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Pampanga's Barangay Health Information System (PBHIS): A Decision Support & Health Information System for Rural Health Unit 1

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Abstract: A major obstacle of the Rural Health Unit (RHU) was acquiring valuable and timely data and process them in order to provide relevant health services. This study aims to enable RHU to provide health services and programs that reflects the needs of its citizens using decision-support and analytical system.

Key Words: Analytics; Rural Health Unit; Program Planning; Electronic Medical Record; Decision Support System

1. INTRODUCTION

1.1 Background

With the Sustainable Development Goals (SDGs) of the UN aiming to improve health and reduce poverty by 2030, and the ever-increasing threats of diseases globally, the Philippine government is faced with challenges concerning major health issues in the country. In 2013, the national mortality rate was 5 for every 1,000 people (Department of Health, 2016). Moreover, 1 in 4 outpatients are subjected to medication errors (Institute of Medicine, 2000) - some examples of which are remediable with ICT. The City Health Office, through Rural Health Unit 1, intends to advance evidence-based decision making to tailor health services and programs according to the needs of the Fernandinos.

Technology has made rapid advancements in the medical sciences field, ranging from electronic medical records to medical analytics. As such, the application of ICT can improve the current state of health. Moreover, Balas (2001) suggests that the use of information systems will dramatically improve health care in such cases, resulting in better health care, error prevention and the satisfaction of patients.

The system proposed is a decision support and health information system, which makes use of visualization and prescriptive analytics. Information visualization is translated into insights which allow for improved decision-making and strategizing from, while the prescriptive analytics executes the number crunching and processing to recommend targets based on the data collected. Visualizing the context and evidence while simultaneously prescribing targets and strategies allows an effective process to improve the overall health care delivery.

1.2 Challenges

One of the problems faced was the challenge of being able to deliver relevant health services along with valuable clinical knowledge in a very timely manner at the avenues of the government, from prevention to treatment.

With thorough research, interviews, and the use of cause effect analysis, the core problem identified by the researchers was the difficulty in providing

relevant health programs by the RHU for its citizens. Several causal factors were discovered: (1) encoding errors; (2) difficulty in processing huge amount of physical data; (3) difficulty in report generation due to manual transportation of documents; (4) delay in report submission; (5) untailored reports.

Due to the stated compounded problems, they were not able to properly prioritize the services they provided to their citizens' need.

1.3 Significance and Aim

The objective of the study aimed to enable the RHU to provide tailored health services and programs that reflected the needs of its citizens using the proposed decision-support and analytical system.

The significance of the study lies in empowering the RHU with the technological capability to address the increasing challenges of growing rural areas and the need for better health care.

This is relevant not only to the RHU, but in a greater sense, the Philippines' move towards attaining the UN's SDGs in 2030, including but not limited to (1) no poverty, (2) zero hunger, (3) good health and well-being, and (4) clean water & sanitation. As such, these goals can be attained with the help of the proposed system.

1.4 Scope

This dissertation presents the proposal of Pampanga's Barangay Health Information System (PBHIS), a decision support and health information system for Rural Health Unit 1. The paper covers decision-making at a rural health unit level, encompassing all the barangays and barangay health centers (BHC) that it encompasses. The scope starts from patient registration at a BHC to program planning and prescription for the RHU.

2. METHODOLOGY

The researchers used the Agile-Waterfall hybrid methodology for the development of the system due the complexity and scale of the project (Kindly see fig. 1 below). To be able to produce a complex system for a local government unit that has numerous interactions with other entities in just a span of few months, the researchers carried the planning and requirements gathering of Waterfall while incorporating Agile techniques. This allowed the researchers to incrementally develop the modules and features of the system while taking into account user involvement, to accommodate additional requirements and to ensure that the entire system development is in accordance with the stakeholders' needs.

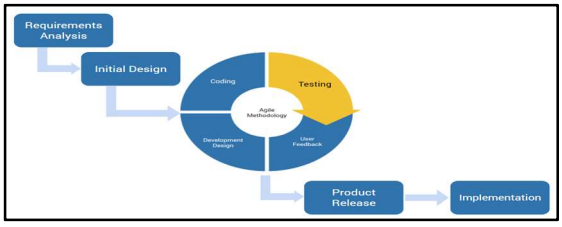

Fig. 1. Agile-Waterfall hybrid methodology

The hybrid methodology was concluded as the best fit for the study after deliberating it among the Waterfall Model, Structured Analysis, and Rapid Application Development (RAD) due to several factors. With the system being developed on a municipal level that interacted with many government entities, the Waterfall method allowed the researchers to understand the processes from an end-to-end bird's eye point of view, while the Agile method allowed for iterative consulting with the stakeholders, as the RHU itself had been undergoing process changes during the project, such as changes in forms. The iterative consulting ensured that the stakeholders and researchers were aligned despite unforeseen changes in the project requirements. The hybrid model allowed the development of a laid out deliverable but was still flexible enough for changes in stakeholder needs.

2.2 Framework

The proposed process can be generalized into three parts: it starts with (1) patient consultation data being collected and processed by the system. (2) Analytics is then applied to the data, therefore giving actionable information and insights to the RHU. (3) In light of this, the RHU is now able to provide relevant health services & programs to its citizens. Additionally, the health programs are stored for future use in

recommending programs. The general flow can be seen below:

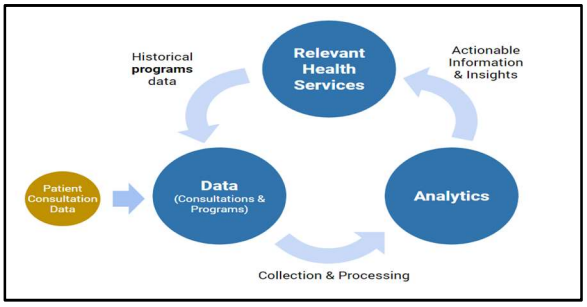

Fig. 2. Proposed System Flow

With the problems identified, a conceptual framework had been created which summarizes the modules proposed to solve the problems identified. Expected inputs, outputs, and users were also pinpointed. See framework below for the figure:

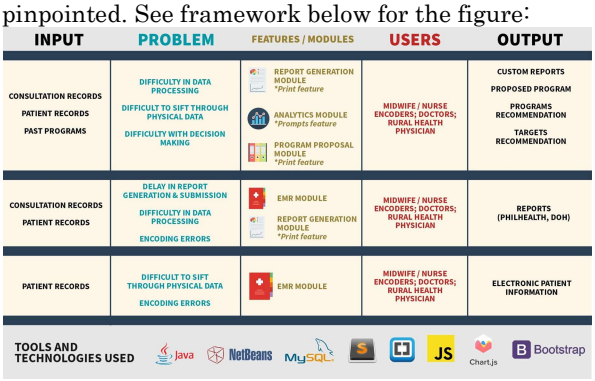

Fig. 3. Conceptual Framework

3. RESULTS AND DISCUSSION

Pampanga's Barangay Health Information System (PBHIS) was developed as a decision support and health information system to specifically cater to the Rural Health Unit I of San Fernando City in providing relevant health programs it its citizens. It has 5 main modules: (1) System Users Module, (2) EMR Module, (3) Reports Generation Module, (4) Analytics Module, (5) Program Proposal Module. The modules were defined through benchmarking that best fit as solutions to the problems identified.

3.1 Modules

The first module focuses on the registration of the users of the system who have different levels of access which corresponds to their respective responsibilities from maintaining the system, encoding data, and generating reports.

The second module, EMR Module, focuses on the recording and tracking of patient health information which includes patient data, health details and consultation records. It was identified that the client used paper records, which was one of the sources of the problems. Therefore, this module was built as a central document repository for the RHU, moving towards their goal of being paperless. Digitized patient records allowed for a faster and efficient retrieval of data which had been previously performed by a nurse sifting through the documents of the entire health center. This module is a vital part of the system as the data collected is also utilized in other modules. With the EMR module, the client can now collect and track patient data. See Figure 4 below for the now electronic Individual Treatment Record:

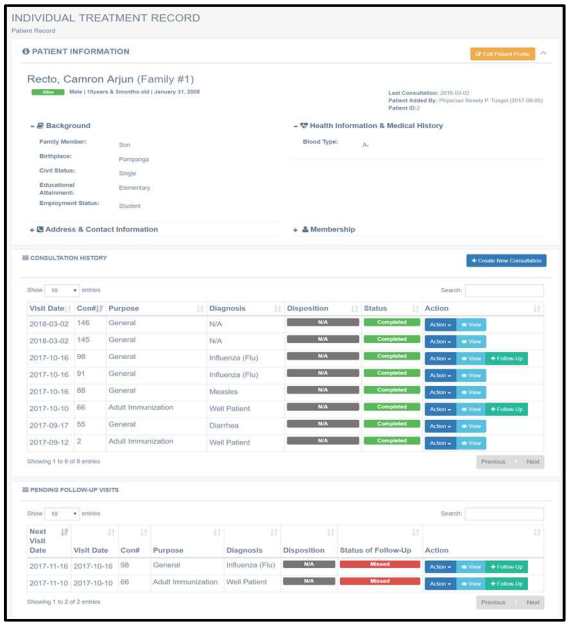

Fig. 4. Screenshot of EMR Module

The third module, reports module, allowed the RHU and BHCs to generate and print mandated reports requested by the Department of Health and PhilHealth. This module addressed the difficulty in

processing and generating reports which cause delays in report submission of the RHU to the respective health agencies. With the reports module, the clients were able to have more time in providing health services to constituents rather than having spent time creating reports.

The fourth module is composed of descriptive and prescriptive analytics that is capable of handling and manipulating EMR. The major function is to present data in a way that can assist in program proposals and decision-making by helping prioritize programs to deliver, diagnosis to tackle, and define targets. It is achieved by presenting data with the context of data visualization, system prompts, and customized reports, as well as suggestions for a program proposal from the system based on previous evaluated programs. The features of this module is mainly seen embedded with the program proposal module.

The last module focuses on program proposal for use in the RHU and evaluation of accomplished programs for future use as historical data. Being integrated with the analytics module, it provides alerts and recommendations which will be used as sufficient evidence and cause to propose and plan a program in response to cases of concern.

The analytical capabilities of the system can be generalized into two parts: (1) targets recommendation and (2) programs recommendation.

3.1.1 Targets Recommendation

Based on the patient consultation data, the system recommends the target parameters/demographics such as age, gender, and barangay. Each parameter is visualized as a pie chart, and column charts respectively. For the visualization and recommended targets, see screenshots below (Fig. 5 and 6):

Fig. 5. Screenshot of Visualization

The algorithm for suggesting a gender is triggered when either of the genders, male or female, equates to greater than or equal to 60% of the total cases. For example, if 6 out of 10 cases of a diagnosis is male, the system suggests to target males. Otherwise, it will suggest both genders. Suggesting the age group and barangay works similarly, as the target age group or barangay is triggered when it equals or exceeds the mean amount of cases for the entire RHU 1. See figure 6 and Eq. 1 below:

Fig. 6. Screenshot of Recommended Targets

$$\mu = C / B \qquad \text{(Eq. 1)}$$

where:

μ = average threshold score
C = total quantity of cases in RHU
B = total quantity of barangays

Moreover, the system recommends the number of participants to target with the program. This is done by getting the sum of all household members that have at least one member affected by the disease. The Target Participants Recommendation is seen below:

$$T = \sum_{i=1}^{n} q_i \cdot d_i \quad \text{(Eq. 2)}$$

where:

T = total target participants
i = household
q_i = quantity of household members in household
d_i = is 1 if at least one household member in household i has the disease and 0 otherwise

3.1.2 Programs Recommendation

Based on the historic data of programs, the system recommends related programs successfully conducted in the past for the user to use as a template. The system recommends a program when either the disease/diagnosis or the program category matches (as seen on Fig. 7). Moreover, only programs with a score of 4 or 5 is included in the suggestions. The results are then sorted by the weights of each variable: a weight of 50 points is given of the same disease/diagnosis, 30 points of the same program category, and 20 points multiplied by the rating. Therefore, more priority is given to matching target disease/diagnosis than the rest.

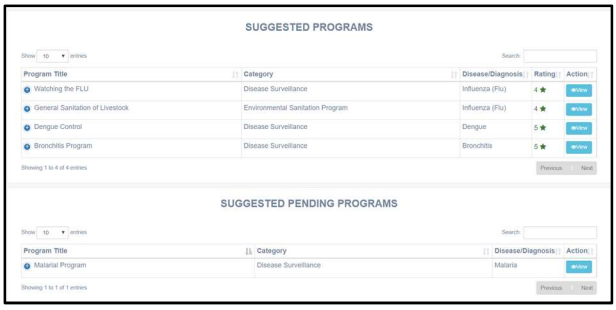

Fig 7. Screenshot of Recommended Programs

With the suggestion of past programs as templates, as well as the prescribed targets presented in a visualized manner, the user can create programs with parameters that are accurate to the target demographics based on consultation data. The outcome of this process is the creation of relevant health services in the form of programs.

With the proposed process, non-value adding time and resources were spent on more productive and value adding tasks, such as providing health services to constituents. See figure 8 below:

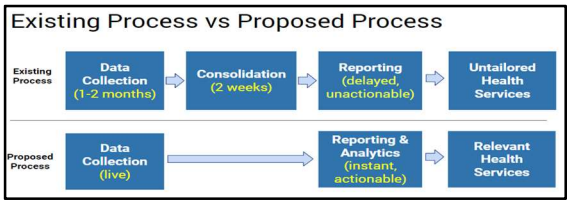

Fig. 8. Existing Process vs Proposed Process

3.2 User Acceptance Scores

The developed system has undergone the unit, system and integration testing. The researchers conducted screen and functional prototyping with the target users in order to perform the various testing. The comments received from these sessions were then addressed and incorporated to the design revisions. After integrating the different modules and conducting final integration testing, the researchers conducted the user's acceptance testing (UAT).

The UAT was performed with the target system's users, which includes the head physician, I.T. encoder, and several nurses of the RHU. The users were shown the use of the system considering some scenarios and were asked to fill up the User Acceptance Test Form to quantify the users' acceptability of the different modules.

The User Acceptance Test Form is a questionnaire designed in such a way that the target users can rate the functionality and usability of the system. Questions were divided into 4 major categories namely: 1) General Functionality, 2) User Interface, 3) Security, and 4) Overall Performance of the system. It is answerable with a rating from 1-5, with 1 being least satisfactory to 5 with most satisfactory.

Table 1. User Acceptance Test Results
R = Respondent

Question Category	R#1	R#2	R#3	R#4	R#5	R#6	Average Rating
General	4.67	5	5	5	5	5	**4.94**

User Interface	4.27	5	5	5	5	5	**4.88**
Security	5	5	5	5	4.75	5	**4.96**
Overall Performance	4.6	5	5	5	5	5	**4.93**
Total Average							**4.93**

The post-revision results of the UAT scored an overall average of 4.93 out of 5, having met the user requirements and with users being generally satisfied with the system. There are comments and feedback gathered during the UAT but most of them are under User Interface (UI) - wherein they indicated that the visibility and sizing of some buttons and tables were not as clear. As a solution, the researchers made the components bigger and more visible.

4. CONCLUSION

With the system created, the researchers were able to create a system that not only allowed them to provide relevant health services, but the system created also acts as a platform to create, store, and consolidate important medical data, which acts as a data backbone and have great use for future clinical purposes.

As a result, the system made the processes of the RHU faster, generate accurate reports, and provide relevant and actionable information. PBHIS aimed to help the RHU analyze the data taken from its patients, identify key areas of concern, and make better and well-informed decisions. By giving the RHU the information it needed, it will be able to deliver relevant programs and services to the Fernandinos. On the decision-making level in the RHU, information displayed as visualized data, along with prescribed analytics, the programs created will be evidence-based and specifically tailored according to the needs of the Fernandinos.

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