

Decision Support System with Analytic: Real-Time Health Monitoring System in Butuan City

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Abstract

The different types of Local Government Units (LGU) in Butuan City like rural health units, local units, and barangay health centers used the traditional data gathering method in storing data to monitor young ages 0 to 72 months which posed risks in data loss and data vulnerability. Thus, the researchers developed a system utilizing advanced tools that can help to improve the current way of gathering data on young ages health status. The researchers used Decision Support System (DSS) with analytics in health monitoring of young ages 0 to 72 months. The web system itself was developed with the CodeIgniter which utilizes Model View Control Framework. In addition, the researchers applied Agile Method of Development for rapid development to achieve the goal within the desired timeframe. As a result, the system with analytics provides decision support technologies for the health care provider aimed at enabling knowledge workers such as physicians, nurses, and health officials, health policymakers, and pharmacists, to gain insight and make better and faster health decisions. Further, the Technology Acceptance Model (TAM) was employed to examine the behavioral intention of the target end users to use for the system. Moreover, the finding of study shows that the beneficiary of the systems positively adopted the system since it is very useful in monitoring and in the decision-making process. Amongst the constructs used in the TAM,

Security, Technological Complexity and Perceived Ease to Use were not statistically supported. However, the practical relevance of the finding could be considered by the management in order to improve the consistency of work in the barangay health centers in Butuan city.

Keywords: Decision Support System, Data Analytics, Health Monitoring Systems

1. Introduction

Young age health interventions are treatments, technologies, and key family practices that prevent or treat childhood illness and reduce deaths in children under five years of age (Lithuania, 2019). When interviews were conducted, 70% among the barangays health workers stated that child interventions is what the city of Butuan needs and its manual recording of information leads to delayed reports to the City Health Office. This prompted researchers to find ways in improving the consistency of output in barangay health centers in Butuan City.

Healthcare analytics have been identified as a solution to such a problem. These applications can be considered a "collection of decision support technologies for the health care provider aimed at enabling knowledge workers such as physicians, nurses, and health officials, health policy makers, and pharmacists to gain insight and make better and faster health decisions" (Raghupathi, & Raghupathi, 2013)

2. Related Literature

In recent years, the health sector has been rapidly integrating technology in the monitoring, diagnosis, and treatment of patients remotely and on site (Tupel et al.,2017). Thus achieving to improve the quality of life of patients and greater traceability of information from them. Most studies reviewed point to a child health monitoring which is responsible for the first development and implementation of the child health monitoring intended for analysis of preventive child health check-up and morbidity data (Lithuania, 2019).It is a very important way to develop a comprehensive solution where no matter what kind of diseases, type of check, or different units to be handled, this can become a possible solution for sequential monitoring of these patients (Batumi, 2019).

Other systems have found special features which make use of their development. In the case of the monitoring system using sensor technology, which is provided to a school organization to monitor the

child's physical condition (Heartbeat and Body temperature), it can be determined using sensors (Tupel et al.,2017).

Within these systems, it can also be found that the development of some of these is dedicated to patient care through telemedicine. Through interactive media and development of alternative technologies, it could contribute to improved consultation and clinical monitoring as well as anything related to health care from home, proposing a terminal for the integration of medical services from home using external sensors for measuring vital signs (Chen et al., 2018).

The health monitoring system includes a lot of data about the patients. There are patient safety issues that arise mainly from medical errors and result in increased patient deaths and financial and legal consequences for the providers and because of that, data warehouses merge disparate data to create health dashboards, clinical data repositories, and individual patient views (Ahmed, 2016). Health entities are moving toward predictive analytics, building on the capabilities of descriptive analytics to forecast future events using various models and what-if analyses (Bouayad, 2017). According to Jaisal (2018), data analytic is the art of exploring the facts and figures from the data with specific answers to specific questions. It draws conclusions from the information that is available so as to enable the employer of analytics to arrive at the right decisions. Moreover, Mehta, & Pandit, (2018) give emphasis that in the case of Big Data analytics, it has strengths in areas such as pattern recognition, information retrieval, parsing and production of natural language, translation from one representation to another, several kinds of reasoning, planning and problem solving (Shahzad et al. 2017)

3 Research Methodology

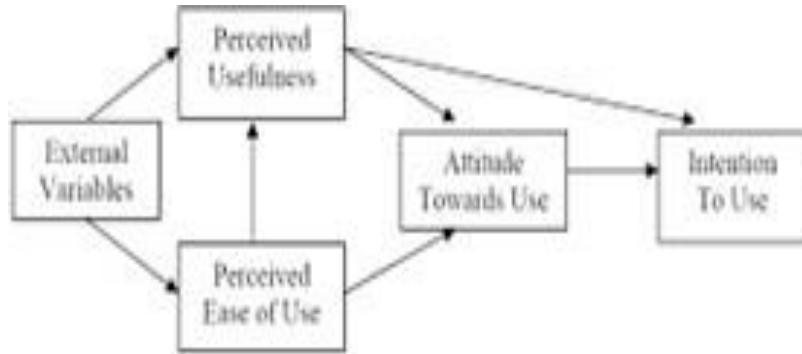


Figure 1: Technology Acceptance Model (TAM)

The system will then be developed using the Sublime Text 3 and coded in CodeIgniter using Visual Studio Code version 1.39, using the Agile model in SDLC. The system will be uploaded online using GoDaddy web hosting. The Technology Acceptance Model (TAM) by Davis et al.(1989) was used to determine user acceptance of the technology with regards to Perceived Usefulness, Perceived Ease of Use, and Behavioral Intention of Use. There will be 60 respondents.

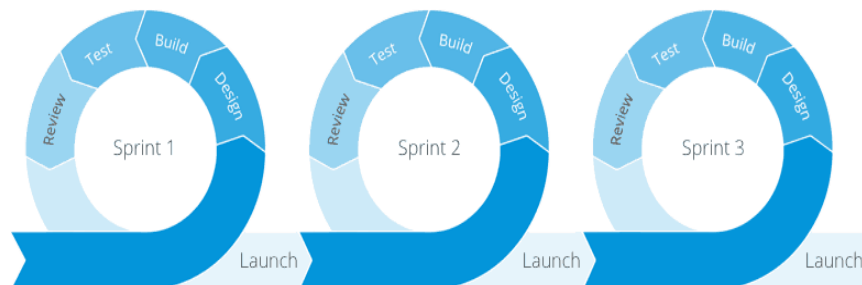


Figure 2: Agile Model Diagram

The researchers used the agile model of Systems Development Life Cycle which contains the six important stages that flow from one to the next and are essential to the developers. The initial phases where researchers are involved with creating a set of plans, scouting of an available company, accumulating all necessary information, conducting interviews, and setting appointments for further information. In the next phase, researchers will develop a web-based system that can monitor the child's health status in real-time and can store and retrieve data in one database of all health facilities that render services in child health. In the design phase, it is significant to analyze how the system works and visualize the flow and processes of the system by the use of the Flowchart and Data Flow Diagram. After completion, the System Usability Scale (SUS) was implemented to test the system with fifty (50) respondents.

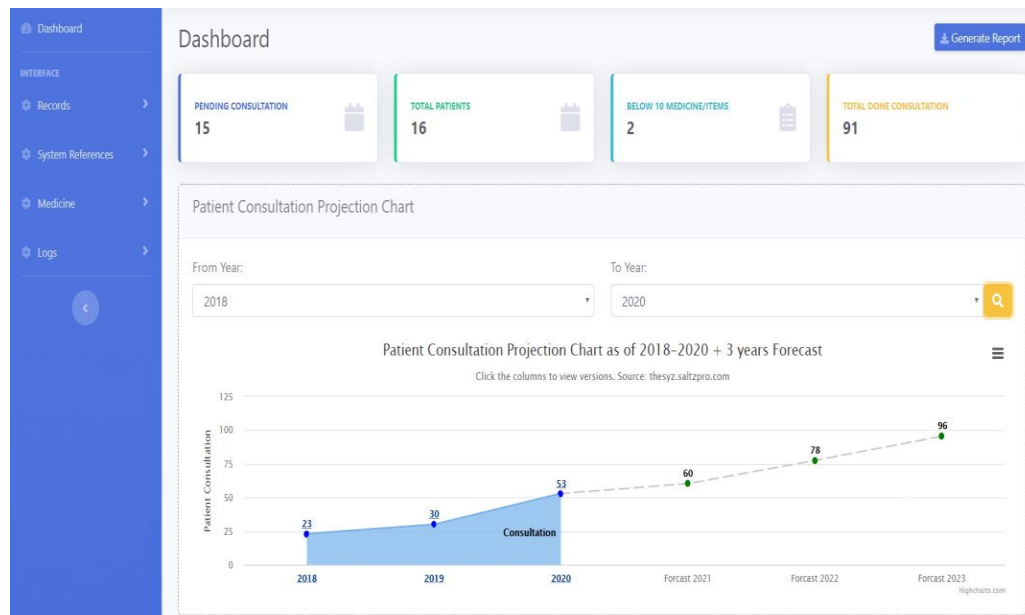


Figure 3: Admin user Dashboard

The admin user has all the privileges in the system, can create a user, and can control the amount of medicine allotted to the barangay health centers.

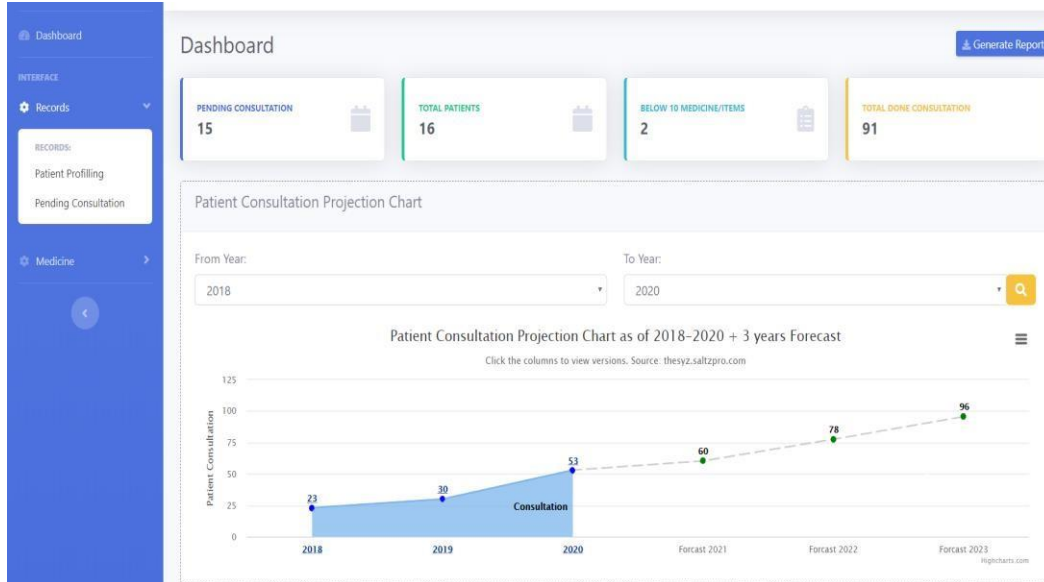


Figure 4: End user Dashboard

The end user can only add and edit patient's health records and consult and they can also see all the graphs

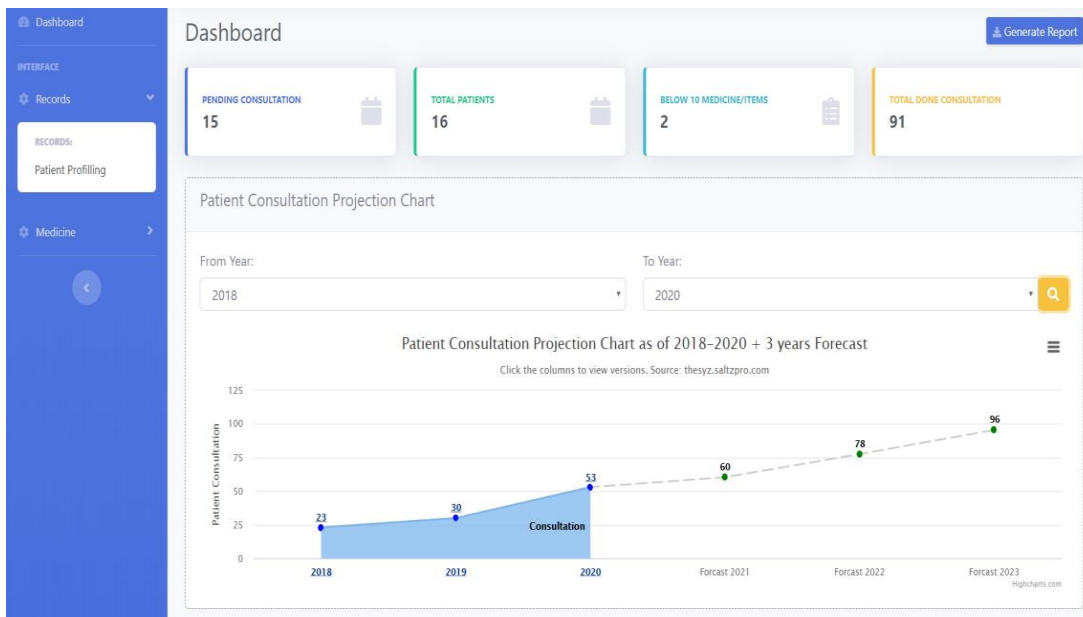


Figure 5: Encoder Dashboard

The barangay health workers/Encoder user can only add and edit patient's health records.

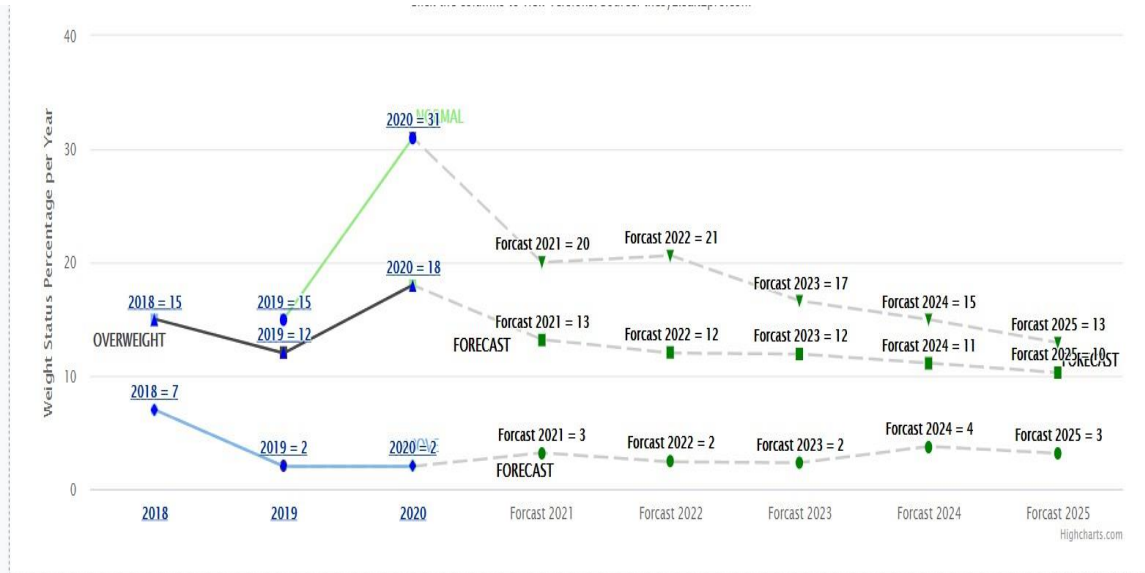


Figure 6: Projection graphing

Figure 3, Figure 4, Figure 5, and Figure 6 are the Screenshots of the System

4. Results and Discussions

This chapter presents the analyses and interpretations of the data gathered for the study. The system was successfully developed and a pilot system was deployed to selected health care centers within Butuan City. The researchers also collected data to examine the likelihood that the target users will use the system. Using the TAM framework, the Behavioral Intention was used as the dependent variable. Performances Usefulness, Perceived Ease of Use, Attitudes Towards System use, Facilitating Conditions, Self-Efficacy, Technological Complexity, S-Security, Risk, Reliability, Portability are considered as the independent variables. The respondent's Age, Job Designation, Gender, Employment Categories, Educational Level, Years of Work Experience, Experience Using an Automated system, Internet Access at the worksite, Internet Access at home are utilized as the moderating variables.

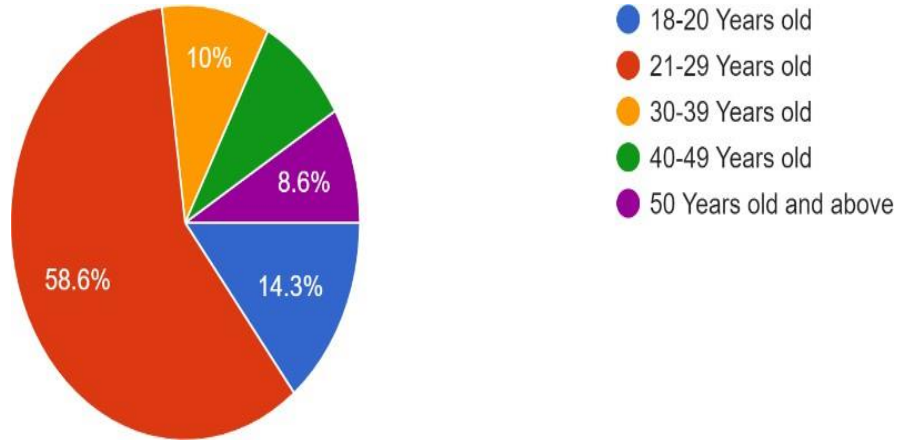


Figure 7 : Profile of the Respondents According to Age

Figure 7 indicates that the respondents of the study are mostly 21-29 years' old that comprised 58%, followed by 18-20 years' old which is 14.3%, next is the 30-39 years old comprising 10%, the 50 years old and above representing 8.6%, and the 40-49 years old with 8.5% of the respondents. This also assumes that there is a diverse representation included as data for the different age groups in the people of Butuan City.

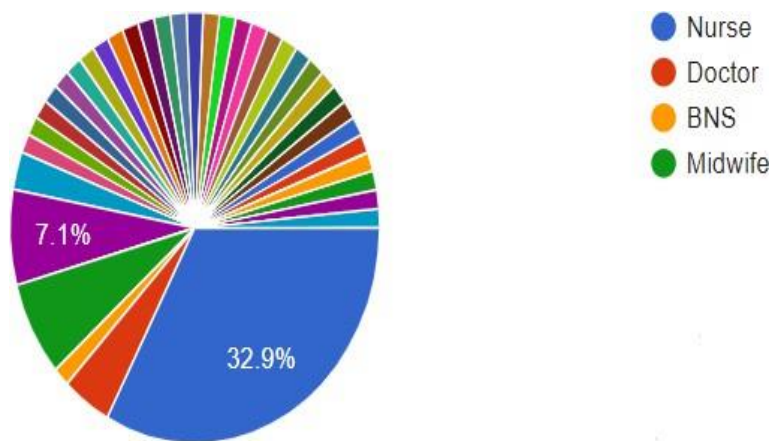


Figure 8: Profile of the Respondents According to Job Description

Figure 8 indicates that the respondents of the study are mostly nurses, twenty of them, which comprised 32.9%, followed by 5 BNS which is the 14.3%, next is Midwife 7.1%, then the doctors at 4.3% and the rest are other respondents.

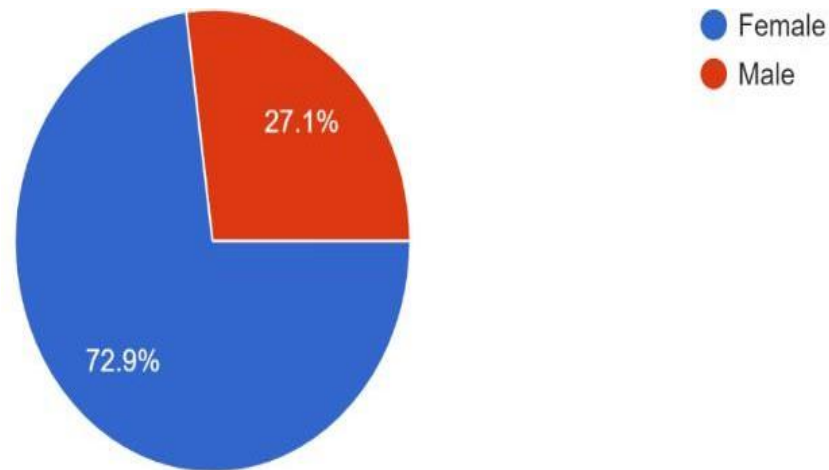


Figure 9: Profile of the Respondents According to Gender

The chart in Figure 9 shows that there are 19 identified as males comprising 27.1% of the total samples while 51 individuals were recognized as females comprising 72.9%. In total, there were 70 people in Butuan City who served as respondents for the TAM survey.

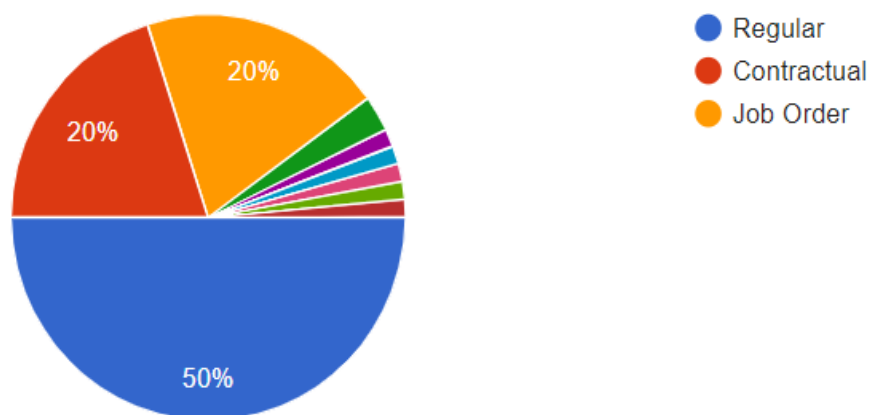


Figure 10: Profile of the Respondents According to Employment Categories

Figure 10 indicates that the respondents of the study are mostly regular which comprised the 58%, followed by contractual which is the 20% and job order which is 20%, and then the Others which consists 10% of the respondents. This will assume that most respondents are regular employees.

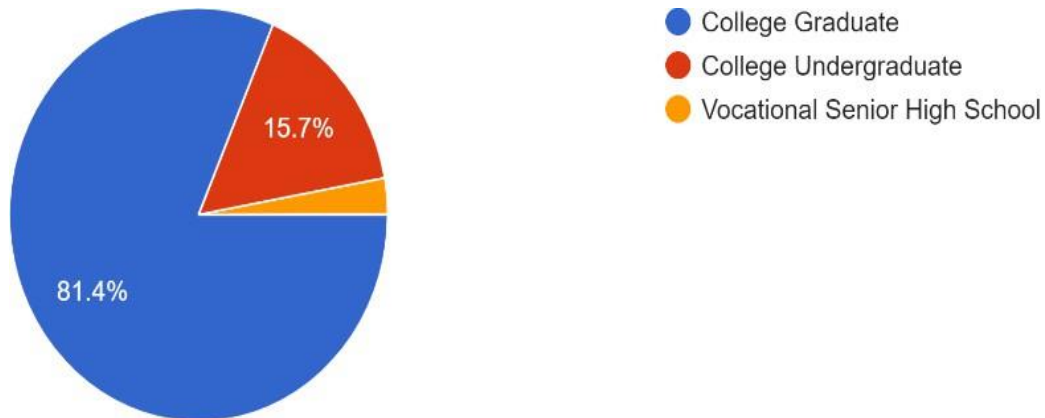


Figure 11: Profile of the Respondents According to Educational Level

Figure 11 indicates that the respondents of the study are mostly 21-29 years' old which comprises 58%, followed by 18-20 years old which is 14.3%. Next is the 30-39 years' old which comprises 10%, next is the 50 years old and above which is 8.6% and then the 40-49 years old consists 8.5% of the respondent. This also assumes that there are diverse representations included as data for the different age groups in the people of Butuan City.

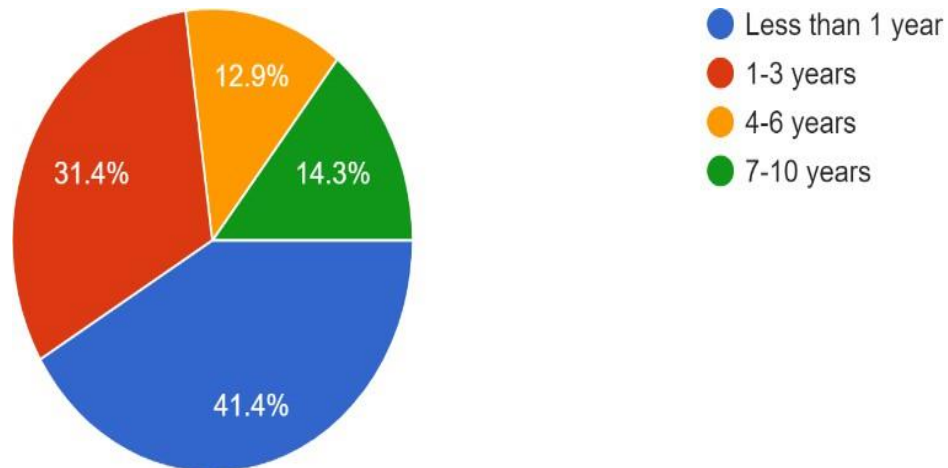


Figure 12: Profile of the Respondents According to Years of Experience

Figure 12 indicated that the respondents of the study are mostly less than year 1 year which comprised 41.4%, next is 1-3 years which is 31.4%, while 7-10 years comprises 14.3% and 4-6 years is 12.9%. This assumes that most respondents are working less than 1 year.

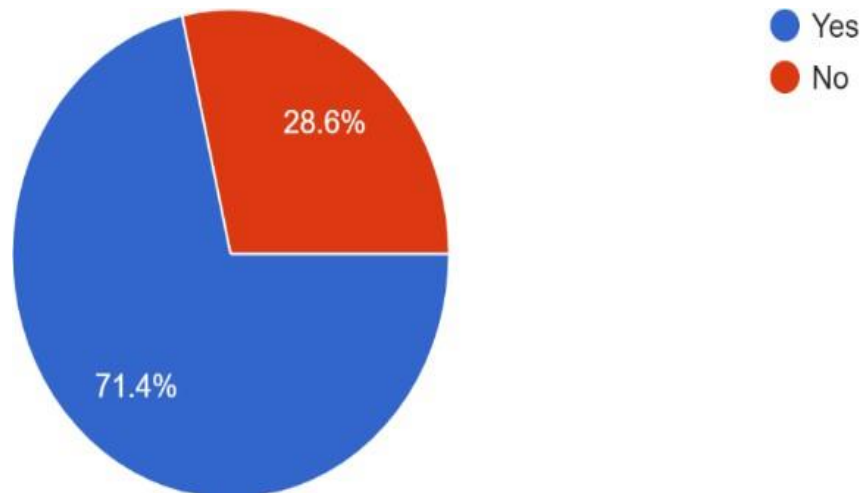


Figure 13: Profile of the Respondents According to Experience Using an Automated System.

Figure 13 shows that there are 20 responses for No comprising 28.6% of the total samples, 50 responses for Yes comprising 71.4% comprising 72.9%. This also assumes that 71.4% of the respondents already encounter an automated system.

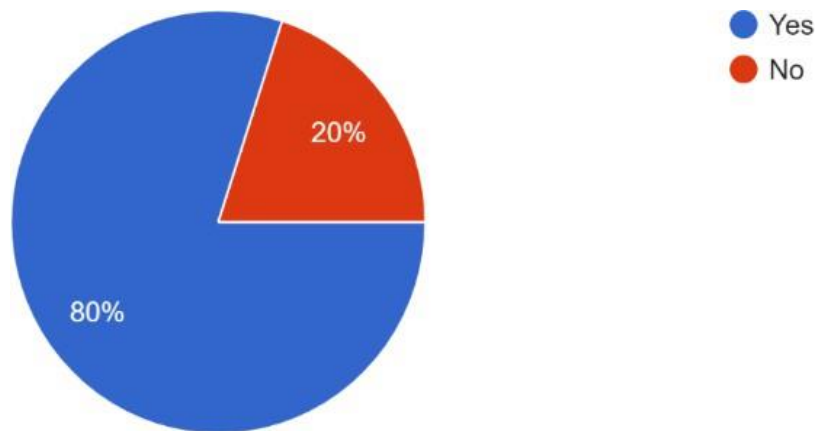


Figure 14: Profile of the Respondents According to Internet Access at Worksite

Figure 14 shows that there are 14 responses for No comprising 20% of the total samples, 56 responses for Yes comprising 80% . This also assumes that 80% of the respondents have internet access at the worksite.

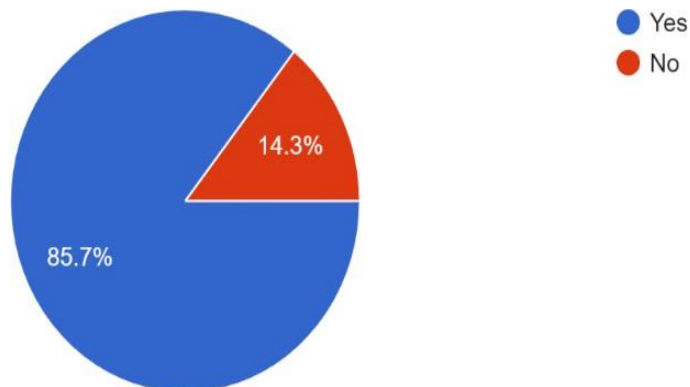


Figure 15: Profile of the Respondents According to Internet Access at Home

Figure 15 shows that 85.7 % respondents answered yes and 14.3% answered No. This also assumes that 85.7% of the respondents have internet access at home.

This study was guided by the following null hypotheses tested at the 0.05 level of significance.

H1: There is no significant relationship between the different features of an automated system and the behavioral intentions of end-users.

H2: There is no significant relationship between the different features of an automated system and the attitude of end-users.

H3: There is no moderating effect on the list of the demographic profile of the respondent to the model that studies the relationship of different features of automated systems and the behavioral intentions of end-users.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.811 ^a	.658	.596	.3902

a. Predictors: (Constant), Portability, Risk, Peruseful, Falcon, TechComp, Selfeffic, Security, Perease, Reliability

Model for Features and Attitude

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.780 ^a	.608	.536	.4010

a. Predictors: (Constant), Portability, Risk, Peruseful, Falcon, TechComp, Selfeffic, Security, Perease, Reliability

Model for Features and Behavioral Intention

Table 1: MRA -Attitude and Behavioral Intention as Predicted Variables

Table 1 shows the multiple regression analysis (MRA) that was utilized to determine the importance of varied features of the real time health monitoring system to the attitude towards system use and behavioral intentions of end users. As shown in the model summary table above. For attitude, the R squared showed that 65.8 % of the variance can be explained by the model while for the behavioral intention, R squared showed that 60.8 % of the variance can be explained by the model. The models provide insights to the features of the automated system that are relevant to the users. The models also showed that there is enough evidence to prove the association between varied features of the real time health monitoring system to the attitude and behavioral intentions of end users, thus rejecting the two null hypotheses.

Real-Time Health Monitoring System	Behavioral Intention		5% Level of Significance H0 is	Conclusion
	Rho value	P- value		
Perceived usefulness	0.352	0.002	Reject	Significant

Table 2: Result on Hypothesis Test of Perceived Usefulness

Table 2 indicating perceived usefulness is statistically significant, and the highest predictor of intention to use with a p value of .002; As a result, the null hypothesis is rejected and thus supporting the previous empirical study of technology acceptance.

Real-Time Health Monitoring System	Behavioral Intention		5% Level of Significance H0 is	Conclusion
	Rho value	P- value		
Perceived ease of use	0.304	0.019	Reject	Significant

Table 3: Result on Hypothesis Test of Perceived Ease of Use

Table 3 Perceived Ease of Use is significant and has a p-value of 0.019. It indicates strong evidence to prove the relationship with behavioral intention. This means that most of the users agreed that the system is very helpful to improve their performance and it requires minimal skill to use it.

Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.794	.436		4.118	.000
	attitudeto	.563	.103	.587	5.480	.000

a. Dependent Variable: Behavinten

Table 4: Result on Hypothesis Test of Attitude

Table 4 Attitudes Towards System Use is significant and has a p-value of 0.000. It indicates strong evidence to prove the relationship with behavioral intention of users of the automated system. This means the users deem it valuable to use the system.

Real-Time Health Monitoring System	Behavioral Intention		5% Level of Significance H0 is	Conclusion
	Rho value	P- value		
Facilitating Condition	0.517	0.00	Reject	Significant

Table 5: Result on Hypothesis Test of Facilitating Condition

Table 5 Facilitating Condition is significant and has a p-value of 0.000. It indicates strong evidence to prove the relationship with behavioral intention. This means that the users perceive that the organization's IT infrastructure is available for their daily use.

Real-Time Health Monitoring System	Behavioral Intention		5% Level of Significance H0 is	Conclusion
	Rho value	P- value		
Self Efficacy	0.253	0.074	Accept	Not Significant

Table 6: Result on Hypothesis Test of Self-Efficacy

Table 5 Self-Efficacy is not significant and has a p-value of 0.074. It indicates that there is not enough evidence that proves a relationship with behavioral intention. This means that a possible reason for this could be that the user feels that they cannot complete tasks earlier if someone cannot show them how to do it with a Real-Time Health Monitoring System.

Real-Time Health Monitoring System	Behavioral Intention		5% Level of Significance H0 is	Conclusion
	Rho value	P- value		
Technological Complexity	-0.138	0.274	Accept	Not Significant

Table 7: Result on Hypothesis Test of Technological Complexity

Table 7 Technological Complexity is not statistically significant and has a p-value of 0.274. It indicates not enough evidence to show the relationship with behavioral intention. This means that a possible reason for this could be that the user thinks it will take too much in terms of familiarizing if they find the system complicated.

Real-Time Health Monitoring System	Behavioral Intention		5% Level of Significance H0 is	Conclusion
	Rho value	P- value		
Security	-0.110	0.453	Accept	Not Significant

Table 8: Result on Hypothesis Test of Security

Table 8 Security is not statistically significant and has a p-value of 0.453, indicating that there is not enough evidence to prove the association with behavioral intention. This means that a possible reason for this could be that the user thinks that the system cannot provide a security password if they find it is easily attacked by a hacker.

Real-Time Health Monitoring System	Behavioral Intention		5% Level of Significance H0 is	Conclusion
	Rho value	P- value		
Risk	0.054	0.474	Accept	Not Significant

Table 9: Result on Hypothesis Test of Risk

Table 9 Risk is not statistically significant and has a p-value of 0.474 it indicates not enough evidence to show the relationship with behavioral intention. This means that a possible reason for this could be that the user may find any risk in using a Real-Time Health Monitoring system if they find that the system is not secured.

Real-Time Health Monitoring System	Behavioral Intention		5% Level of Significance H0 is	Conclusion
	Rho value	P- value		
Reliability	0.253	0.162	Accept	Not Significant

Table 10: Result on Hypothesis test of Reliability

Table 10 Reliability is not statistically significant and has a p- value of 0.162 it indicates not enough evidence to show the relationship with behavioral intention. This means that a possible reason for this is that adopting a Real-Time Health Monitoring System is not reliable in protecting data privacy, recovery against shutdown if the system is not reliable to use.

Real-Time Health Monitoring System	Behavioral Intention		5% Level of Significance H0 is	Conclusion
	Rho value	P- value		
Portability	0.416	0.007	Reject	Significant

Table 11: Result on Hypothesis of Portability

Table 11 Portability is statistically significant and has a p-value of 0.007 it indicates strong evidence to prove the relationship with behavioral intention. This means that the user finds it convenient to use the Real-Time Health Monitoring system since the system is user friendly.

Moderating Variable	P-Value	5% Level of Significance H0 is	Conclusion
Age	0.073	Accept	Not Significant
Job Description	0.400	Accept	Not Significant
Gender	0.198	Accept	Not Significant
Employment Categories	0.329	Accept	Not Significant
Educational Level	0.170	Accept	Not Significant
Work Experience	0.117	Accept	Not Significant
Experience in an automated system	0.817	Accept	Not Significant
Internet access at a worksite	0.072	Accept	Not Significant
Internet access at home	0.889	Accept	Not Significant

Table 12: Statistical treatment of moderating variable

Table 12 The P-value of Age is 0.073, and P-Value is less than $\alpha = 0.05$ the age of respondents does not have any moderating effect in the model. Also, at P-value of Job Description is 0.400, the job description

does not have any moderating effect in the model. At P-value of 0.198, the Gender does not have any moderating effect in the model. At P-value of 0.329, the employment categories do not have any moderating effect in the model. At P-value of 0.170, the Education Level does not have any moderating effect in the model. At P-value of 0.117, the Experience in using Automated system does not have any moderating effect in the model. At P-value of 0.072, the Internet access at home does not have any moderating effect in the model and at P-value of 0.889, the Internet access at work does not have any moderating effect in the model. This shows significance and indicates less evidence for the null hypothesis.

The moderating variables do not influence the relationship between the Independent variables to the Dependent variable. This means that age, job description, gender, Employment categories, educational level, work experience, experience in automated system, Internet access at a worksite and internet access at home were consistently not significant in the model and therefore was not a predictor for Portability, Risk, perceived usefulness, facilitating condition, Technological Complexity, attitude towards system use, Security, Self-efficacy, Perceived ease to use, Reliability

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.781 ^a	.610	.548	.3957

a. Predictors: (Constant), Portability, Risk, Peruseful, Falcon, TechComp, attitudeto, Security, Perease

Table 13: Summary Result of Technology Acceptance Model Survey for Decision Support System with Analytics: Real-Time Health Monitoring System in Butuan City

Table 13 indicates that the PEU, PU, ATU, FC, SE, TC, S, RI, RE, and P has an overall R-Square of .610, which shows a capability of explanation of almost 61% in relation to the proportion of the variance in the dependent variable BI that is explained by PEU, PU, ATU, FC, SE, TC, S, RI, RE, and P. The higher the R^2 value, the better the model fits to predict the behavior of data.

The results revealed that Portability, Risk, perceived usefulness, perceived ease of use, facilitating condition, Attitude Towards system use, Self-efficacy, and Reliability have positive influence on Real-Time Health Monitoring System adoption and continued use by the nurse, midwife, and other employees in health facilities in Butuan city. The Security, Technological Complexity, reliability, and risk were not statistically significant but must be considered by management to improve the consistency of work in the barangay health center in Butuan city. Health workers were positive that they will adopt an automated system soon.

5. Conclusion

The system improved the present way of gathering data on child health status and the system was very useful in the decision-making process due to its analytical capability. By using DSS: Child health monitoring system, it will help in various things such as time to time update of data using the web procedures, provide a piece of standard data information in all health facilities in CARAGA Region on inputs and outputs on data, and analyze report generation, and to collect, process, store, and present information in child health monitoring through a web-based application. In addition, Portability(P), Risk(R), Performances usefulness (PU), Facilitating condition (FC), Attitude Towards system use (ATU), Self-efficacy (SE), and Reliability (RE) have a positive influence on Real-Time Health Monitoring System adoption and continued use by the nurse, midwife, and other employees in health facilities in Butuan city. The Security(S) and Technological Complexity (TC) were not statistically significant but must be considered by the management to improve the

consistency of work in the barangay health centers in Butuan city. Health workers were positive that they will adopt an automated system soon.

6. Recommendations

The research which includes system development and data analytics paved the way for new opportunities to augment the life of community. The researchers recommend further improvements and promote the automated system in health care facilities in Butuan city. Also, this project recommends further work to the patient that will be notified through SMS (Short Messaging Service) before the day of their schedule. Double authentication for users could also be implemented on the system to secure when they log in to the system.

The findings of the study provide new information to the body of knowledge and will serve as reference material, and a guide for future researchers who wish to conduct the same experimental study or any study related to Analytics and Monitoring systems.

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