTTP connection (Michal)	DOC	04-04-2015	15-05-2015	Group	CLOSED
45	Description about UML documents • Class diagram (Michal) • Sequential diagram (Gatha)	DOC	04-04-2015	15-05-2015	Group	CLOSED

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46	3rd draft of the report is ready	DOC	15-05-2015	15-05-2015		CLOSED
MILESTONE 4 – Testing and Final report |Deadline 10-06-2015|						
47	Create Unit test cases	DOC	16-05-2015	19-05-2015	Gatha	CLOSED
48	Implement Unit tests	JAVA	17-05-2015	24-05-2015	Gatha	CLOSED
49	Testing	TESTING	24-05-2015	27-05-2015	Gatha	CLOSED
50	Integration test	DOC	27-05-2015	28-05-2015	Michal	CLOSED
51	User acceptance test	TESTING	28-05-2015	29-05-2015	Group	CLOSED
52	Correct or document all discovered bugs	DOC	30-05-2015	31-05-2015	Group	CLOSED
53	Document all tests results	DOC	28-05-2015	31-05-2015	Group	CLOSED
54	User interface	DOC	29-05-2015	29-05-2015	Michal	CLOSED
55	Discussion • Findings • Future improvement	DOC	31-06-2015	02-06-2015	Group	CLOSED
56	Conclusion	DOC	02-06-2015	03-06-2015	Group	CLOSED
57	Review all written documents for the report	REVIEW	03-06-2015	09-06-2015	Group	CLOSED
58	Final report is ready to hand in	DOC	10-06-2015	10-06-2015	Group	CLOSED
HAND IN – Final report with the product |Deadline 10-06-2015|						