

Vital Signs Monitoring System - Portable Mobile Application for Health Care Workers and Households

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Abstract: - Information Technology has transformed the ways modern medical systems acquire, store, access and communicate medical information. The aim of this study was to determine the effectiveness of portable and cost-effective mobile application for an Android device that can monitor body temperature, respiration rate, blood - oxygen saturation level and pulse rate. Descriptive method and developmental method research was used in this study. 20 medical practitioners and 30 parents were interviewed by their experiences in using the portable medical device in Divine Word Hospital, Tacloban City, Philippines. Findings indicated that the portable medical device is a cost-effective device, and give medical practitioners and parents the chance to save time and effort in detecting health problem and monitor health status. It also improves the task efficiently and conveniently between them. Replicating this study using other media and technologies can be developed.

Keywords: Information Technology, Android Application, Mobile Application, Body Temperature, Blood - Oxygen Saturation, Respiration rate

I. INTRODUCTION

Our world today has changed a great deal with the aid of information technology. Things that were once done manually or by hand have now become computerized operating systems, which merely require a single click of a mouse to get a task completed. With the aid of IT, we are not only able to streamline our business processes, but we are also able to get constant information in 'real time' that is up to the minute and up to date. The flow of information has changed the way we live in today's world. Information is the backbone of every system.

Information Technology has transformed the ways modern medical systems acquire, store, access and communicate medical information. These developments offer significant benefits to medical practitioners and parents. One useful approach to continue the use of IT in medicine while minimizing its costs is through making application software for Android devices. Ultimately, the role and limitations of IT as a tool to pursue the goals of medicine has to be carefully deliberated, clearly defined and judiciously delineated to ensure its effectiveness and accuracy.

Through the use of modern development tools, the researcher has come up to study and develop a portable and cost-effective mobile application for an Android device that can monitor body temperature, respiration rate, blood - oxygen saturation level and pulse rate.

II. STATEMENT OF THE PROBLEM

Some medical devices are currently being used in hospitals and clinics by medical practitioners in monitoring patient's health conditions. Each medical device can have one function or have several tasks in diagnosing a patient. It varies in size which may find them bulky and have a tendency to be misplaced and the cost which can be expensive. There is a potential health risk when a medical instrument is containing mercury breaks. It becomes a burden for them using medical devices which are not functioning correctly, have a poor visual display, does not provide accurate results, and replacing batteries for battery - operated medical devices.

The parents have the burden of going to the hospital or clinics to have their health conditions as well as their children's health conditions checked or monitored except if medical assistance from medical practitioners is needed. Especially here in the Philippines where going to the hospitals/clinics is ineffective because it is crowded usually public hospitals/clinics. In addition to that the fees that will be charged per check-up exceptionally private hospitals/clinics.

The research questions to be addressed are:

1. What is the most appropriate medical device for medical practitioners in monitoring health conditions?
2. What could be a solution for parents to lessen the burden of going to hospitals/clinics to have their health conditions checked as well as their children's health conditions?

III. THEORETICAL FRAMEWORK OF THE STUDY

This study focuses on the development of a cost-effective android application that can monitor body temperature, respiration rate, blood - oxygen saturation level and pulse rate in a Graphical User Interface of an Android Application in an Android Device. The following are concepts and theories that guide the development of this study:

Method of Operation

The Theory of Operation defined as how the device or the system should operate. In this project, the microcontroller serves as the mainboard for the sensors connected to read and acquire data as executed by the user in the Android device.

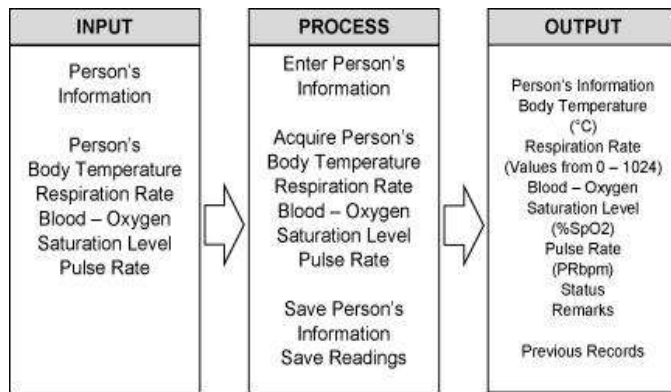
Media System Dependency Theory

The Media System Dependency Theory developed by Sandra Ball-Rokeach and Melvin DeFleur in 1976. This theory proposes an integral relationship among audiences, media, and the broader social system. This theory predicts that a person depends on media information to meet particular needs and achieve specific goals.

The Media System Dependency Theory conducted is related to this study in a way that research through the use of media that people nowadays can depend on since the world today is advancing through the use of technology. The makes it easier to do research and to communicate with one another. Therefore, media makes a person more dependent on it that it meets some needs to provide.

Conceptual Framework of the Study

The figure below shows the conceptual framework of the study to be implemented to have an idea of howthe system works and developed.



The user for monitoring uses an android application installed in an Android device. If the person has no record in the form, the user inputs and saves his/her personal information: Last Name, First Name, MI, Age, Address, and Mobile Number if the person has a record already, the user searches and selects the person's history. The user then connects to the hardware using Bluetooth then picks which data to be acquired: body temperature, respiration rate, blood - oxygen saturation level or pulse rate. The user may select all to obtain all data. Sensors are used to collect data.

The microcontroller executes the process of acquiring data to the sensor for reading. The sensors connect to the sensor adapter in the microcontroller. There are three sensors attached: body temperature sensor, airflow sensor, and pulse oximeter sensor. After the data is acquired, it will send to the android device for display and for saving readings.

Communication between Android Device and Microcontroller

Bluetooth Technology is used to support the connection and data transmission between the microcontroller and the android device. Since Bluetooth cannot provide power, a power cord is included to supply power.

Displaying and Saving Readings

Acquired data will be saved and presented in a Graphical User Interface of the application in the android device. It will also include the status of the person's body temperature, blood - oxygen saturation level and pulse rate. The user may also input remarks he/she wishes to provide more details. These will allow the user to view a person's previous records.

Measurement of Readings

Measurements are determined when the person is at rest and not performing any activity. When recording the body temperature in the person's electronic medical record, the scale used for the results is Degree Celsius (°C). Body temperature depends upon the place in the body. The commonly accepted average core body temperature (taken internally) is 37.0°C. The table below shows the frequency of body temperature.

Table 1.1 Body Temperature Measurements

Hypothermia	Less than 35.0 °C
Normal	36.5 °C - 37.5 °C
Fever or Hyperthermia	37.5 °C - 38.3 °C
Hyperpyrexia	Greater than 40.0 - 41.5 °C

Source: Wilburta Q. Lindh, et. al. (2010). *Delmar's Comprehensive Medical Assisting Administrative*

IV. METHODS AND PROCEDURES

Research Design

The research design used in this study is a descriptive method. It is a fact-findingsurvey that will provide adequate and accurate findings through a survey questionnaire to the respondents in the research locale. The data gathered will be analyzed and presented to draw up implications and inferences for the study.

For the development of the whole study, the research design also includes the internet. Thiswill allows the proponents to explore and gather useful information to come up with a concept and the needed software and hardware resources.

Research Locale

This study focused on the Divine Word Hospital and Barangay 109 V&G Subdivision. There are two research locales for this study as there are two different set of respondents considered. Samples are selected purposively. With this, the elements included in the example were chosen by unique characteristics and peaceful cooperation among the respondents.

Research Procedures

Upon the approval of this study, the proponents have come up with several research method procedures to gather essential data needed in this study. These procedures

are necessary for analyzing data and for the structure of this study.

The proponents considered in surveying the respondents from the research locale. There were two different set of respondents, medical practitioners, and parents. Each is having different research locale and provided with a different set of survey questionnaire but at the same time focuses on drawing up implications and inferences towards their current system and the feasibility of implementing the proposed study.

Samples have purposively taken within the research locale with a self - structured questionnaire. The questionnaire is composed of questions mainly about their current system, problems encountered in the current system, and the feasibility of implementing the proposed study.

For the development of the whole study, useful information is sourced dominantly from the internet. Research through the internet has allowed the researcher to gather more information from the existing medical devices and information for the development of this study. Published materials are available from the internet like e-books are also considered by the researcher as the source of information especially for software and hardware development tools.

V. RESULTS AND DISCUSSION

Table 2.1 Data Analysis from Medical Practitioners

Functions	No. of Responses (Frequency)	Percentage
Body Temperature	20	100.00%
Respiration Rate	10	50.00%
Blood - Oxygen Saturation Level	20	100.00%
Pulse Rate	20	100.00%

Table 2.1 shows that 100.00% or all of the respondents know what medical device touse in reading body temperature. 50.00% of the respondents understand what medical equipmenttouse in acquiring respiration rate. 100.00% of the respondents understand what medical equipment to use in obtaining blood - oxygen saturation level, and 100.00% or all of the respondents know what medical device to use in reading pulse rate.

All of the respondents answered thermometer as the medical device used for reading body temperature.

Five of the respondents answered the cardiac monitor as the medical device used for reading respiration rate. The cardiac monitor can also be used to understand the blood - oxygen saturation level in which three of the respondents answered the same and pulse rate in which five of the respondents responded the same. Half of the total number of respondent did not reply to what tool to use for reading respiratory rate. Five of the respondents answered that by manually counting the number of breaths per minute and

using a watch as the timer, they would be able to read the respiration rate of their patients. Nineteen of the respondents answered pulse oximeter as the medical device used to read the blood - oxygen saturation level and fourteen of the respondents answered the same for pulse rate. Seven of the respondents replied that by manually counting the number of pulse per minute and using a stethoscope or a watch, they would be able to read the pulse rate of their patients.

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Table 2.2 Problems encountered in the Existing Medical Devices

Problems Encountered	No. of Responses (Frequency)	Percentage
Mercury spill of a broken thermometer	10	50.00%
Replacement of Drained Battery	17	85.00%
Misplaced	14	70.00%
Bulky	12	60.00%
Poor Visual Display	15	75.00%
Others: Not Functioning, Not Accurate	2	10.00%

Table 2.2 shows that 50.00% of the respondents stressed that they could have a problem with mercury spill of a broken thermometer. 85.00% of the respondents emphasized that it is a hassle to buy a replacement of drained battery for battery - operated electronic medical devices like digital thermometer and pulse oximeter especially when they need it and the battery runs out. 70.00% of the respondents agreed that they are sometimes having a problem of misplacing small medical devices like a thermometer, pulse oximeter, etc.. 60.00% of the respondents agreed that sometimes they find it bulky carrying medical devices depending on its size and weight. 75.00% of the respondents stressed that they are having problems with some medical devices having a poor visual display. 10.00% of the respondents have other issues like some medical devices are not functioning, and some are

not displaying accurate readings.

Table 2.3 Response to Improve the Current System

Choices	No. of Response (Frequency)	Total Number of Respondents	Percentage
Yes	18	20	90.00%
No	2	20	10.00%
Total		20	100.00%

Table 2.3 shows that 90.00% of the respondents agreed to make room for improvement for the current system of using medical devices while 10.00% have expressed satisfaction with the current system of using medical devices that it is no longer needed to be improved.

Table 2.4 Suggested Features found on the Proposed System

	No. of Response (Frequency)	Percentage
Monitor Body Temperature	20	100.00%
Monitor Respiration Rate	20	100.00%
Monitor Blood - Oxygen Saturation Level and Pulse Rate	20	100.00%
Capability to Enter Patient’s Name	18	90.00%
Capability to view Patient’s Records	15	75.00%

Table 2.4 shows the features that respondents would like to see on the proposed system.

The table shows that for the development of the proposed system, the first three features as suggested got a percentage of 100.00% or all of the respondents have approved that to monitor body temperature, respiration rate, blood - oxygen saturation level, and pulse rate should be on the proposed system.

Following are the capability of the user to enter the patient’s name with 90.00% and the capability of the user to view the patient’s records with 75.00%.

Data Analysis from Parents

Table 2.5 Actions on how they check Health Conditions

Actions	No. OF Responses (Frequency)	Percentage
Consult Family Doctor	13	43.33%
Visit Hospital / Clinic	19	63.33%
Use Thermometer (Body Temperature)	16	53.33%
Use Pulse Oximeter (Blood - Oxygen Saturation Level & Pulse Rate)	3	10.00%
Manually Count Number of Respirations per minute (Respiration Rate)	5	16.67%
Manually Count Number of Beats per minute (Pulse Rate)	9	30.00%

43.33% of the respondents consult their family doctor; 63.33% of the respondents visit the hospital or clinic for a check-up. 53.33% of the respondents use a thermometer to monitor body temperature. 10.00% of the respondents use a pulse oximeter to monitor blood - oxygen saturation level and pulse rate. 16.67% of the respondents manually count the number of respirations/ breaths per minute, but for them, it is less critical to monitor respiration rate. 30.00% of the respondents manually count the number of beats per minute.

Table 2.6 Problems encountered in the Current System

Problems Encountered	No. of Responses (Frequency)	Percentage
The line in a crowded hospital/clinic	20	66.67%
Pay Fees	25	83.33%
Unavailable Doctor/s	13	43.33%
Time Inconvenience (Time to Travel / Waiting)	22	73.33%
Others	0	0.00%

Table 2.6 shows that 66.67% of the respondents stressed that they are uncomfortable queuing for their turn in crowded hospitals or clinics. 83.33% of the respondents emphasized that they find it hassle having regular checkups and pay fees so they discover that the proposed system will limit them visiting hospitals/clinics in which they will have to pay the taxes every time they will have their check-up. 43.33% of the respondents stressed that there are times the doctor is not available. 73.33% of the respondents find inconvenience in time to travel and to wait.

Table 2.7 Response to Improving the Current System

Choices	No. of Responses (Frequency)	Total Number of Respondents	Percentage
Yes	27	30	90.00%
No	3	30	10.00%
Total		30	100.00%

Table 2.7 shows that 90.00% of the respondents agreed to make room for improvement for the current system while 10.00% have expressed satisfaction with the current system that it is no longer needed to be improved.

Table 2.8 Feasibility of the Implementation of the Proposed System

Choices	No. of Response (Frequency)	Total of Respondents	Percentage
Yes	28	30	93.33%
No	2	30	6.67%
Total		30	100.00%

Table 2.8 shows that 93.33% of the respondents agreed on the implementation of the proposed system and 6.67% have not decided. Most of the respondents have agreed on implementing the recommended method for the reason that they find it portable that the can monitor theirs and their

children's health condition.

Table 2.9 Suggested Features on the Proposed System

Features	No. of Response (Frequency)	Percentage
Monitor Body Temperature	30	100.00%
Monitor Respiration Rate	26	86.67%
Monitor Blood - Oxygen Saturation Level and Pulse Rate	27	90.00%
Capability to Enter Person's Name	23	76.67%
Capability to view Records	28	93.33%

The table shows that for the development of the proposed system, all respondents approved that monitoring body temperature should be in the proposed method. 86.67% for monitoring respiration rate, 90.00% for watching blood - oxygen saturation level and pulse rate, 76.67% for the capability to enter person's name, and 93.33% for the ability to view records.

VI. SUMMARY OF FINDINGS

This study was conducted with the objective to study and develop a portable and cost-effective mobile application for an Android device that can monitor body temperature, respiration rate, blood - oxygen saturation level and pulse rate in a Graphical User Interface using an android device. It was also conducted for the purpose to draw implications and inferences from medical practitioners and parents towards the current system, problems encountered, and the feasibility of implementing this study.

The researcher used the descriptive method of research and the utilization of a structured survey questionnaire for gathering data. The census served as the instrument for collecting data. Twenty samples of medical practitioners and 30 samples of parents were the respondents. The inquiry took place in Divine Word Hospital for medical practitioners and Barangay 109, V&G Subdivision for parents.

The respondents perceived their convenience and their time as very important. Furthermore, 95% of the medical practitioners and 93.33% of the parents find that this study is feasible to be implemented to be a flexible medium for monitoring health conditions.

VII. CONCLUSION AND RECOMMENDATIONS

Conclusion

It is essential that the findings or result is given by the use of medical apparatuses to be accurate and factual. Actual and factual findings or results are required to enable to provide useful advice and action. Furthermore, being able to use a portable, cost-effective device will give medical practitioners and parents the chance to save time and effort. Therefore, the proponents have developed a system that will help medical practitioners and parents to do their task efficiently and conveniently. This study is an extended

approach to continue the use of IT in medicine while minimizing its costs.

Although the Mobile Application - Based Body Temperature, Respiration Rate, Blood - Oxygen Saturation Level and Pulse Rate Monitoring System using Android Platform for Medical Practitioners and Parents offers a few functions with medical importance, it can be further developed to have more services and features. Moreover, with the aid of information technology and the fast growth of technology, it is only a matter of time that every medical practitioner and parents would have a modern and efficient and portable medical device.

Recommendations

Although the implementation of the Mobile Application - Based Body Temperature, Respiration Rate, Blood - Oxygen Saturation Level and Pulse Rate Monitoring System using Android Platform for Medical Practitioners and Parents are already successful, the study should still undergo some improvements, like any other systems. For future studies, here are some points to consider:

1. Maximizing the use of the Sensor Adapter designed and provided to handle ten medical sensors namely: Patient Position Sensor (Accelerometer), Glucometer Sensor, Body Temperature Sensor, Blood Pressure Sensor (Sphygmomanometer) V2.0, Pulse Oximeter Sensor, Airflow Sensor (Breathing), Galvanic Skin Response Sensor (GSR - Sweating), Electrocardiogram Sensor (ECG), Muscle Sensor, and Electromyography Sensor (EMG) that could also determine health conditions, by this, more effective predictions about health status of a person.
2. Designing an electronic device having medical functions of this study as well as the functions suggested above using the same or other platforms. By this, everything will be in a single device making it more portable.

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