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Computerized Senior Citizen Health Monitoring using Mobile Application

Nursyafiqah Aisyah Ahmad Yani [a,1,*], Mohamad Fadli Zolkipli [a,2]

[a] School of Computing, Universiti Utara Malaysia, Sisiran Sintok 1, Sintok, 06010, Changlun, Kedah, Malaysia
[1] nursyafiqah_aisya@soc.uum.edu.my, [2] m.fadli.zolkipli@uum.edu.my
* corresponding author

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ABSTRACT

Health is the primary concern of senior citizens because they might experience many changes and uncertainties that might affect their lives. Further, ageing people tend to forget things, including taking medicine. Failing to follow medication instruction may lead to serious side effects and can worsen their health. The advancement of technologies, especially in mobile applications, could assist senior citizens in managing their health. Therefore, this project proposes a mobile app for senior citizen health monitoring, developed to provide a health monitoring facility for senior citizens by exploiting advanced information and communication technologies. It aims to provide healthcare support for senior citizens to have greater control over monitoring their health. This application assists them daily in their life, such as organizing their medication and taking medicine on schedule with the correct doses. Other than that, the information about their health condition such as allergies, medicine intake, and doctor's information can be accessed quickly from their mobile device in case of emergency. This project was developed using the agile methodology.

1. Introduction

In Malaysia, older people are defined as those who are 60 years and above [1]. Most of them nowadays have been living on their own without anyone accompany them because their children are busy with work. There is a high risk of a bad incident that could happen while they are alone at home. By alone, it is considered that an elderly person who does not reside with their family members, including those who live with employees [2]. Therefore, it is essential to provide an effective solution to help senior citizens to manage themselves at home and assist them to live independently. As the global population is rapidly ageing, and many services are now offered online through mobile applications, it is necessary to design accessible mobile user interfaces (UI) that consider senior citizens' needs. These needs are related to cognitive, perceptual, and psychomotor changes that occur in the ageing process, which affect the way older people interact with a mobile device [3].

Ageing is a stage of the life cycle, irreversible, natural and that occur differently from individual to individual [2]. As people age, health becomes a critical factor because they might experience many changes and uncertainties that might affect their life. Having a good life while growing old is dependent on several factors such as nutrition, physical health, the ability to perform activities of daily living, lifestyle and psychological health [4]. Sometimes senior citizens might forget to take their medicine on time, causing them to skip doses. Failing to follow medication instructions may

lead to serious side effects and worsen their health. Changes in functional ability are noticeable as age advances [5].

Health is the most important things in life and should not be taken for granted. Therefore, this project is focusing to provide healthcare support especially for senior citizen in term of medicine intake and storing medical record. Sometimes it can be difficult for them to remember details of medicine intake such as the time to take the pills. By using this application, they can set a schedule reminder when to take the medicine and record the medicine intake in a day. The name of the medicine and its function can be recorded as well. It also acts as a personal health information system that stores information such as their medical concerns or allergies. Although, health is the major concern, they still can have a quality health with the usage of this mobile application which enables them to monitor their health systematically. Information and communications technologies (ICTs) have been seen as tools in providing services and supporting social inclusion and quality of life, also for the growing population of a senior citizen [6].

This objective of this project is to improve the health and well-being of senior citizens by providing unique features such as schedule reminders for medicine intake and record health concern. In addition, this project aims to provide healthcare support especially for senior citizen in their daily life.

This article organized and divided into six parts which are Section I is the introduction of this project while Section II discuss the background and related studies. Section III is the methodology used to develop this project. Section IV divided into two parts which are the list of functional requirements and prototype of Mobile Apps for Senior Citizen Health Monitoring. Section V contains the result of the evaluation conducted. Section VI is the conclusion of the topic for this article. Also includes at the end of this article is acknowledgement and references that been used for this article.

2. Background And Related Studies

The trend of using the internet through mobile devices such as smartphones and handheld tablet devices rather than via laptops and personal computers are nowadays acknowledged as powerful means to tackle the challenges of an ageing population [7]. The mobile application is becoming a trend to society of all ages as it provides "on the go " access to any kind of information needed. Furthermore, the use of health-related information and communication technologies (ICT), including computerized devices, home computers, and the internet, may serve to provide cost-effective healthcare solutions for the older adult population [8].

The advanced technologies for older adults must be designed to meet older adults' needs while considering their capabilities and limitations in order to be accepted by elderly people. Indeed, there are suggested that many older people are more comfortable using simpler designs [9], [10]. The design and development of ICT product must support the elderly end users, especially to overcome their feelings of fears and enable them to accept technological aids and mobile devices in their lives [11]. Mobile apps with simple design attract users as they do not require complex interactions. A typical mobile app for seniors should have such characteristics that are easy and straightforward for the elderly to understand [12].

In designing the user interface, the senior citizen condition should be taken into consideration. The main problem faced by the senior citizens is visibility. Many of senior citizens has short-sightedness problem and blurred vision [13]. According to [14], text and button sizes should be kept large. Basically, anything that's meant to be read or clicked should be scaled up. These criteria should be implemented in the application.

3. Methodology of The Study

The study was conducted following the agile methodology. Figure 1 shows the agile development process. Generally, agile development provides continuous iteration of development and testing in the software development process [15]. This methodology was chosen because this application is on a small scale and simple. All the tasks can be divided into a small unit and the most important items will be prioritized to deliver a high-quality product. This method also allows for small changes to be added without affecting other requirements. The progress of the project can be measured after each iteration. Phases below were followed to deliver the product:

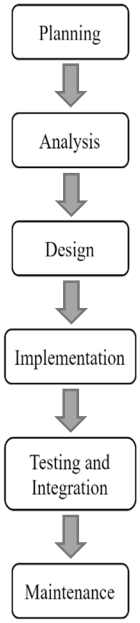

Figure 1. Agile development process

The planning phase involve several processes such as topic selection, preparing and presenting proposal. After the topic for the project was selected, research on the related field was conducted to gain more information and have a better understanding of the topic. The strategic planning about the project involves duration and resources was documented in a proposal which needs to be presented upon its completion.

The requirements of the senior citizens such as the ability to use the mobile device were gathered in the analysis phase. The functionalities of the mobile application that needed by senior citizen in this application were listed in requirement specification report. The concept and objective of this project were also identified from this project.

To have a clear picture of how the mobile application operated, the system architecture was design before it is implemented. The list of requirements from previous was used to design the flow of this mobile application. The characteristic that needs to be considered when designing the user interface for senior citizen is simple navigation, clear content and user-friendly. The design was transformed into a low-fidelity prototype to represent the concept of this mobile application.

The coding part took place in the implementation phase. The project was constructed in this phase using the chosen programming language. The mobile application was constructed based on requirements that have been gathered at the beginning of this project as well as in the design phase. High- fidelity prototype that consists overall functionality was prepared and demonstrated.

Testing phase takes place after implementation to validate the application quality. This application undergoes a series of testing such as functional testing, performance testing, compatibility testing and usability testing to find the error that needs to be fixed. The final product was achieved after all the testing is passed.

The last phase of the agile development process was maintenance. Performance of the mobile application was monitored. At the end of this project, a final report that consists of details of Mobile Apps for Senior Citizen Health Monitoring was presented.

4. Design And Development

This section describes the design and development of Mobile Apps for Senior Citizen Health Monitoring for each functionality. This section is divided into two-sub sections; (1) the list of functional requirements and (2) the prototype of Mobile Apps for Senior Citizen Health Monitoring.

Table 1 shows the functional requirements for the Mobile Apps for Senior Citizen Health Monitoring. This project consists of five major requirements namely monitor health progress, add medicine details, set medicine reminder, track appointments, and view summary. The priority of the requirements is indicated by; (M) mandatory.

Table 1. List of Functional Requirements

No.	ID	Requirements Description	Priority
1	**SCHM1**	**Monitor health progress**	M
	SCHM1_1	Assistant can monitor health progress of the senior citizen.	M
	SCHM1_2	The application must display a page that allow assistant to record: a. Blood pressure b. Heart rate c. Blood sugar	M
	SCHM1_3	The application must save all the recorded details.	M
2	**SCHM2**	**Add Medicine Details**	M
	SCHM2_1	Assistant can add medicine details.	M
	SCHM2_2	The application must display a page that allow assistant to record: a. Medicine Name b. Appearance c. Dosage d. Instruction	M
	SCHM2_3	The application must save all the medicine details.	M
3	**SCHM3**	**Set Medicine Reminder**	M
	SCHM3_1	Assistant can set medicine reminder	M
	SCHM3_2	The application must display a page that allow assistant to set reminder to take medicine based on: a. Time b. Medicine name	M
	SCHM3_3	The application must save the reminder.	M
4	**SCHM4**	**Track Appointments**	M
	SCHM4_1	Assistant can track appointments with doctors.	M

	SCHM4_2	The application must display a page that allows the assistant to track appointment details: a. Date b. Time c. Venue d. Doctor's name e. Doctor's phone number f. Purpose	M
	SCHM4_3	The application must save all the appointment details.	M
5	**SCHM5**	**View summary**	M
	SCHM5_1	Senior citizen can view summary of health progress and medicine intake.	M
	SCHM5_2	The application will display a page that allow senior citizen to view daily, weekly, or monthly summary of health progress and medicine intake.	M
	SCHM5_3	The application will allow senior citizen to go back to main page if they want to terminate the process.	M

A use case model for the mobile application consists of two actors; senior citizen and assistant. There are five use cases namely monitor health progress, add medicine details, set medicine reminder, track appointments, and view summary as illustrated in Figure 2. The use case diagram shows the communications between use cases and the actors.

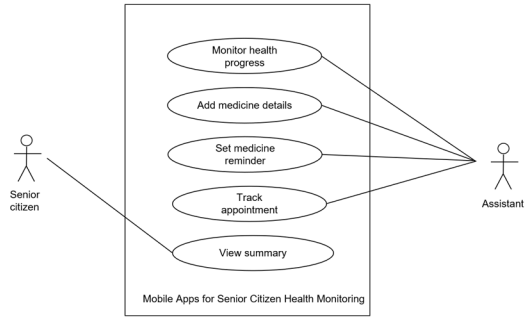

Figure 2. The use case diagram of a Mobile Apps for Senior Citizen Health Monitoring

The structural component of Mobile Apps for Senior Citizen Health Monitoring was represented in a class diagram as illustrated in Figure 3. The class diagram shows the interaction between attributes and the operation. The interaction between each class is shown in the figure below.

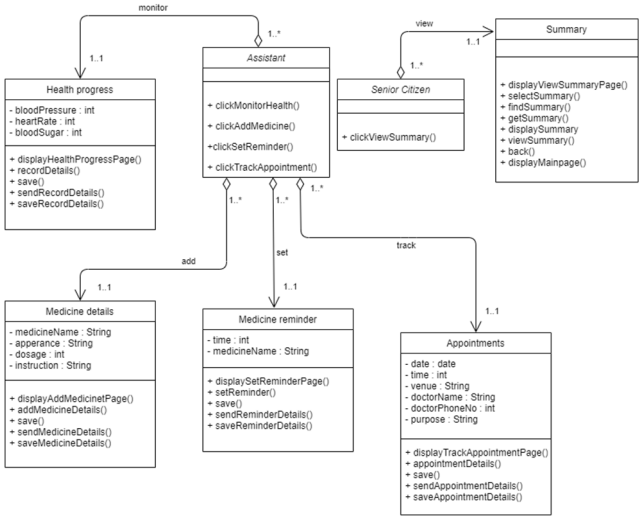

Figure 3. The class diagram of Mobile Apps for Senior Citizen Health Monitoring

A prototype of Mobile Apps for Senior Citizen Health Monitoring was developed. This prototype is a representation of the requirement listed previously. The purpose of the prototype is to demonstrate to user on how to use this application. The programming tools used to develop low-fidelity prototype are Visual Studio Code and Flutter. While the database use to store the data is phpMyAdmin. Figure 4,5,6, and 7 shows the screenshot of Mobile Apps for Senior Citizen Health Monitoring interface.

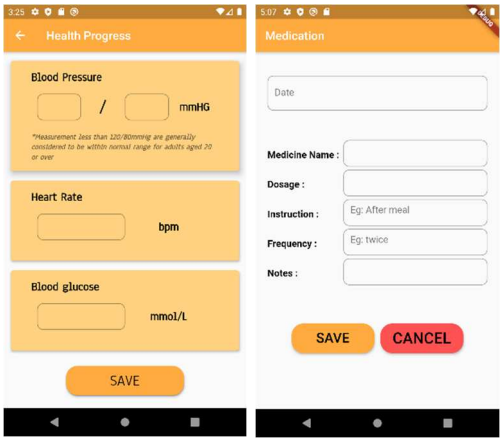

Figure 4. The interface for main screen (left) and profile screen (right)

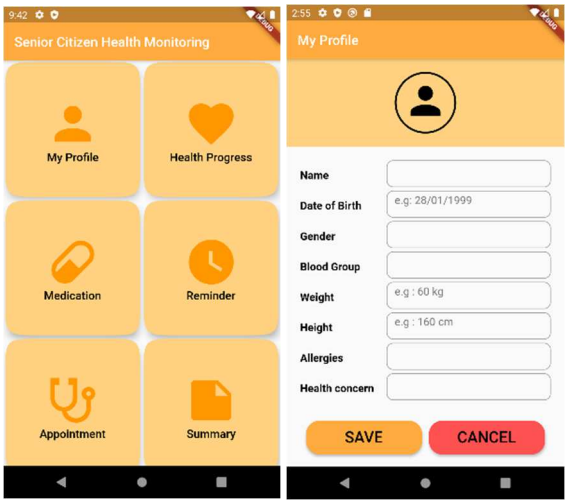

Figure 5. The interface for health progress screen (left) and medication screen (right)

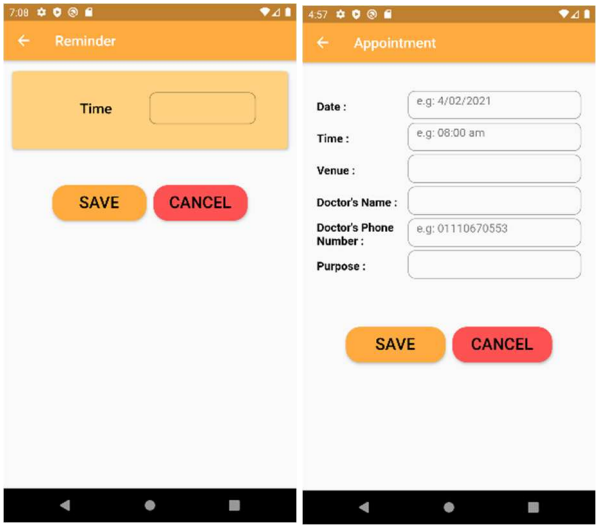

Figure 6. The interface for reminder screen (left) and appointment screen (right)

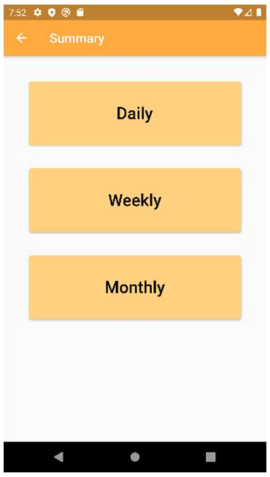

Figure 7. The interface for summary screen (left)

5. Evaluation

In this paper, a three-operand binary addition technique and its VLSI architecture are proposed for efficient computation of modular arithmetic used in cryptography and PRBG applications. This proposed design is unique in that it reduces delay and area in the prefix computation stages of PG logic and bit-addition logic, resulting in a reduction in critical path delay, area-delay product (ADP), and power-delay product (PDP). Furthermore, the proposed adder architecture is used to replace the CS3A three-operand adder architecture in a 32-bit MDCLCG architecture (previously published in the literature), and the design is prototyped on a commercially available FPGA platform to validate the design on a silicon chip.

5.1. The Evaluation Setting

The evaluation method applied in this study was unmoderated remote usability testing. Since its MCO, the evaluation was conducted remotely through multiple online platforms. The usability evaluation was conducted on 30 participants among senior citizen and people who live with senior citizen. First, a google form was distributed to get participant's consent and collect the post-task question. Other than that WhatsApp's was used to recruit and communicate with the participant. They were given links to download the .apk file of the application and answer the post-task questionnaire after completing the evaluation.

5.2. The Participants' Demographic

Table 2 depicts the participants' demographic data covering their status, gender, age, health concern of the senior citizen, medication intake, ways senior citizens manage their medicine, forgetting to take the medicine, their knowledge to use a mobile device, and ownership of the mobile device.
The majority of the participants (83.3%) lived with a senior citizen while the other 16.7% were senior citizens. Among the 30 participants, 66.7%, 20 of the senior citizens are female, and the remaining 10 senior citizens, 33.3%, are male. The senior citizen was divided into 4 categories of ages. There were 11 senior citizens (36.7%) from the first category (60 - 70 years old). The second category (71 - 80 years old), with a total of 14 senior citizens (46.7%) recorded the highest percentage age group of the senior citizen's age. For the third category (81 - 90 years old), there were 2 participants (5.7%) followed by the third category (36 - 45 years old) with a percentage of (20%). The fourth category (91 years old and above) is the least age group.

20 of the senior citizens, with a percentage of 66.7%, have health issues. Meanwhile, another 20 senior citizens (33.3%) have no health issues. In term of medication intake, 70 % of the senior citizens depend on medication while the rest (30%) is not. There are many methods use by senior citizen to manage their medicine. Most of them were helped by the assistant, their son, daughter, or grandchildren. 36.7% of senior citizen remember all the medicine by looking at the medicine bag.

A total of 19 senior citizens (36.7%) answer that they used to forget to take medicine while the rest had never forgotten to take medicine. The result shows an equal number of senior citizens who know how to use a mobile device and do not know how to use it with a percentage of 50% each. On the other hand, quite a few senior citizens have a mobile device with a percentage of 66.7%.

5.3. The usability of Mobile App for Senior Citizen Health Monitoring

Table 3 shows the result of the participants who answered the questions on the usability of Mobile App for Senior Citizen Health Monitoring. Most of the participant (43.3%), satisfied with the ease of completing the task by rated agreed. Notably, almost half of the participants agreed that they satisfied with the amount of time it took to complete this task.

5.4. The usefulness of Mobile App for Senior Citizen Health Monitoring

Table 4 shows the result of the participants who answered the questions on the usefulness of Mobile App for Senior Citizen Health Monitoring. Most participants (40.0%) agreed that Mobile App for Senior Citizen Health Monitoring has useful function. However, there are 2 participants (6.7%) who disagreed with this statement. Therefore, half of the participants 15 (50.0%), agreed that this application meets their needs. The second and third scale consists of an equal number of participant's rating which is 2 participants (6.7%).
15 participants (50.0%) strongly agreed that it is easy to navigate through this application. There is only 1 participant who strongly disagreed with the statement. Quite a few participants strongly agreed that they are comfortable using Mobile Apps for Senior Citizen Health Monitoring, with a percentage of 46.7%. Meanwhile, 4 participants rated neutral for this statement. Nearly half of the participant (14%) strongly agreed that they could understand the flow of this application. Only a small minority of the participant disagreed with the statement.

Among 30 participants, 13 of them (43.3%) agreed that application was pleasant. There are only 2 participants that disagree with the statement. Half of the participants strongly agreed that the information provided was easy to understand. However, 5 participants choose to stay neutral. Therefore, 9 out of 30 participants agreed that they need time to understand how this application works.

In term of application complexity, 9 participants (30.0%) agreed that this application was complicated. The percentage of participants that agreed and disagreed with the statement is 20.0%, respectively. Finally, 13 participants agreed that this application was very useful. The second and third scale share the same number of participant's rating which is 1 participant (3.3%) respectively.

5.5. The ease of uses of Mobile App for Senior Citizen Health Monitoring

Table 5 shows the result of the participants who answered the questions on the ease of use of Mobile App for Senior Citizen Health Monitoring. A total of 13 participants (43.3%) strongly agreed that Mobile App for Senior Citizen Health Monitoring was easy to use.12 participants (40.0%), strongly agreed that the application was user-friendly while 6 of them choose to stay neutral. 13 out of 30 participants strongly agreed that it was easy to learn and remember how to use this application.

The majority of the participants (36.7%) agreed that it was not complicated to use this application. Only 1 participant disagreed with this statement. In term of functionality, there are 15 participants

agreed that the function of this application was well-organized. Most of the participants need time to understand how this application works because it is shown in the table that 10 participants agreed, and another 7 participants strongly agreed with this statement. Meanwhile, many participants did not need help from other people to be able to use this application. This is supported by the total number of participants that strongly disagreed and disagreed is greater than those who agreed and strongly agreed.

5.6. The satisfactions of Mobile App for Senior Citizen Health Monitoring

Table 6 shows the result of the participants who answered the questions on the satisfaction of Mobile App for Senior Citizen Health Monitoring. There are 13 participants (43.3%) satisfied with all the function provided in Mobile App for Senior Citizen Health Monitoring by rated strongly agreed for this statement. However, only 1 participant disagreed with the statement. Among 30 participants, 13 of them (43.3%) agreed that they will continue using Mobile App for Senior Citizen Health Monitoring in future. Most of the participant would recommend Mobile App for Senior Citizen Health Monitoring to their friend. The total of the participant who agreed and strongly agreed are 10 participants (33.3%) and 11 participants (36.7%) respectively. Over half of the participants, (60.0%), strongly agreed that this application is beneficial. Only 1 participant strongly disagreed with the statement. In the context of participants' satisfaction with the application, 14 participants (46.7%) strongly agreed with the statement.

Table 2. The Participants Demographic

	n	%		n	%
Status			**Ways senior citizen manage their medicine**		
Senior citizen	5	16.7	Remember all medicine by looking at the	11	36.7
Living with a senior citizen	25	83.3	medicine bag		
Total	**30**	**100.0**	Help by assistant (son/daughter/grandchildren	14	46.7
			etc.)		
Gender			Use notebook	3	10.0
Female	20	66.7	Others	2	6.6
Male	10	33.3	**Total**	**30**	**100.0**
Total	**30**	**100.0**			
			Forgetting to take medicine		
Age			Yes	19	36.7
60 - 70 years old	11	36.7	No	11	63.3
71 - 80 years old	14	46.7	**Total**	**30**	**100.0**
81 - 90 years old	3	10.0			
91 years old and above	2	6.6	**Knowledge to use mobile device**		
Total	**30**	**100.0**	Yes	15	50.0
			No	15	50.0
Health issues			**Total**	**30**	**100.0**
Yes	20	66.7			
No	10	33.3	**Ownership of mobile device**		
Total	**30**	**100.0**	Yes	20	66.7
			No	10	33.3
Medication intake			**Total**	**30**	**100.0**
Yes	21	70.0			
No	9	30.0			
Total	**30**	**100.0**			

Table 3. The Usability of Mobile App for Senior Citizen Health Monitoring

Usability of Mobile App for Senior Citizen Health Monitoring	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
Overall, I am satisfied with the ease of completing this task	1 (3.3%)	2 (6.7%)	2 (6.7%)	13 (43.3%)	12 (40.0%)
Overall, I am satisfied with the amount of time it took complete this task.	_	3 (10.0%)	1 (3.3%)	14 (46.7%)	12 (40.0%)

Table 4. The Usefulness of Mobile App for Senior Citizen Health Monitoring

Usefulness of Mobile App for Senior Citizen Health Monitoring	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
1. Mobile App for Senior Citizen Health Monitoring has all the useful function.	_	2 (6.7%)	6 (20.0%)	12 (40.0%)	10 (33.3%)
2. Mobile App for Senior Citizen Health Monitoring meets my needs.	_	2 (6.7%)	2 (6.7%)	15 (50.0%)	11 (36.7%)
3. It is easy to navigate through this application.	1 (3.3%)	_	3 (10.0%)	11 (36.7%)	15 (50.0%)
4. I feel comfortable using this application.	_	2 (6.7%)	4 (13.3%)	10 33.3%)	14 (46.7%)
5. I can understand the flow of this application.	1 (3.3%)	1 (3.3%)	4 13.3%)	10 (33.3%)	14 (46.7%)
6. The interface of this application is pleasant.	_	2 (6.7%)	3 (10.0%)	13 (43.3%)	12 (40.0%)
7. The information provide is easy to understand.	_	1 (3.3%)	5 16.7%)	9 (30.0%)	15 (50.0%)
8. I need time to understand how this application works	2 (6.7%)	4 (13.3%)	7 23.3%)	9 (30.0%)	8 (26.7%)
9. This application is complicated.	6 (20.0%)	6 (20.0%)	7 (23.3%)	9 (30.0%)	2 (6.7%)
10. Overall, this application is very useful.	1 (3.3%)	1 (3.3%)	3 (10.0%)	13 (43.3%)	12 (40.0%)

Table 5. The Ease of Use of Mobile App for Senior Citizen Health Monitoring

Ease of Use of Mobile App for Senior Citizen Health Monitoring	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
1. Mobile App for Senior Citizen Health Monitoring is easy to use.	_	2 (6.7%)	4 (13.3%)	11 (36.7%)	13 (43.3%)
2. This application is user friendly.	_	1 (3.3%)	6 (20.0%)	11 (36.7%)	12 (40.0%)
3. It is easy to learn how to use this application	1 (3.3%)	1 (3.3%)	3 10.0%)	12 (40.0%)	13 (43.3%)
4. I can easily remember how to use this application.	1 (3.3%)	1 (3.3%)	2 (6.7%)	13 (43.3%)	13 (43.3%)
5. It is not complicated to use this application.	_	1 (3.3%)	5 (16.7%)	13 (43.3%)	11 (36.7%)
6. The functions of this application are well-organized.	1 (3.3%)	_	3 (10.0%)	15 (50.0%)	11 (36.7%)
7. I need time to understand how this application works	2 (6.7%)	5 (16.7%)	6 (20.0%)	10 (33.3%)	7 (23.3%)
8. I need help from other people to be able to use this application.	8 (26.7%)	7 (23.3%)	3 (10.0%)	8 26.7%)	4 (13.3%)

Table 6. The Satisfaction of Mobile App for Senior Citizen Health Monitoring

Satisfaction of Mobile App for Senior Citizen Health Monitoring	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
1. Mobile App for Senior Citizen Health Monitoring is easy to use.	_	1 (3.3%)	6 20.0%)	10 (33.3%)	13 (43.3%)
2. I will continue using Mobile App for Senior Citizen Health Monitoring in future.	_	1 (3.3%)	6 20.0%)	13 (43.3%)	10 (33.3%)
3. I would recommend Mobile App for Senior Citizen Health Monitoring to my friend.	1 (3.3%)	1 (3.3%)	7 (23.3%)	10 33.3%)	11 (36.7%)
4. I believe this application is beneficial.	1 (3.3%)	_	1 (3.3%)	10 (33.3%)	18 (60.0%)
5. Overall, I am satisfied with this application.	1 (3.3%)	_	2 (6.7%)	13 (43.3%)	14 (46.7%)

6. Conclusion and Future Works

This paper describes the development process of Mobile App for Senior Citizen Health Monitoring. The proposed project intended to provide a mobile application for senior citizen to monitor their own health. It acts as the personal health system that record their health condition daily.

It undeniable that it is quite challenging for the senior citizen to use this application as they did not have this technology back in their days. Some of them might be able to use it on their own but most of them are not familiar with the use of mobile device and need guide from their family member. These are the limitation from this project. However, it is not possible for them to use it with the guide and support from the family member.

There is certain aspect of this project that needs enhancement. The application could be more useful if the reminder feature function well. Other than that, the user interface needs to redesign so it could help the elderly use the smartphone effectively. For input for date and time could use a picker instead of a textbox to make more interactive. In future, this application could be extended by implementing the sensor technology to detect movement of the senior citizen in case of emergency.

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