City e-Health with Geographic Information System and Decision-Support System

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ABSTRACT

The purpose of this paper is to implement a system that has been developed because of the importance of information technology in the present day scenarios in terms of monitoring resources in almost all institutions. The computer-based monitoring and the decision support system application specifically on health sector basically provides updated information and supports decision on the health situation of a community. Part of the research is to develop a system known as City e-Health, a system designed to provide Geographic Information System (GIS) and Decision Support System (DSS). In the software development process cycle, programming model is used to plan the various stages of developing an application. The respondents of this study are the City Health Offices and community health centers of the 26 communities of Digos City as a pilot study. Results of the survey showed on its preliminary observation that most of the six (6) majors cities have internet connection that are ready for implementation but no system available that are installed in the office. In the community level, not all selected office is ready to have a system but installing such project is highly commendable by the officials.

Keywords: *e-Health, Geographic Information System, Decision Support System, Agile Modeling, Scrum Model*

INTRODUCTION

Information technology plays a major role in the present-day scenarios of monitoring resources for various institutions. The computer-based monitoring and the decision support system application specifically on health sector basically provides updated information and supports decision on the health situation of a community.

In Europe, researchers made a study in creating e-Health implementation towards simulation and it has been discovered that methodologies used in developing the said project lessen the time in decision making. Information and Communication Technology (ICT) in health recognizes the impact in the quality, access and efficacy of healthcare. In some first world countries like Europe and US are embracing innovative ICTs to enable better cures and better means for early detection of diseases (Europe Journal of e-Practice, 2009).

In Central Asia, e-health is pushed to public and private establishment more specifically in Afghanistan. A private institution which is the French Medical Institute for Child Health (FMIC) implemented e-health to support a hospital in order to improve its services and building capacity, to evaluate a model for telehealth activities between Provincial hospital in Afghanistan and a tertiary hospital in Kabul (FMIC). Moreover, the e-health in the hospital is mainly to have an on-line diagnosis and continuous medical education and to ensure provision of right care, effective and innovative health care; is the step towards changing the nature of health care and to uplift the situation in rural area like Afghanistan (Jan, 2010).

The Cardinal Santos Medical Center (CSMC) in San Juan City, Philippines, encounters a more complicated but challenging experience about using the technology of internet in terms of health. The implementation of the e-health in the hospital is by means of WiFi connectivity. Thus, the perception of most establishments offering free WiFi connectivity to its patrons is considered the

use of technology as its step to the exploration and satisfaction on the need of the clinical equipment. Through this, the use of technology was able to break the barrier in terms of healthcare offerings, such as improvement in patient's safety, delivering better services and increase employees' productivity. The experience of the CSMC may lead to the continuing study of the performance of technology in the field of health sector (Tuazon, 2011).

In Digos City, the Department of Health-Center for 2004 Health Development Annual Report indicated in its report that during the past three years, eight of the ten leading causes of morbidity in Davao Region were communicable but highly preventable diseases. Communicable diseases like diarrhea, influenza, tuberculosis, malaria and dengue were now included as a fourth priority research area by the Regional Health Research and Development Committee (RHRDC). This entails that in order to rapidly monitor and control the spread of communicable diseases as early as possible, research on the use of information system in health must be included, not discounting the idea of establishing one to aid the RHRDC in monitoring the prevalence of communicable diseases in the Region and prevent it from further spreading.

This study is proposed in order to address the problem of the community in Digos City as a pilot study in terms of communicable diseases and general health monitoring. At present, all community health centers submit reports to City Health Center to the Department of Health Regional Office using manual system. In using the electronic health system, health centers could easily transmit reports to the Department of Health and in return, the information is easily disseminated to the local leaders and people of the community in Digos City and to the people concerned about geographic information and decision making. The Geographic Information System (GIS) gives the community the necessary information about the status of the prevalence of the disease and the health of the residents as well. Hitherto, the system aids the leaders in employing necessary measures in confluence with the City Health office to ensure certain steps are undertaken to prevent further spreading of communicable diseases. The curiosity of the researcher comes into realization on what is the reaction of the stakeholders of the City/Community Health Offices in Digos City if the system is realized. The system makes the transaction on each City/Community Health Office channeled down to the health offices of the community under them to have a better and more realistic view of the health situations of Digos City. The very gist of the study, which is ensuring that communicable diseases are monitored in a faster, more reliable and within a quick-response mechanism, is what inspires the researcher to infuse systems falling on the reinforcement of a feasible e-health systems for Digos City.

Statement of the Problem

This study aims to provide answers to the following questions:

1. What are the technical requirements in the development process of the Geographic Information System (GIS) of the City Health Centers in Digos City?
2. What is the implementation framework of Geographic Information System (GIS) of the City Health Centers in Digos City?

FRAMEWORK

Hassani (2012) stated that a system can achieve its standard level of quality by clarifying the needed requirements of the systems' developers and users and understanding the nature of the system. The well-known model is called the FURPS+, which stands for Functionality, Usability, Reliability, Performance, Supportability and the "+" extends the acronym to include quality components that are specific to individual software like design, implementation and physical

requirements. The project uses this FURPS+ model to check and clarify the effectiveness of the system. To ensure the accuracy of the geographic information system and decision support system of the project, the three-tier architecture is used to ensure the reusability, flexibility, manageability, maintainability, and scalability. Three-tier architecture is a general-purpose information system suitable for GIS and DSS.

The special nature and exclusive characteristics of geographic information pose special functional requirements on the architecture in terms of conceptual and logical models, data structures, access methods, analysis techniques, or visualization procedures. Luaces (n.d.) stressed that the model is very important to determine the special requirements and functionality of GIS applications beyond those of general-purpose information systems in order to design and implement a GIS application framework with appropriate capabilities for modelling, collecting, querying, and visualizing geographic information.

With the theories hinged by this study, the researcher came into a theory called the "Gear-Success Theory" to check the software's success. This project will be linked to a gear where all the mechanical parts need to function efficiently for the whole system to run smoothly.

The Figure 1.1 show the "Gear-Success Theory" of the City e-Health with the Geographic Information System (GIS), the Decision Support System (DSS) and the other modules namely the Residents' Information System (RIS), Medicine Supply Inventory (MSI) and Report Generator (RG).

Figure 1**.** The Model of Gear-Success Theory

A gear is a mechanism wherein parts are connected to each other and the functions are related to one another. The gears success is dependent upon the mechanism that makes the entire mechanical operation to work. Same with the Gear-Success Theory in Figure 1, each characteristic that is part of the mechanism affects the performance of the entire project. For the e-Health, the gears that are connected to it are the functionality, usability, reliability, performance, supportability, design, implementation, and physical requirements. Connected to the e-Health are the Geographic Information System (GIS) and the Decision Support System (DSS). Their success will rely on the mechanism of e-Health. Their functions are evaluated for its reusability, manageability, maintainability, flexibility and scalability.

On the other hand, Figure 2 below shows the variables to be statistically tested in the latter part of the study. Satisfaction on using the software is the independent variable while its acceptability is the dependent variable. Meanwhile, test of difference will be conducted to measure if satisfaction and acceptability of the system significantly differ between the experts and the actual system users.

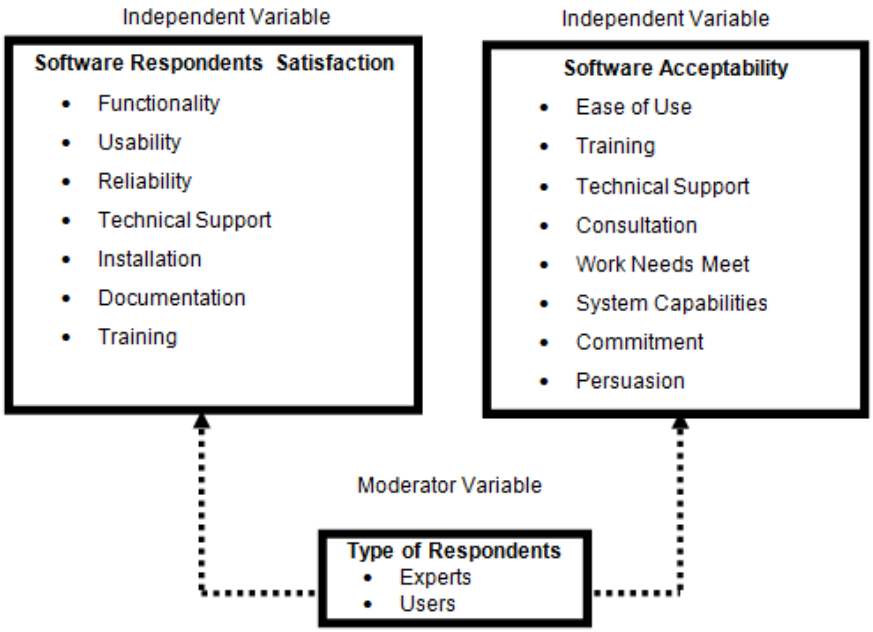

Figure 2. Conceptual Framework of the Study

METHODS

Research Design

Part of the research is to develop a system known as City e-Health, a system designed to provide Geographic Information System (GIS) and Decision Support System (DSS). All successful systems need blueprints or master plan to facilitate faster and accurate process. In the software development process cycle, programming model is used to plan the various stages of developing an application. The model used is the Agile Model based on Agile Philosophy. Another model used is the Scrum Model for software development for both management and development processes.

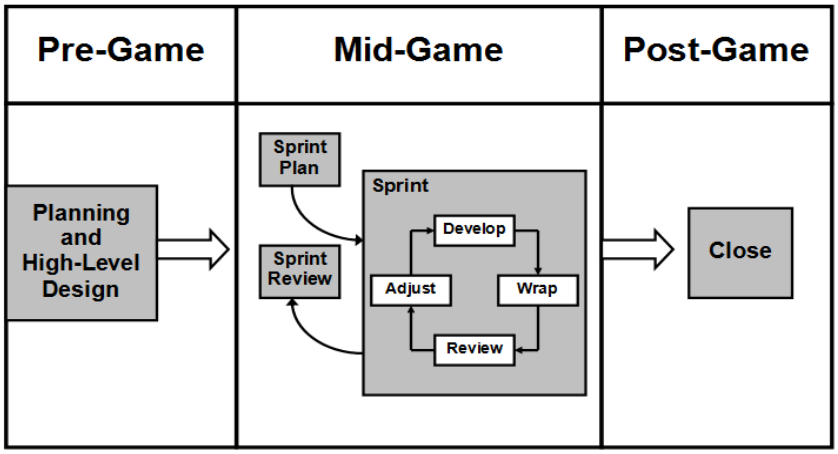

Figure 3. The Scrum Model (Serena.com, 2007)

Figure 3 illustrates that after the developer completes the project scope and high-level designs, the development process is divided into a series of short iterations called sprint. Each sprint aims to implement a fixed number of backlog items. Before each sprint, the researcher

identifies the backlog item for the sprint. At the end of the sprint, the developer reviews the sprint to check progress. When the backlog has been implemented and worth putting into production, management closes the development process. The developer then performs integration testing, training, and documentation.

During development, the developer determines the changes necessary to implement a backlog item. The developer then writes the code, tests it, and documents the changes. During wrap-up, the team creates the development to demonstrate the changes. In the review, the developer demonstrates the new features, adds new backlog items, and assesses risk. Finally, the developer consolidates data from the review to update the changes as necessary.

Following each sprint, the entire beneficiary of the system including the developer, users, and other experts demonstrate progress from the sprint and review the backlog progress. The developer then reviews the remaining backlog and adds, removes, or reprioritizes items as necessary to account for the new information and data gathered during the sprint.

The system is evaluated with the Gear-Success Model to ensure the software acceptability in eight variables namely: Ease of Use, Training, Technical Support, Consultation, Work Need Meet, System Capabilities, Commitment, and Persuasion. It is also used to evaluate customer satisfaction on the software customer in terms of seven (7) variables, namely: Functionality, Usability, Reliability, Technical Support, Installation, Documentation, and Training.

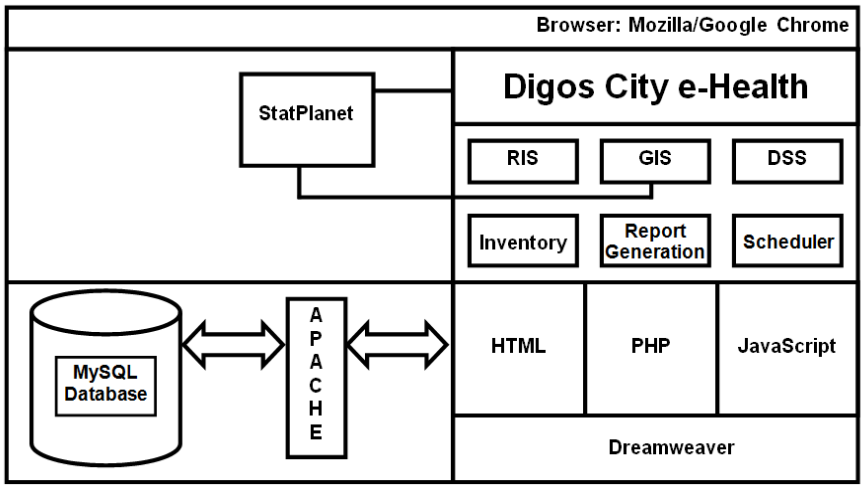

Figure 4. The System Architecture for the Digos City e-Health (Development Environment)

Figure 4 shows the system architecture when deploying to the City/Community Health Offices in Digos City and their subordinate community health centers. The system can be opened through any internet browser such as Mozilla Firefox or Google Chrome. The RIS, GIS, DSS, inventory, report generation and scheduler are developed in a Dreamweaver application for its HTML, JavaScript and PHP programming language. The GIS is created and its settings using Stat Planet software. The server that is used in the system is the Apache server which will connect the system and database using MySQL.

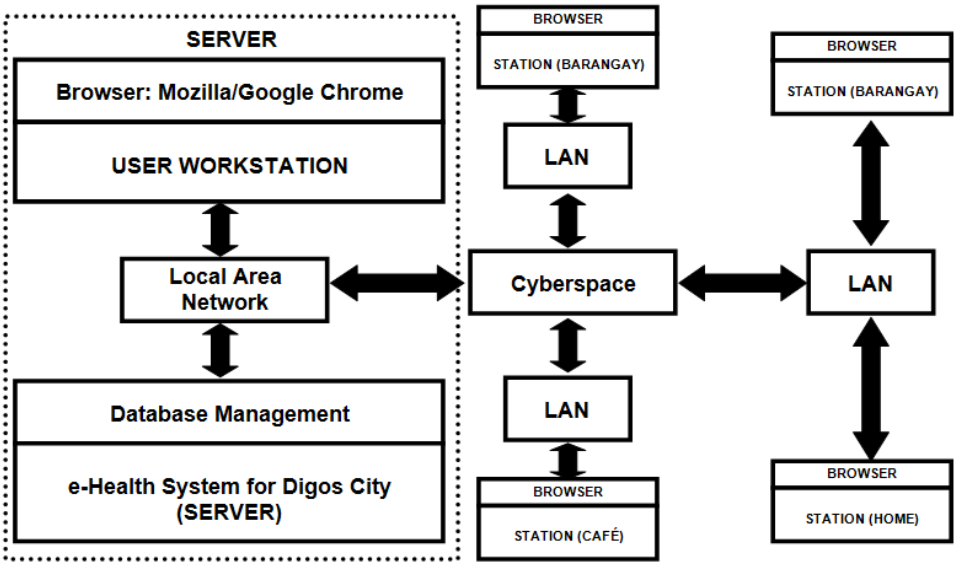

Figure 5. The System Architecture for the Digos City e-Health (Deployment Environment)

Figure 5 shows the system architecture deploying online to be retrieved by the administrators and users. The architecture in Figure 2.3 is considered a workstation, where each workstation can be accessed by the City Health Officer as the administrator, or a nurse, doctor, midwife, *barangay* (community) health workers (BHW), the chairperson of the community's Health Committee and front desk officers. The workstation is connected to a server then it can be accessed anywhere. The system uses a virtual-server that is installed to the Digos City Health Office (DCHO).

Respondents

The participants of this study are the City Health Office and community health centers of the twenty-six (26) community of Digos City. Participant groups composed of the City Health Officers (CHOs), the doctors and nurses employed in the city level, the midwives, community health workers and the Health Committee chairperson concerned in the community level, and the experts who will be officially be selected as IT experts.

Procedure of the Study

Seeking Permission to Conduct the Study. The researcher personally gives a letter seeking for permission and approval to conduct the study to the Office of the Mayor through the City Health Office of Digos City.

The following activities are conducted to ensure the completeness of the information gathered.

Observation of processes in City Health Offices. The researcher familiarizes himself with the routine transactions inside the city health offices in each city.

Administration of questionnaires (e-Health status). The researcher distributes the evaluation sheets to the participants for the rating on the satisfaction of the user and expert of the system. They are given ample time to answer the evaluation sheet completely and honestly.

Preliminary Interviews. The researcher conducts an in-depth interview with personnel responsible in order to initially gather needed data, rectify unforeseen errors based on the context of the interview conducted and triangulate or substantiate initial

results. Interviews are the basis in contextualizing the study to the situations of the City Health Offices in DigosCity.

Collecting of Forms. The forms that are needed in submitting reports are collected to ensure the preciseness of format of the auto generated report development. The forms are the following:

Information Sheets. The form that the information of residents is placed.

Monitoring Sheets. The form that the health status of the residents is written.

Monthly Report Sheets. The form that the monitoring of the community in terms of program implementation.

RESULTS AND DISCUSSION

The proposed system can have the following system/modules that this project can accomplish to address the objectives and solve the problem of the study.

e-Health. This module has different sub-modules namely the Geographic Information System (GIS), Decision Support System (DSS), Resident Information System (RIS), Medicine Supply Inventory (MSI), and the Report Generator (RS). The users of the system are the Doctor, Nurses, Rural Midwives, City Health Officers (CHO), Barangay Health Workers (BHW), Barangay Councilor, and Barangay Front Desk (BFD). The users can access the system with corresponding account. The users are given username, password and necessary information that only the doctor, nurse and rural midwife can produce.

Resident Information System (RIS). The RIS can add, edit, and delete (mark) information. The identification code of each resident is auto-generated. Only the Doctor, Nurse and the Rural Midwives can access the three main functions for the purpose of data standardization. The remaining users can access only of viewing purposes.

Medicine Supply Inventory (MSI). The MSI can add, edit, and delete (mark) information of the medicines that are available in the location. Deductions of the quantity are automatic upon releasing one to the resident. The monitoring, request and alerts are also included. MSI can be accessed by the Doctor, Nurse, and the Rural Midwives. The City/Barangay Front Desk can access the module with the approval of the city/barangay as releasing officer of the medicine.

Report Generator (RG). The RS can generate necessary report of the city/barangay. The residents' information, inventory of medicine, released medicine, and monitoring of residents' health status. All users can access the RS for reference.

Geographic Information System (GIS). The GIS can display the health information of the city/barangay in a graphical format. A color scheme is assigned to distinguish the condition of one area (i.e. critical, outbreak, etc.) calculated on the standard formulation based on what is normal.

Decision Support System (DSS). The DSS will predict/assess the condition of one area (i.e. City, Barangay, Purok, Sitio, etc.) on to what extent does the incident of a specific communicable disease will reach with specific time frame (i.e. in days, in weeks, in month, in years, etc.). One special feature of the DSS is that, it can suggest first-aid, precautions, and programs that can be implemented to refrain or even stop the outbreak.

Functions of the Developed System

Update Function. This function allows the system to update the database of the specific information. This function is very important because of its feature of allowing changing the information that has been inputted correctly. This part of the system is also tried to make perfect information.

Delete Function. This function allows the system to delete the information in the database when it is not anymore useful in the system. This allows lessening the used space in the storage of the system. Allowing this function facilitate in the cleaning the database to used only the information that are useful.

Search Function. This function allows the system to search information that is to be manipulated. This is the easiest way to locate the information. Searching functions is very important for it helps the users in turning the system into a user friendly system and making the system transaction more faster which is the main reason that the system is created.

Insert/Change Picture Function. This function allows the system to include the picture of the resident as part of the information of the resident. Picture is to be taken personally or existing picture is also acceptable to insert in the system.

Hierarchical-Input–Process Output

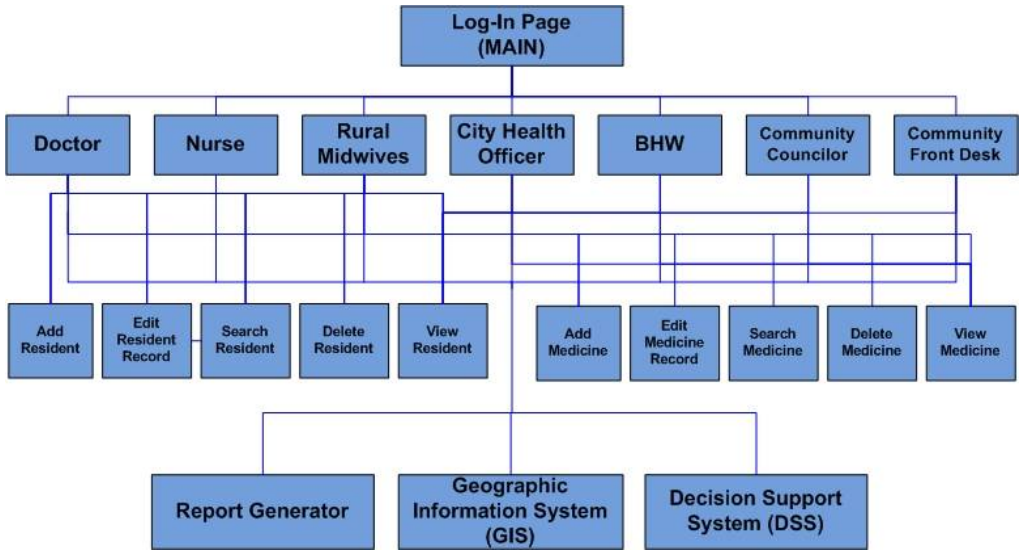

Figure 6. HIPO of CeH_GISDSS

Entity Relationship Diagram

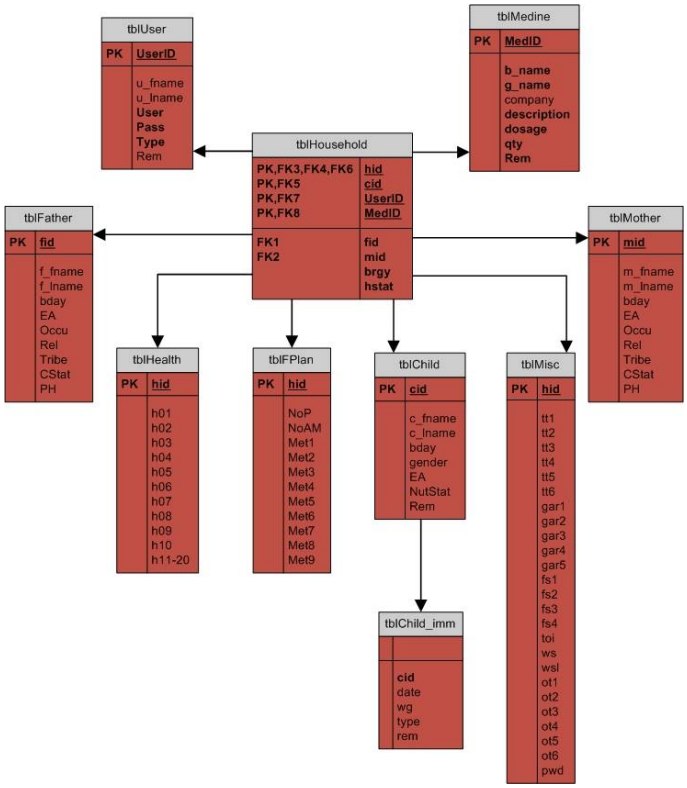

Figure 7. ERD of CeH_GISDSS

Physical Design

This part of this chapter illustrates the two physical parts of the system. The first part is the hardware physical design and the second part if the system physical design.

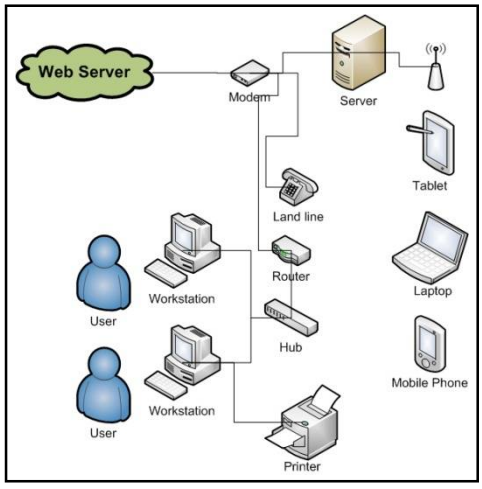

Figure 8. Hardware Physical Design in the CHO

Figure 8 explains the physical design of the system in terms of hardware set-up. The following hardware is peripherals installed as part of the proposal. The work station is a personal computer unit that can access by the users. This is connected to a hub that can identify the workstation address via IP address and to a router that handles the connection to the modem that access the cyber space. The server of the in the CHO is the one who handles the entire transaction in the office to have the conformity in the saving and accessing the web server. The printer is also accessed by the entire user for it is also shared. A WIFI is installed so that any users that want to access the system can through connection from the server to the web server.

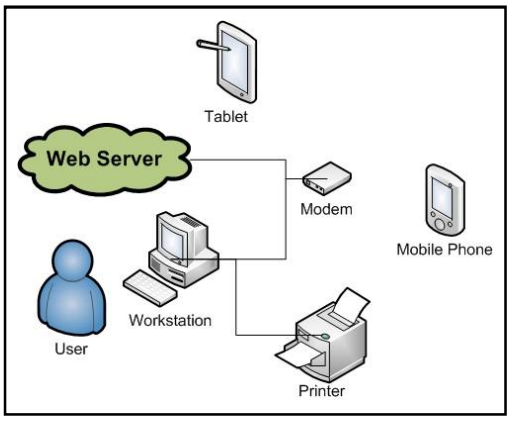

Figure 9. Hardware Physical Design in the Community

The connections and the process is the same as in CHO but it has only changes that would fit to the status and availability of connection to the area. The modem peripheral can be connected to a specific internet provider that is available in the area. When internet provider is not available a broadband of any telecommunication company can be used as modem so that the community can access to the system.

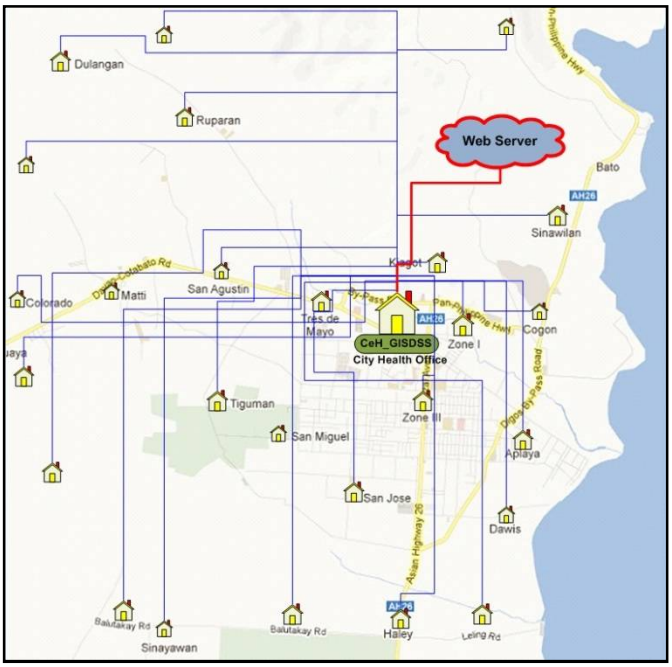

Figure 10. Implementation Infrastructure of CeH_GISDSS

CONCLUSION

The study made to be effective in the sense of implementation of the City e-Health with Geographic Information System (GIS) and Decision Support System (DSS) most especially to the community of Digos City.

Upon the analysis of the results the connectivity between the satisfaction and acceptability created a notion that the gear-success theory of the researcher supports the completion of the entire study. The gear-success theory made to be likely not far with the results of the structural model of the technology acceptance model that claims to be closely the same in implementation theory.The motivations on continuous improvement in a software implementation in all agencies are the solution that the study addresses. The agencies that requires upgrading in their different transaction makes them globally competitive. This means that the result of the research come to a realization that the implementation on the initiatives of private and government programs (i.e. CHITS, etc.) must be supported with enough resources.

As to the future implementation of the system, the researcher made more improvements in the system's to ensure its acceptance. The model and theory was tested only with the CeH_GISDSS but not in all types of system. It may only effect on the study or may have also effect to other types of system in real-setting.

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