A MOBILE APPLICATION FOR ANXIETY DISORDER TEST USING HRV

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A project report submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering (Hons.) Software Engineering

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DECLARATION

I hereby declare that this project report is based on my original work except for citations and quotations which have been duly acknowledged. I also declare that it has not been previously and concurrently submitted for any other degree or award at UTAR or other institutions.

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APPROVAL FOR SUBMISSION

I certify that this project report entitled "**A Mobile Application for Anxiety Disorders using HRV**" was prepared **Ong Ming Chen** has met the required standard for submission in partial fulfilment of the requirements for the award of Bachelor of Science (Hons.) Software Engineering at Universiti Tunku Abdul Rahman.

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ABSTRACT

Stress are one of the most common issue that are facing by most of the people especially students and also employees. Strong competitive in between human beings are getting more and more significant right now, as number of human beings are increasing every day, while there are limited resources for those who are capable to participate in these intense competition.

For anxiety disorder, it is a condition where the patient will be experience this kind of issue where they are persistent and also excessive worry. Anxiety disorders can take in many forms, like fear, stress, panic and etc. But anxiety disorders are treatable and there are number of effective treatments that are already in the medication field. This treatments had already proven that it can resolve the anxiety disorders issue of a patient.

The main purpose of this project is to help whoever that need the instant solution to detect and also resolve their anxiety disorder issue like stress at the shortest time, cheapest cost and also convenient for them. This will benefit the user a lot without costing them much.

The implementation of this project are using the camera and also the flashlight around the camera to detect the user's pulse, then determine the HRV from user's pulse and show their stress level. Moreover, user stress data will also be send back to the server automatically for future reference, and this is to improve the accuracy of the stress data for future development.

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CHAPTER 1

INTRODUCTION

1.1   Background

Anxiety is a natural condition as every one of us will be facing even for a children. Anxiety is the evolution of the fight/flight response that we had experienced and our mind will designed specifically to warn you that there may have a danger present and make sure that we are prepare to react to whatever that may harm us. So, a normal anxiety is a total normal condition for a normal people for the self-protection purpose.

But sometimes, the over concern in certain things will resulting in anxiety disorder. This will causing the victim experiencing a significant distress even when there is no danger present. Anxiety disorder will bring a huge stress in term of physical as well as in their mental condition.

There are few signs which are the symptoms of anxiety disorder. Signs like irritability, edginess, muscle tension/ aches, insomnia and easy fatigue are the most significant sign showing that a particular person may facing an anxiety disorder. Most of the anxiety disorder person are unable to relax themselves and may even facing some communication difficulty with people. Anxiety disorder can be caused by the genetics problem of a person. People which have close relative like parents that have the anxiety disorder condition have the five times higher chances than people without it to develop anxiety disorder. Sometimes bad experience of a people may also cause anxiety disorder (Simpson et al. 2010).

Stress is one of the most serious sign in anxiety disorder and due to stress issue that people facing are getting more and more frequent, hence, in my project, I will be using the smartphone and develop an mobile application for the Stress test and provide series of attention trainings that may able to lower the Stress level. This stress test will be operate using the camera device that provided on the smartphone by collecting the pulse rate and use Heart Rate Variability (HRV) to display the stress level that the user are currently

experience (Guede-Fernandez, Ferrer-Mileo and Ramos-Castro 2015). The stress level of a user will be display in an animation image as well as in a form of graph. For example, during the measurement phase, the user's heart beating will be shown as a video which have bright and shaded red that indicate the heartbeat.

Before the stress measurement using Smartphone camera and flashlight, user can make choice which is to measure together will the questionnaire for a more accurate data or straight proceed to camera stress measurement. Questionnaire was prepared based on the Perceived Stress Scale (PSS) (Cohen et al. 1983), where marks will be given on each of the question.

Afterward, there will be a series of attention trainings will be provided for the user to take the training. After the training is completed, then the stress test will have to be conducted again to check whether there is any decreasing in user's stress level or not, then user will have to redo the stress measurement again after the training is done. This purpose is to get a better stress result by comparing stress level before and after attention training. For the training, it will be provided in the form of meditation audio (Beller 2008) and deep breathing video. This training will be provided once the first stress test is completed. At last, the stress result will then be gather and feedback to the server automatically after the whole stress process (stress test then attention training, then stress test again and lastly view the result).

1.2   Problem Statement

For my stress level detection mobile apps are targeting adult user which are in the age group of 15-50 years old and above. This age group have the highest population that are having the anxiety disorder due to the heavy responsibility in term of work, money as well as job stability. This heavy responsibility can be known as their main concerns that forcing them to have such huge amount of stress on their lives.

For those who are around 15-30 years old can be known as the group of age that are having the highest stress level, as it is the age of learning and the start of their career life. Some of them may have to study and at the same time worrying about the financial problem so that they can cope with their studying environment. While some of them who didn't not have the study responsibility may have the desire to start their own business at hence may have the huge stress level as well.

Teenagers and Adults group (15 – 50 years old and above)

- 15 – 30 years old are in the pursuing their highest education level like Diploma, Degree, Master and etc. Some of them are trying to startup their career.
- 31 – 40 years old have a lot of problem in startup family as well as their career issues
- 41 – 50 years old and above may have to maintain their business and some of them may have struggle with their children education financial issues. (Jinho et al. 2007)

Furthermore, user not only seeking for anxiety disorder testing equipment only, but also required some activities to help them solve their anxiety disorder if they have it.

1. Stress faced by different age group of people.
2. People are seeking some solutions that may help them decrease their anxiety disorder problem.
3. People are seeking for the easiest and fastest way to check their current stress status

1.3 Scope

1.3.1 Deliverables

This project is to develop a mobile application that are able to connect with the smartphone camera, and then detect the pulse from the user's finger. Frame of video from the camera will be analyze as the detection of pulse. This pulse will be used to analyze and display the stress level of user. This mobile application also have contain a series of attention trainings like audio, music or games that will used as stress release tools, but currently, the mobile application attention training will be using Deep Breathing Video. This mobile application also will gather the stress data and return back to us from future reference.

1.3.2 Modules

1. Registration and login for user
   a. User will have to register if they are the first-time user, and then will have to login in in order to use the mobile application

2. To enable connection of mobile application with the camera on the smartphone, then use Smartphone Application Frame Processing to process (Guede-Fernandez, Ferrer-Mileo and Ramos-Castro 2015).
   a. Smartphone Application Frame Processing to process the frames gather using camera
   b. Display the heart rate from the frames.
   c. Display the stress level based on the heart rate.

3. Include attention trainings in the mobile application to use by the user
   a. Provide deep breathing attention training video

4. Review back the stress level history of user
   a. User can check back their stress level on particular time and day at the history activity.

5. Stress Data management
   a. Gather the stress level data of the user for future reference

1.4   Objectives

1. To study the use of existing camera on smartphone to detect the pulse from user's finger, and the pulse that will be used to detect the user stress level.

2. To provide series of attention trainings in the mobile app to show user decrease in their stress level.

3. To develop a mobile application that will display the stress level gathered using animated image.

4. To develop a mobile application that will be managing the stress data for future reference.

1.5   Justification

This mobile application can let the user check on their stress level anywhere, anytime, which provide a huge convenience to the user. Hence, it will be able to help user to save their time from keep on concerning on how is their stress level. At the same time, it also can have other usage like enable heart attack disease, high blood pressure patients to keep update about their stress level, as well as updating on their heart condition from the pulse.

Next, with the help of this mobile application, user may able to decrease their stress level through two kind of attention trainings video. And also it may help user to refresh themselves and increase their working effectiveness.

1.6   Proposed Solution

From the mobile application that will going to be develop, it should be able to helps those user that are eager to know their stress status at a quick way, as this mobile application no need any internet connection while taking the stress measurement and can be conducted at any environment. With this mobile application, user also no need to pay extra medication fees and can instantly know the stress result.

Next, if user know that they are currently facing stress issue, then they may seek for some solutions to solve their stress level. Hence, there will be two deep breathing attention training videos to be provided right after the stress measurement is done. The attention trainings provided might have the opportunity to help the user decrease their stress level.

After the stress measurement is done, then it will move to listing view to display the history of the stress level before and after attention training, and at the same time, the stress level of the user will be store as well in the server for further reference by admin. This feedback is to help us to improve the attention trainings provided, gather stress level for research purposes as well as improve overall of the mobile application.

CHAPTER 2

LITERATURE REVIEW

2.1   Introduction

Stress is one of the most concerning issue by all the people right now. With the increase in population of human beings, competition in between peoples are getting more and more intense in order to get a better lifestyle. But most of the people does not have the time or even strong financial support to keep seeking for solution from the professional medication treatment to deal with their stress issue. Hence, people require some stress detection device which are convenience as well as portable, so that they can measure their stress anytime anywhere and also try to decrease their stress level if they have to.

Currently, one of the most convenience and reliable way of making this kind of stress detection device are using the most common equipment that we had in our daily life which is the Smartphone. Smartphone have multiple hardware as well as detector contain inside it which can benefit user by providing convenience. Stress level of a user can be detected using the Heart Rate Variability (HRV) which is the change in the time intervals in between adjacent heartbeats, which is related to the efficiency and health of the body regulatory systems (H.M. et al. 2004). Stress acts directly on the autonomic nervous system, where if the autonomic nervous system is in a good condition, then the HRV will be higher and if it is not in good condition which mean is in stress, then HRV will be lower. Hence, HRV should be a good biomarker for stress.
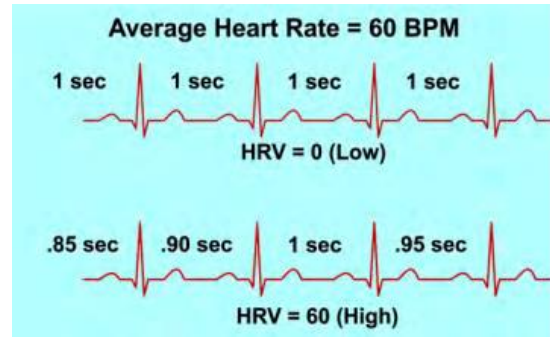
Figure 2.1 HRV figure

For the high HRV, the interval time between adjacent heartbeat are not the same while for low HRV the interval time between adjacent heartbeat are consistent, but with people with high HRV are tend to be more flexible, where he are more capable of dealing with the stress that he should handle (H.M. et al. 2004).

For HRV, there are several way of measuring HRV, such as Interbeat Interval (IBI), Standard deviation of normal-to-normal intervals (SDNN) and etc (Nunan et al. 2010). During the stress measurement of this mobile application, there will be two methods that will be using to calculate HRV which is IBI and SDNN. IBI is the time of interval between each two beats, while SDNN will be using the IBI collected and calculate the standard deviation of the time interval between two peak beats. The standard time-domain of SDNN measurement will be around 5 minutes (Nunan et al. 2010), but due to the inefficient of time-domain, the reduction of time-domain to 2 minutes were recommended for mobile application, and the difference in between result of 5 minutes and 2 minutes gather are respectively the same.

$$\text{SDNN} = \sqrt{\frac{1}{N-1}\sum_{j=1}^{N}(\text{RR}_j - \overline{\text{RR}})^2}$$

Figure 2.2 SDNN formula

There are stress detection or similar mobile application that had been developed and can be found on the google play store where these mobile application also using the camera as well as the LED flashlight on the mobile device to detect the pulse rate of the user either to display heartbeat or detect stress level as well.

2.2 **Existing similar mobile application**

2.2.1 **SweetBeat HRV**

The SweetBeat HRV is one of the mobile application that had been developed by SweetWater Health organization. SweetBeat HRV will be providing the real-time monitoring using state-of-the-art sensor technology and data correlation algorithms. SweetBeat HRV correlates with metrics like HRV, stress, heart rate and etc, where it have a like monitor/relax feature. In the monitor/relax feature, the monitor allow the users to choose what sessions they would like to take: Heart Rate Recovery, Stress monitoring or HRV for training. And we will be focusing on the Stress monitoring session, which have the interface like this:

Figure 2.3 - Screenshot of SweetBean HRV stress detector

This figure is in the iOS operating system version. SweetBeat HRV are currently more stable in iOS operating system compare to Android version. In the Stress monitor, user can see their stress levels in the real time, and give them the chance to take action that may help them to reduce their stress level. Hence, in SweetBeat HRV will be providing an activity where it will providing training in deep breathing that includes calming images as well.

Other features is that SweetBeat HRV allow users to save and upload their sessions to their BeatHealth. Account.

2.2.2   Stress Check by Azumio
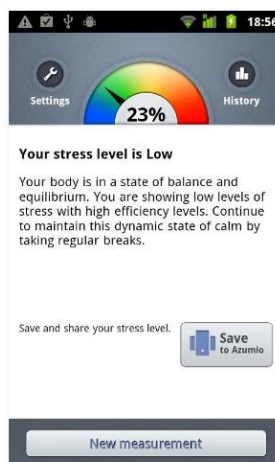
Figure 2.4 - Screenshot of Stress Check by Azumio

Figure above is the interface of Stress Check by Azumio application that displaying the result of the stress level. In the mobile application, user will have to insert their gender as well as their age. Afterward, user can start the testing by click the play button and placing their finger at the camera, and this process will take up to 2 minutes to complete. After 2 minutes, it will display the stress level as shown on above figure.

In this mobile application it is also using the heart rate variability (HRV) method to estimate the user level of stress. The analysis of HRV will requires the heart pulse data to be measured continuously for a certain period of time, hence the result will be getting more and more accurate as the time of using this application more frequently.

The algorithms that are used to analyze the HRV for this mobile application are following the recommendations of the European Society of Cardiology (ESC) and the North American Society of Pacing and Electrophysiology (NASPE).

The concept is that when heart beats blood and oxygen to whole body, where the oxygen will be rich in the blood at that moment. The rich oxygen contents will absorb more light which may show a darker frame of the video at that moment. This is very similar with the medical pulse oximetry that are used in the professional medication field.

2.2.3   Instant Heart rate

Figure 2.5 - Screenshot of Instant Heart Rate

Instant Heart Rate which are one of the heart rate detector mobile application that have the best rating in the Google Play Store, this is because Instant Heart Rate can provide a very accurate Heart Rate without using any external hardware.

It also using the concept of placing the finger tip on the mobile camera with LED light, and then after several seconds, then the user's heart rate will be shown, and a real-time chart will also be shown at the same time. Finger under the LED light will dime and bright which is due to the heartbeat the pam the blood to the blood capillary on the finger tip.

Then the analysis of the heartbeat will be done based on the frames of bright and dime on the finger tip that had been recorded through the camera on mobile phone.

It is using the same technique as the medical pulse oximetry. But it does not use the HRV methods which is calculate the interval time between two adjacent heartbeats, but give an instantaneous measurement of the heart rate.

2.3　　　Technology Involved

The mobile application will be using several technologies for it to achieve the main functionalities. The technologies involved are SQLite which is the mobile database engine that used to store the user stress raw data in their phone, next is the Android mobile operating system.

2.3.1　Mobile Database Engine

Why do we need mobile database engine for this project? It is because there are more and more mobile application need data in order to do some actions, and databases are needed in order to store the data. Moreover, in this project, there have a situation where the mobile database engine are needed, which are store the stress level records, and also the stress data feedback to the server for future reference.

Hence, embeddable databases will be used, as embeddable databases are lightweight, and also self-contained that no need to link with server. With this, mobile application can choose either to store data on local device or store at the cloud server.

There are several database engine that we had to compare and choose the best of it to use in this project, which is BerkeleyDB, CouchbaseLite, LevelDB, SQLite and UnQLite (Roukounaki 2014).

Database	Type of data stored	License	Supported platforms
BerkeleyDB	relational, objects, key-value pairs, documents	AGPL 3.0	Android, iOS
Couchbase Lite	documents	Apache 2.0	Android, iOS
LevelDB	key-value pairs	New BSD	Android, iOS
SQLite	relational	Public Domain	Android, iOS, Windows Phone, Blackberry
UnQLite	key-value pairs, documents	BSD 2-Clause	Android, iOS, Windows Phone

Table 2-1 Mobile Database Engine table (Roukounaki 2014)

2.3.1.1 BerkeleyDB

BerkeleyDB can be known as the database that can store most type of the data compare to the other four databases. It contain the most common relational database using SQL, also have key-value pairs and also have the documents based database type. For BerkeleyDB it supports both in-memory and also on-disk databases

Another feature that BerkeleyDB have is that it is compatible with SQLite with the SQL API contain in BerkeleyDB, hence, SQLite applications are no need to be rewrite when they use BerkeleyDB as the underlying storage engine, and can be completed just by connect them to the suitable BerkeleyDB library.

But there are some disadvantage on BerkeleyDB which is Berkeley DB are known as the heavyweight solutions, but for mobile application are more suitable to be used on the lightweight database, therefore, BerkeleyDB are not recommended unless that there are features that the mobile application are needed.

2.3.1.2   Couchbase Lite

Couchbase Lite is a document based database where the data will be stored in JSON format. Couchbase Lite supports the persistent indices which is also known as views and also using map-reduce to manage and query them.

Couchbase Mobile which was introduced by Couchbase where Couchbase Lite, Couchbase Sync Gateway and also Couchbase Server are cooperate together and be as the components of the NoSQL JSON mobile database solution. Couchbase Mobile have a built-in synchronization system using Couchbase Sync Gateway, where it will be in between the local databases known as Couchbase Lite and databases in cloud known as Couchbase Server. This had enabled the developers to sync their code so that they can have backup or even more convenience for them to retrieve their code.

Since Couchbase Lite are storing data in the form of JSON, but in my project, there are no need of storing my data in JSON format. It is because JSON format type of data are mostly used for the purpose of API, but in my project there are no need of doing any API for my mobile application.

2.3.1.3 LevelDB

For LevelDB, it is an open-source library which are using key-value type of database type to store the database. Keys and values are in the byte arrays form, where data will be stored by assigning a key to it. This key can be used for the purpose of sorting and labelling, and this sorting are the main feature that distinguish LevelDB with other similar embedded data storage database. Next, LevelDB are written in C++, hence it can be used directly in iOS mobile application as iOS are using C++ language. But for the Android developers, then LevelDB can only be used via JNI and NDK.

But there is one limitation on LevelDB which is that there are only one process that can have access to a specific database at a time.

2.3.1.4 UnQLite

UnQLite are open-source database that are using key-value and document based database type, where it supports in both in-memory and on-disk databases, transactions, multiple concurrent readers, and also cursors for linear traversal.

UnQLite are not NoSQL type database but instead it have some similarity SQLite, where UnQLite are also using cross-platform format to store database in a single file on disk.

UnQLite is written in C and hence, it can be used for both the iOS and Android mobile application as well.

2.3.1.5 SQLite

SQLite is a library that are on itself which are serverless and are transactional SQL database engine. The main reason of using SQLite mobile database engine in my project is basically it is in public domain which mean that it is free to be used in any purpose. SQLite which can be known through its name, which it is using SQL database engine, the only reason it is different with other SQL databases is because it does not have a separate server process. For SQLite, it can reads and writes straight to the disk files on the device itself. Due to it can reads and writes on the disk files itself, hence, most of the memory constrained device like mobile phone are using SQLite as the database engine (SQLite n.d).

In this database, there are few data that need to be store which is the stress data and profile data. In the stress data, the data will be recorded in integer form as the HRV will be shown in miliseconds. Moreover, there will be the stress status that had be analyze in the mobile application and stored it in the SQLite database in the form of string.

So in conclusion, SQLite will be the database engine to be used in my project.

2.3.2   Mobile Operating System

2.3.2.1 Android Mobile Operating System

Android is a mobile operating system developed by Google Company which that it is in Linux kernel. Android are basically designed for the devices that are using the touchscreen features like smartphone and tablets. Android's user interface are mainly using the direct manipulation which is touch gestures like swipe, tap drag and etc to interact with the objects on the screen (Wikipedia n.d). But currently, not only touch gesture that the android are emphasize only but also including the voice controlling as well.

There are so many brands of smartphone devices that are currently using android operating system, it is because android is an open source where it can provide technology company that require ready-made, low-cost and also customizable operating system for their devices.

As we can see from the market, Android Operating System can be known as the big giant in the mobile devices, it is because Android Operating System it is an open source that encouraging large community of developers to use it open source code as the basis for their community-driven projects.

In this project, the mobile application that are going to be develop will be support by the Android Kit-Kat 4.4.2 and above. As start most of the smartphone in the current market are at least at Android Kit-Kat 4.4.2.

2.3.2.2 IOS Mobile Operating System

iOS mobile operating system is one of the strongest competitor of Android. iOS mobile operating system is created and developed by the Apple Inc, and iOS mobile operating system only be able to use on the Apple product hardware unlike Android where almost most of the smartphone devices are using it. iOS are similar like Android which are using the concept of direct manipulation where also using drag, slide, swipe, tap and etc (Wikipedia n.d).

Why iOS are one of the strong operating system on the market like Android? First of all, iOS are not an open source like the Android operating system, which mean that there are not many source that developers can refer to, Furthermore, iOS also require payment for most of the access and development for the mobile application for Apple device, hence there are lesser mobile application software compare to Android that develop by freelance developers (Wikipedia, n.d.). But this is not a big problem for the Apple iOS mobile operating system, instead, it bring a huge advantage for them as because of the close source of iOS operating system, Apple Store does not have the junk application as well as provide only clean mobile application. Most important is the security of the iOS mobile operating system are very good, as every installation will require the confirmation from the user, hence, user will know and deny the installation of software from unknown source.

2.3.2.3 The Verdict

It is an obvious choice for us to choose on the operating system in between iOS and Android platform. Android operating system are more suitable for this project due to few factors. First, it is free, where the development does not require any payment except when publish it on to the Google Play Store that require one-time payment. Moreover, Android can also be develop at any environment as well, any kind of computers that have sufficient spec, then it should be able to develop any

kind of the Android mobile application. And lastly, there are more users in the market that are using Android operating system devices compare to iOS operating system devices. Hence, this project should target on Android mobile application in order to get more reviews on it.

2.3.3   Number of devices in Market

From the statistics that had been done seen the year 2009, we can see that the global mobile OS market share are starting to dominate the market. By using the data from the year 2015 Q2 onward, we can see that android operating system are far too dominating the market share compare to other operating system like iOS, Microsoft, RIM and etc. This data can be clearly seen in the statistics and study performed by Gartner on the Global mobile OS market share in sales to end users from 1st quarter 2009 to 1st quarter 2016, as shown in the figure below:

Global mobile OS market share in sales to end users from 1st quarter 2009 to 1st quarter 2016

	Q1 '15
• Android	78.8%
• iOS	17.9%
• Microsoft	2.5%
• RIM	0.4%
• Other	0.5%
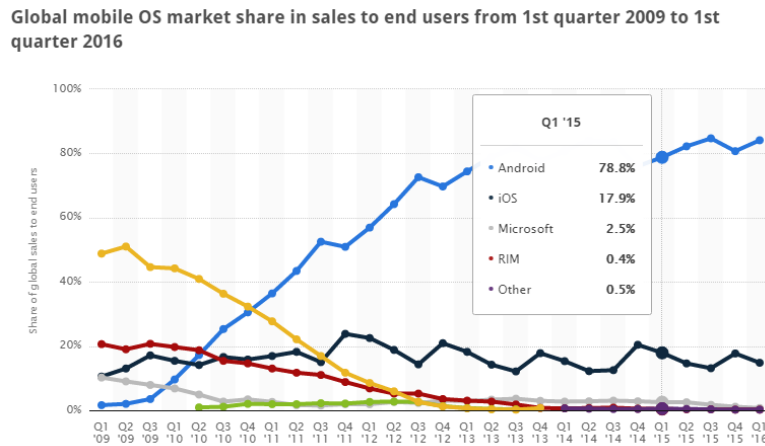
Figure 2.6 - Market share of mobile operating system from Q1' 15 to Q1' 16 (Statista, n.d).

Worldwide Smartphone Sales to End Users by Operating System in 1Q16 (Thousands of Units)

Operating System	1Q16 Units	1Q16 Market Share (%)	1Q15 Units	1Q15 Market Share (%)
Android	293,771.2	84.1	264,941.9	78.8
iOS	51,629.5	14.8	60,177.2	17.9
Windows	2,399.7	0.7	8,270.8	2.5
Blackberry	659.9	0.2	1,325.4	0.4
Others	791.1	0.2	1,582.5	0.5
Total	349,251.4	100.0	336,297.8	100.0

Table 2-2 Table of market share of mobile operating system from Q1' 15 to Q1' 16 (Gartner, 2016)

From this statistic we can see that the usage of Android based operating system devices (84.1% in year 1Q16) are far beyond than the number of any other based operating system mobile devices, (iOS 14.8%, Windows 0.7%, Blackberry 0.2%, others 0.2% in year 1Q16), hence this is one of the reason why this project are developing in Android operating system, as most of the users are using Android based operating system mobile devices.

2.3.4   Open source

For Android operating system, it is well known as the open source where encouraging all developers from any environment to have the ability to create their own mobile application with low or even zero development cost (Wikipedia n.d). And of course, due to this reason, Android are full of crowd created plugins and also frameworks that help to improve the way of developing Android mobile application. But this cannot be the same for iOS development, as the development require huge cost in term of development tools, and also publish fees as well.

2.3.5   Development Cost

Due to Android are the open source based, hence it can be develop on any kind of the operating system like Windows, Mac OS, Linux, and etc. While for iOS is a close open source which cannot be simply develop on any operating system, the only way of developing the iOS mobile application is using Mac OS which only run on the Apple product like Macbook or iMac, while the Apple product are not cheap in the market, the cheapest in the market also around RM 3000 and above, which are far more expensive than the usual computer or laptop of other brand which using other operating system.

Furthermore, when publishing the mobile application, for the Android mobile application have to be publish at the Google Play Store, and it only need the first-time payment which is around $25 before publishing the mobile application on the Google Play Store. While for the iOS mobile application, it will

have to be publish on the App Store which the requirement is to become the developer member that require to pay the member fees of around $99 per year. Therefore, iOS mobile application will have a higher development cost compare to Android mobile application.

2.4 Fact Finding

Fact finding is the process that are going to be used for the collection of data and information through several techniques like research, observation, questionnaires, interviews and prototyping. Fact finding is very effective to be used and deal against this project, as this project still have a lot of difficult and significant decision to be made with only limited and also conflict information. Hence these several fact finding techniques will be compared in this part in order to find the most suitable fact finding techniques for my project to gain sufficient requirement for it.

2.4.1 Research

There are currently have a lot of existing documents in the field that had been solved by the other professional researchers, hence, analyze on the existing documentation will short down the research time and at the same time collect the require data for the project. This information can be get through the database, reference books, case studies and also Internet (UKEssays n.d.).

a) **Advantages of Research**

Firstly, research that had been solved by the professional researchers can save the time of the new researchers to search on the similar field of the problems. Secondly, new researchers can gather different researches that had been solved by different researchers and make a better problem solutions by combining all of the solution.

b) **Disadvantages of Research**

Some of the research sources require authority access where payment will have to be made in order to get the appropriate source of information. Even though UTAR have provide us the authority to some of the research sources like IEEExplore, but there are still have numbers of research sources that UTAR are unable to provide the authority.

2.4.2   Interview

Interview are one of the most common fact finding technique that had been used to gather the information from all the related stakeholders. Interview provide the project a clear, verify facts, and also involved the stakeholders in the project. Moreover, interview can also allow the project to identify requirements, gather ideas and also gather opinion that are related to the project (UKEssays n.d.). There are two types of interviews: Unstructured interviews and structured interviews

i)   Unstructured Interview

Interview will be conducted with general goal in mind and also few specific questions, and it is a kind of open-ended question type, where interviewees can answer using their own answer freely.

ii)   Structured Interview

Interview will be conducted by providing a set of questions that are already predefined, and it is a close-ended questions type where interviewees can only answer using specify choices that are short and direct responses.

a) **Advantages of interview**

With the involvement of stakeholders through interview, it can increase the certainty of the project requirements, and also get a better quality of the responding from the interviewees. Moreover, interviewers can also prepare questions for the interviewees based on their individual suitability.

b) **Disadvantages of interview**

Interview are time consuming and also costly fact-finding technique, and it also required the interviewer to have a strong communication skills in order to get a better result through interview.

2.4.3 Prototyping

Prototyping is another fact finding technique where a sample of small working model and it is also known as the pre-design of the project. Prototype will have to be develop at the early stage to show the stakeholders on the basic idea on how is the mobile application going to be work like when the actual mobile application are successfully been developed (UKEssays n.d.).

a) **Advantages of Prototyping**

Prototyping are able to be test and understand by the users as well as developers to know how is the system should be working before apply on the final implementation. Moreover, prototyping also allow developers to determine whether the development of the system is possible or not before applying high development costs on the system. Besides that prototyping also shorten the time spends on the fact finding.

b) **Disadvantages of Prototyping**

For prototyping, training for the developers will have to be done. Some of the users will thought that the prototype will be as the final product, where the performance, reliability and features of the prototype as the real results, hence, the developers will have to notice users that the prototype will be cover the functionality and interface in rough form, and it is not a complete system. Moreover, development cost and schedule may also been influenced by prototyping.

2.4.4 Questionnaires

Questionnaires can be said as the most common fact finding technique where almost all kind of project will require it as the fact finding. Questionnaires is a quantitative type of fact finding where it will collect information from large number of users, and users will have to fill up all kind of related questions to the project, and then developers will have to analyze those answered questionnaires and get the useful information to develop the useful a system (UKEssays n.d.).

i) Free-format questionnaires

User are allowed to answer the questions in the questionnaires freely with no limitation for some of the questions. Moreover, free-format questionnaires can learn about the feelings, opinions, as well as the experiences of the respondents.

ii) Fixed-format questionnaires

Fixed-format questionnaires is used to gather information for predefined questions, where there will be multiple-choice questions, rating questions or ranking questions.

a) **Advantages of Questionnaires**

People can fill in the answer freely on to the forms, and the cost for this fact finding is very cheap, where questionnaires can be publish using google form or printed paper. Moreover, in Questionnaires, respondents will not be publishing their personal information, and hence, respondents will be more willing to spend time doing questionnaires instead of interview.

b) **Disadvantages of Questionnaires**

Some of the respondents may be respond to the questions without appropriate answer and the body language of the respondents are unable to retrieve as well.

2.4.5 The Verdict

From the comparison of fact findings that stated on the above, using the advantages and disadvantages of each of the fact findings, I found out that Questionnaires, Prototyping and Research fact finding techniques are most suitable for my project which is A mobile application for anxiety disorder using HRV. Questionnaire are used to gather the information related to the anxiety disorder issues, while prototyping will be used to create a prototype of mobile application to show the functions and basic interface that will going to be developed. For Research fact finding techniques, I will be using it to understand all kind of questions that I'm facing during the process of the project.

2.5　System Development Methodology

2.5.1　Waterfall

Waterfall is the earliest introduced Software Development Life Cycle that was been used for the software development process during early of the software era. Waterfall model is a linear-sequential development model, where it is easy and simple to be understand and also easy to be use. Waterfall model is one phase link to another phase and each of this phase will have to be completed first before it go to the next phase (Tutorialspoint.com n.d.).

Figure 2.7 - Waterfall model

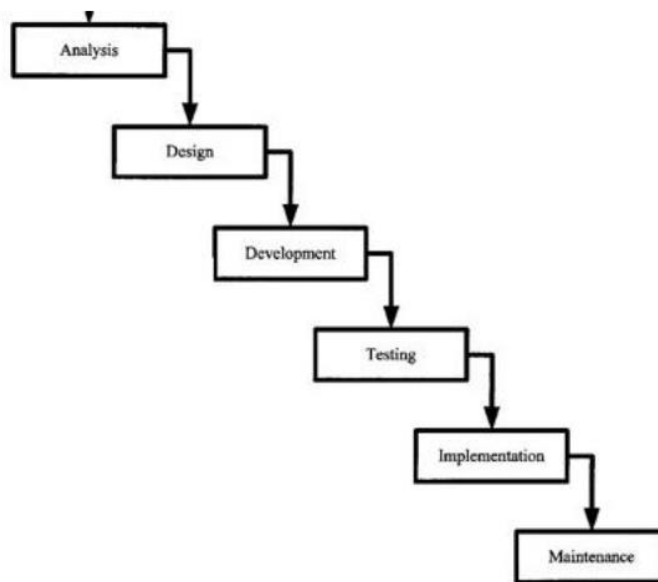In waterfall model there should not be any phases that are overlapping each other.

a) Requirement Gathering and analysis

　All the related requirements of the system will have to found at this phase and documented in the documentation.

b) System Design

　All the requirements that had been stated in the Requirement Gathering and Analysis phase will have to be studied in System Design phase and also

prepare the system design of the system. Specifying hardware, system requirements and also the overall system architecture will also be touch by the System Design phase.

c) Implementation

After System Design phase is completed, then will jump to this phase where there is a small programs known as units will be develop for the system first. Unit Testing will also been done during this stage after the units were done.

d) Integration and Testing

Units that are successfully been developed in the implementation phase will be integrated into a fully functional system, and then the entire system also will be tested for the faults and failures.

e) Deployment of system

At this phase, the system will be released to the real market after all the required functional and non-functional testing is done.

f) Maintenance

In this phase, it is to fix those issues that had been faced under the client environment, and this fix will be released in the form of patches. Moreover, new versions of product will be released as well.

<u>Advantages of Waterfall</u>

- Waterfall model is simple to be implement and require little amount of resources.
- High visibility, where output will be generated after every phases are completed.
- Work easily for small projects

<u>Disadvantages of Waterfall</u>

- Real projects are rarely using the sequential flow, and may cause confusions as the project proceeds.

- High risk and uncertainty as the project proceeds

- Not suitable for big and ongoing projects

- Not suitable for the project where the requirements that are set still may have the chance of changing it

- The picture of the actual system are hard to be visualize until the late phase

2.5.2 Agile Model

Agile model is a combination of iterative and incremental type of model where it is using practice-based methodology. There will be rapid delivery of the working software product for the customer to determine their satisfaction on the product. In the agile paradigm, every development process like requirement, design, implementation and etc will be keep on be revising throughout the lifecycle, but there should be a deadlines for the every iteration in the agile model (Tutorialspoint.com n.d.).

There are four Agile Manifesto principles (AgileMethodology.org, 2008):

a) Individuals and interactions

Self-motivation and development are very important during the agile development, as are interactions like co-location and pair programming.

b) Working Software

For the communication in between the customer with the developers are not just depending on the documentation only, but also demo the working software during the process phase to check whether the product are still within the customer's requirement or not.

c) Customer Collaboration

If there are not sufficient requirement gathered during the requirement phase, then the project will have to keep in touch with the customer to make sure the product meet their requirement.

d) Responding to change

Agile development is focused on the quick change responses and also continuous development with the changes that may need to apply.
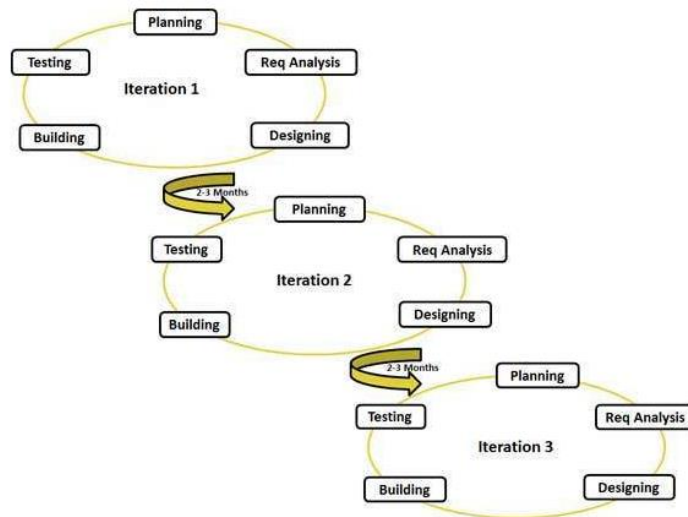
Figure 2.8 - Agile Model 1
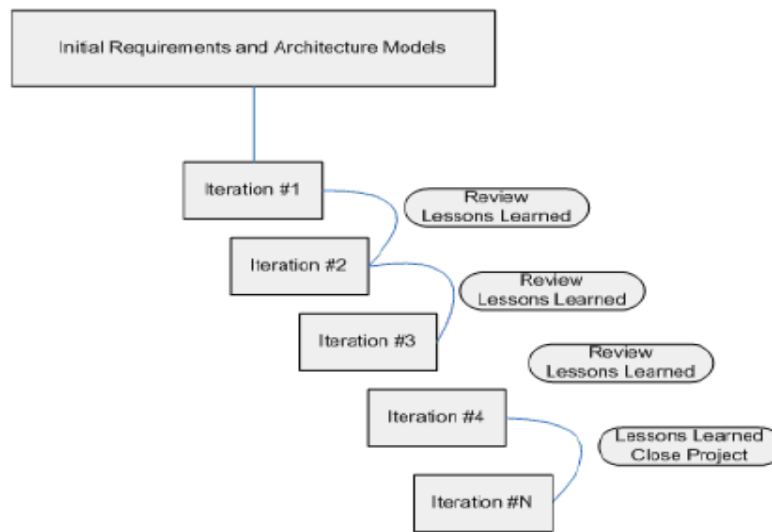
Figure 2.9 - Agile Model 2

Advantages of Agile

- Have the ability to quick respond to the changing of requirements of the project
- Since customers and development team will be involved during the development process, hence, it will prevent conflict on the product produced when final phase which is publish time.
- Minimum the resources of the requirements
- Focus on the teamwork and cross training

Disadvantages of Agile

- Profitable if use on small projects, but efforts and also time required to apply on the project will be difficult to be determine.
- Final decision can mostly made by the senior developers, where the new programmers will have lesser chance to participate in decision making.
- Depends heavily on the customer interaction, where the development team process will be influence if the customer does not have a clear target.
- Since there will be minimum generated in the agile model, hence, there will be a very high dependency

2.5.3 Prototype Model

Software prototyping mean build a software application prototypes which will display the functionality of the product during the development process, but it is not actually to full functions of the actual software application, but just a brief idea on how the product will be work. Moreover, prototyping model also be able to improve the calculation of risks and costs of the project as well.

For prototyping model, it will help the developers in understanding on the customer requirements and by getting feedback from customer through the prototype that had been developed. There are horizontal prototyping which is specific layers of the system like user interface will be built only, while for vertical prototyping is chosen part of the target system will be implement through all the layers (Lichter, Schneider-Hufschmidt,and Zullighoven 1993).

There are 4 approach to design a software prototype:

a) Basic Requirement Identification

This approach is to get the requirement and understand it. During this stage, there will be more focusing on the user interface than those intricate details like performance, security and etc.

b) Developing initial Prototype

The basic user interface that met the basic requirements will be developed at this stage, but this is just a user interface where the features may not be as the actual software that will be developed.

c) Review of Prototype

Present the developed prototype to the customer and stakeholders related to the project, and then get the feedback that should improve the quality of the product that will be developed.

d) Revise and enhance the Prototype

All the feedback and opinion that had been gather during the review approach will be used in this stage, and negotiation with customer can also be conducted during this stage. Then an improved version of prototype will be developed and back to the review stage again. This process will be conduct again and again until it met the customer satisfaction.

There are 3 types of software prototype types which is Rapid Prototyping, Evolutionary Prototyping and Incremental Prototyping

a) Rapid Prototyping

Prototype will be built rapidly until the actual requirement are understood, then only the prototype will be discard and build the actual software application that are stated in the user requirement.

b) Evolutionary Prototyping

An actual functional prototypes will be built with minimal functionality at the beginning. It is a continuous process to adapt the application system in order to rapidly change the organizational constraints.

c) Incremental Prototyping

Multiple functional prototypes of that had been partition into subsystems that then will be integrate all the suitable prototypes to form a complete system.

<u>Advantages of Prototyping</u>

- Increase the involvement of user in the product in the development phase.
- Enable user to have a better understanding on how the software application that are going to be developed will be look like.
- Reduce the time and cost due to the defects can be detected at the early stage.
- Enhance the software application from the feedback of user after testing on the prototype

<u>Disadvantages of Prototyping</u>

- User may get confused with the prototypes and actual software application that are going to be developed.
- The scope of the project may be expand which is beyond from the original planned project.
- Too many effort may be wasted on developing the prototypes.

2.5.4   The Verdict

The Waterfall model are following a strict structure which that every phases like Requirement Gathering phase, Design phase, Implementation phase, Testing phase, Deployment phase and Maintenance phase will required the previous phase to be complete first and then the previous phase will provide the input for the next phase. It is a heavy process as it require a strong goals as well as have a complete planning. Moreover, Waterfall model are not flexible with the changing of requirements, and the rework of all phases will have to be conduct if there are any unfortunate mistakes that had been taken during the requirement phase. Because of this reason, hence, Waterfall model will not be used in this project, as there are still have uncertainty in the requirement of this project.

For Agile model, it is more people heavy instead of process heavy like Waterfall. Every phase there will be a deadline, and there will be a group of experts that will be working on the software application. Hence, each experts will have to deliver the works that had been assigned to them in before the deadline. Moreover, clients of the project may have to attend the meetings frequently to keep update the software progress with the clients. But agile model are not emphasizes on the documentation, instead it is focusing on the solution that had been delivered by the developers in minimal time frame. From here, we can see that agile model are focusing on resolving the problems immediately, hence, it should not be suitable for my project as well.

For Prototyping model, it should be suitable for both the stakeholders and also the developers that are still stuck on creating a clear requirements of the project, therefore, by creating the initial prototype may inspire or help the clients to get a better and clearer requirements for the project. Moreover, it can adapt to the changes of the requirements during the process of the developing as well.

For conclusion, I conclude that I will be using Prototyping model for my system developing methodology, as I think that the pros and cons that I had stated above should be match for the development of Mobile Application for Anxiety Disorder using HRV. There are still have some uncertainty in requirements for the project, hence, by using

prototyping, it may help me to have a get a better requirements and also help my stakeholders understand on how the basic of the software application that are going to be create at the end.

2.6   Heart rate with Mobile Camera

Pulse will be generated once a sudden burst of blood to the circulatory system when the wall of heart contracted. There are currently have multiple devices that are exist in the market for the use of detecting the heart rate pulse. But there is a concept of Photo plethysmography (PPG) where it will used to estimate the heart rate, and this concept can be achieve by using most of the smartphones that are currently in the market, but it need to have camera and flashlight around the camera (Chandrasekaran 2010).

2.6.1   Methods

Whenever there is a heartbeat occur, then there will be a rush of blood into the vessels as well as the blood capillaries on the finger-tips. When the amount of blood are rich in the blood capillaries of the finger-tips, then more light will be absorbed by the blood when the flashlight on the smartphone applied on the finger-tips. When the light were absorbed, then there will be lower reflective index and have darker frame intensities (Chandrasekaran 2010).
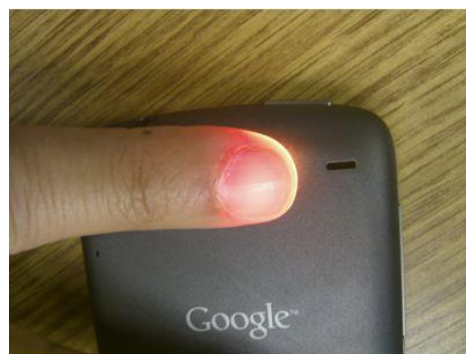
Figure 2.10 - Light transmitted through finger-tip (Chandrasekaran 2010)

When there are lesser blood amount in the blood capillaries, then there will be lesser light that will be absorbed and more light will be getting reflected which leading to the brighter frames. With this changes in the intensity of the light that are passing through the finger can generate a pattern of waves which are similar to a pulse. And these can be refer as the heart rate of a person (Chandrasekaran 2010).
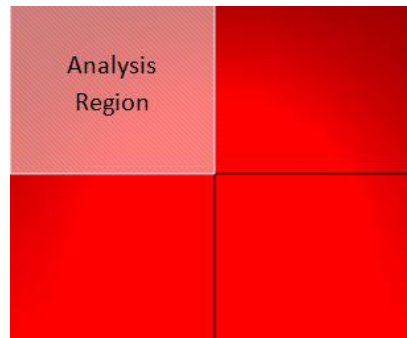
Figure 2.11 - Analysis region on the light intensity gathered (Chandrasekaran 2010)

The figure above is one of the frame that were captured during the video recording with flashlight on. From this frame, select an analysis region and determine the change of intensity of light on the frame. From the frame, we can determine that there are only red color in the frame, and hence there are only going to determine the difference in the red channel intensity of the pixel information. To get a better accuracy result, user should be holding their finger on the camera lens for longer time, and with a gentle strength apply on the camera lens as well.

CHAPTER 3

REQUIREMENT SPECIFICATION

3.1   Requirement Gathering Technique

For my requirement gathering, I will be using Questionnaires as my technique to gather requirement for my project which is A mobile application for anxiety disorder using HRV. And the questionnaire will then be gather and analyze the responses from respondents after published for one month. This respondents respond will be categorize depending on the age group which is 15-30 years old, 31-40 years old and 41-50 years old or above.

3.2   User Requirement

Mobile application for anxiety disorder using HRV are publish to any kind of the user and have no limitation to anyone. But in my project, I will be focusing based on the age group, as different age group of people will have different kind of the stress level depending on what environment are they facing.

3.3 Functional Requirements

Functional requirements will be denotes on the features, functions and also the usage of the mobile application from the perspective of the product and also user. The functional requirements for project Mobile application for anxiety disorders using HRV is:-

a) Application must be store the stress data of different account on the same device.
b) Application must be able to control the mobile device's camera and flashlight beside camera.
c) Application need to be determine the user's stress level using HRV through combination of camera and flashlight
d) Application should be able to display animation during the measurement phase.
e) Application need to have series of attention trainings like video, audio or mini games which are stress relieve related.
f) Application should have a records of user's stress data for history display
g) Application should be able to display and let the user edit their profile details
h) Application should be able to return user's stress data back to the server automatically.

3.4 Non - Functional Requirements

Non – functional requirement are defined as the requirements which specifies how will the system performs a certain function. On the other words is that non-functional requirement will be describing on how will a system as well as the limits of a specific function.

a) Application should be able to let first time user to register an account for the mobile application

b) Application should be able to calculate the HRV and determine the user's stress level in around 2 minutes.

c) Application need to be run on the Android platform version Kit-Kat 4.4 and above

d) Application need to have a smartphone device that have both camera and flashlight side by side.

e) Application will need to connect to any internet connection for the stress level raw data to send back to the server.

CHAPTER 4

METHODOLOGY

4.1   Prototyping

4.1.1   Applications of Prototyping

a) Requirement Gathering phase

There are studies and analysis that are performed before the confirmation and approval of this proposed project, where the details and data required has been gathered through fact finding. This data gathered through fact finding had been analyzed and produced the accurate and comprehensive functional as well as non-functional requirements for this project. Moreover, research on the project related articles or conference paper had been done during the process of gather requirement, in order to get the information that are required for the development of the mobile application.

b) Quick design phase

The design for the project had started once the analysis for the requirement gathering phase had been done. And then from the functional and non-functional requirement that were produced based on the analysis of the requirement gathering, then design the user interface that were fulfilled the requirement. After that, from the user interface designed, create a simple prototype with user interface interaction only.

This phase will be refer back when there are changes to be implemented on user interface or functionalities of the system. Most of the time this phase will be refer back after each iteration of evaluation with the stakeholders or customers had been done.

c) Building prototype phase

This is the development of prototype phase for this project based on the basis design that had been done on the previous stage. Android studio will be used for the development of the prototype application. The prototype should consists of basic core functionalities and the user interface design will not be focused on this stage.

d) Customer evaluation phase

At this stage, the prototype that had been developed during previous stage will be tested by the end user after each time of the completion of the prototype development. User satisfaction as well as their behavior will be observed and recorded to analyze it and get a better understanding on user's requirement. Moreover, user's opinion on the project prototype also will be recorded in order to develop a better prototype in the next iteration or completed product.

e) Refining prototype phase

At this stage, from the feedback and reaction of user on the previous design prototype, then the prototype will be refined and readjust the functionalities as well as the user interface that are necessary. This phase is also a loop where the prototype will keep on be refine until it has been granted and approved by stakeholders and users.

f) Engineer product phase

This stage will only be executed once the prototype that previously design had been approved by the users and stakeholders. This is the final phase of development where the loop of designing will not be held on this stage. The enhanced version of prototype with better user interface design and functionalities will be develop. Before the deployment, then there will be a final user acceptance testing and if it is approved, then the documentation for the project will be done for the reference of the future maintenance of the product.

4.2   Research Methodology

4.2.1   Qualitative

Qualitative Research can be known as the primarily exploratory research, where it will used to get the understanding of reasons, opinions, and also motivations that are related to the project. By using qualitative research method, it may be able to help get insights into the problem, help inspire new ideas, and also hypotheses for potential quantitative research. This can be seem as the dive deeper into the problems, and also may be able to discover a new trends of product for the market. There are some common methodology which is focus group discussion, individual interviews, and observations, hence it can be known as using the data collection methods which are unstructured or semi-structured techniques. The sample size should be small, and the respondents should carefully selected, as there should have a limited quota of sample size for it (FoodRisc Resource Centre n.d).

4.2.2   Quantitative

Quantitative Research is the method where it will quantify the problem by generating a numerical data or some statistics. It will be used to quantify attitudes, behaviors, opinion and other variables through the responses from the respondents. The result should be generate through large number of sample. Quantitative Research uses measurable data to formulate facts and also uncover patterns in research. Compare to Qualitative data collection, Quantitative data collection seem to be more structured, and Quantitative data collection are using a form of surveys like paper surveys or online surveys (FoodRisc Resource Centre n.d).

4.2.3   Mix Methods

Mixed method research is the method where it will conducting the research that are involves in collecting, analyzing and integrating quantitative and also qualitative research method. For the mixed method can enable the researcher to gain the breadth and also the depth of understanding and corroboration that are related to the project itself (Susan 2011).

4.2.4   The Verdict

For my project, I will be using quantitative research methodology which is using questionnaires type of data collection to further understand and gather the require details for the project. There are several issues that cause me to use quantitative research methodology instead of quantitative and mixed research methodology which is the time issue, and also the cost issue, where for time, there are short time for preparation of the requirement phase and also don't have the cost that are going to use for interview, as it need to find for the related experts which have good experience in IT field. Hence, quantitative research methodology which are using quantitative methodology will be my choice.

CHAPTER 5

FACT FINDINGS

For this project, I had used questionnaires as my fact findings, and the results that had been published for one month were analyzed and compiled to get the required information for this project.

5.1 Number of Respondents

For this data collection, I had total 60 respondents that had responded to my questionnaires, and from this 60 respondents, out of 44 respondents (73.33%) are from age group 15-30 years old, and the other 16 respondents, 15 of them (25%) are from age group of 31-40 years old while the last one (1.67%) is on the age group 41-50 years old and above.

From the number of respondents, we can see that there are quite a lot of people are actually have some interests on the mobile application for anxiety disorder.

5.2 Current position and working salary

From the survey that I had done, I found out that there are large number of the respondents (50.8%) are currently working, and there are 45.8% of the respondents are currently students which are still pursuing their study instead of working. While there are only 1.7% of respondents that are currently don't have any position for their status, and also the other 1.7 % of respondents are working as the part timer. From here, we can see that there are most of the respondents are already working, while, there are only small amount of the respondents that are actually have the salary range of RM 6000 ++, and also 13.8 % of the respondents have the salary range of   RM 4000 – RM 5999. These two group of respondents will be consider as rich due to their high salary. Next, there are only 19% of the respondents are in the salary range of RM 2000-RM 3000, and most of them which is 55.2% of the respondents are only in the salary range of RM 0- RM 1999.
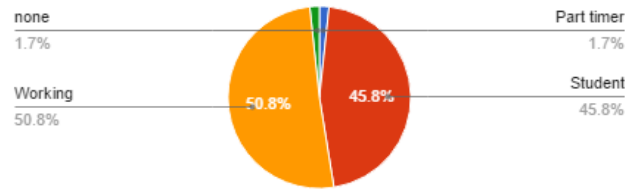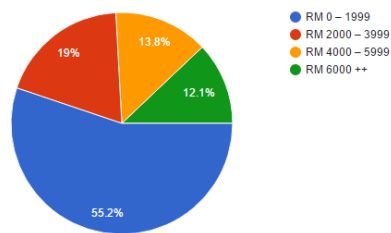
Figure 5.1 - Respondent current position

Figure 5.2 - Respondent salary range

Even though there are students in the salary range of RM 0 – RM 1999, but actually there are large number of respondents that are currently working and their salary are lower than RM 3999 and this can be consider medium low salary. Hence, this may bring anxiety disorder to those respondents who have low income especially those who are in the salary range of RM 0 –RM 1999 including students as well. This low income respondents may have the financial issue that they will have to deal with, especially during this moment where Malaysia have the serious economy crisis, which had cause inflation on most of the items.

5.3   Current position and working salary

From the age group, we found out that there are most of respondents are in the age group of 15-30 years old, and most of the respondents in this age group are around 21-23 years old. And from the questions, "When do you think was the most difficult and stress time you ever had in your life", hence most of the respondent's answer are when studying at school, which have 42.4 % of the respondents responded on this answer. This is due to the huge stress from those who are currently undertaking degree, master and etc.
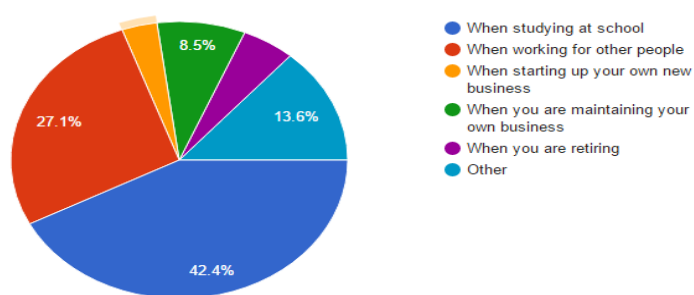

Figure 5.3 – Respondent most difficult and stress time

Besides that, the second largest stress moment that respondents had to deal with is when they have to work with other people. From the survey, we found out that there are actually 50.8% of the respondents are actually working, hence, from their experience, they may had to deal with different kind of the people like colleagues or clients during their working process. There are 27.1% of the respondents are actually think that when working for other people are actually the most stress moment that they had, and these respondents may have a bad experience when they deal with their clients or their colleague before.

There are some of the respondents that are starting up their own business instead of working for other, and 3.4% of the respondents think that they are actually have the toughest and most stress time during the moment when they are starting up their own business. And there are 8.5 % of the respondents think that they have their toughest and most stress time while they are maintaining their own business. Both group of these

respondents (11.9%) will have to put more effort in order for their own business to capable to compete with the other competitors in the markets.

Moreover, there are 5.1% of the respondents are actually think that it will be stress and most difficult time for them when they are retiring. These respondents may feel that they are losing of direction when they are retiring, and this may be the cause of them feel stress during retiring. While there are 13.6% of the respondents choose other, where they had given the response like stress during relationship issues, have to balance in between working and studying, getting bullied by others and etc.

5.4   Handling Stress Issue

There are multiple choice questions for this part of questionnaire, where respondents can choose whether to handle their stress through entertainment like watching movies, hang out with friends and etc, or by sharing out their issues with trustworthy people, or, seek for online stress release training, or meditation, or seeking for professional medication treatment.
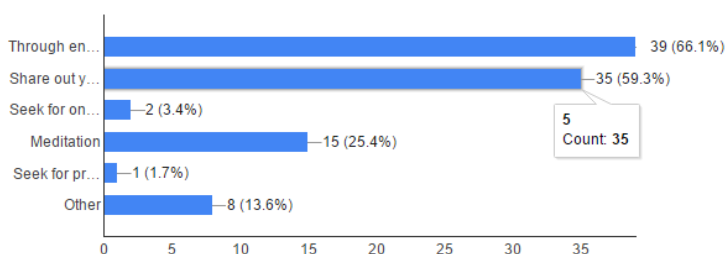

Figure 5.4 - Respondent handling stress issue method

From the responses, I found out that there are 39 out of 60 (66.1%) of respondents think that through the entertainment like playing games, hang out with their friends can help them to resolve their stress issue. It is because through these entertainments, it can make us more relax from been too tension.

Moreover, there are respondents that are choose to share out their issues with trustworthy people to resolve their stress issues, and this is the second highest choice that had been choose among the respondents. There are 35 respondents that were agreed that by sharing out their problem can resolve their stress. This is due to by sharing out the problem that they are facing may help them gain a better solution to deal with the problem, and the problem resolve as well as the stress will be resolve at the same time.

While there are 15 respondents (25.4%) think that through meditation treatment are also one of the way of handling their stress issues, but there are not a lot of respondents choose to used meditation, as it is time consuming process, where it will consume hours for a full meditation process to complete, hence, in this era which are people are competing with each other for survival, there are no extra time for those who are not capable to do meditation process. And this is the same condition for the choice where seek for

professional medication treatment. This is a time consuming process as well as costly for respondents, as from the previous analysis, we found out that most of the respondents did not have high salary for this kind of expensive treatment.

Next, there are 2 respondents think that through online searching for stress resolve solution are the method which are work for them, but due to the reason where most of the resources on the internet are not reliable, hence, not a lot of the respondents are actually depend on this method. While there are also respondents that giving their opinion that they are handling their stress issues using method like exercise, pray, have enough sleeping and etc.

5.5   Respondent reaction on the stress detector in mobile application form
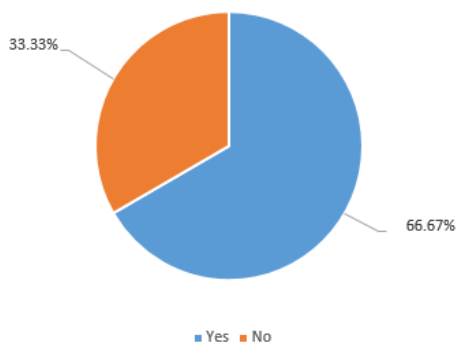

Figure 5.5 - Respondent reaction on the mobile application for stress detector

From the respondents respond, I found out that there are 40 out of 60 respondents which is 66.67% of the respondents are supporting with this project which is mobile application. Hence, this can show that there are actually quite a number of people in our society that are seeking for this kind of convenience way of solving their stress issue, and this also stated by some of the respondents in their opinion.

But of course, there are still have 20 number of respondents which are 33.33% that are not supporting on this mobile application due to the reason like they don't want to rely everything to mobile application, and also some of them suggested that there are no human contact in between the process, which are actually less accurate for the result that obtain and etc.

Next, in the questionnaire, there are a part where asking about the feedback of user's stress record back to the main server for future improvement, and there are 37 respondents that are actually support with this kind of feature. From their opinion, they think that by using their stress data, it can help the development of a better mobile application for anxiety disorders, and it can benefits a lot of other people as well.

Well some of the respondents think that they will not be sharing out their stress data, as they think that this kind of data are private and confidential.

5.6   **Conclusion**

From the analysis, I found out that there are a lot of people are actually facing stress in some time, where most of them are in age group of 15-30 years old, as in this age of group have the most people that are still pursuing high level education like degree, master and etc. While some of them that are not studying will be pursuing their career in their own business or as the employee of other company. Hence, they will be a lot of stress that they will have to handle as during this moment, they will have to experience a lot of failures in order for them to achieve a better lifestyle in the society.

Moreover, there are large number of respondents are actually supporting the creation of mobile application for the anxiety disorder test, hence, this can prove that actually this is one of the mobile application that are pursuing by users in the market as well. Most of the respondents suggested that through entertainment can actually help them resolve their stress issues, hence, the attention training contain in the mobile application should develop in such a way that it can attract user's interest and resolve user's stress level.

CHAPTER 6

TECHNOLOGY

6.1   Technology Involved

There are several technologies that will be involved in this project, which is Android smartphone, Android smartphone with camera and flashlight around the camera and a server.

a) Android Smartphone

   A minimum Android Kit-Kat 4.4 operating system smartphone device

b) Android Smartphone with camera and flashlight around the camera

   The android smartphone need to consist of camera and also flashlight around the camera, as flashlight will be needed to show the pulse and recorded by the camera.

c) Server

   Server will be used to collect the user's stress data

6.2   Development tools

There will be several tools and software that I will be using for the development of my project which is A mobile application for anxiety disorder using HRV. Following will be the tools that I are going to be used for the development of project.

Tools	Description
SQLite Studio 	• The latest version of SQLite studio will be used as the tools for creating the SQLite database. • The database created will be used on the mobile application.
Android Studio 	• The latest version of android studio will be used as the mobile application should be usable by the devices that have Android Kit-Kat 4.4 and above.
Apache server 	• Apache is one of the most popular open source web server • It provide fast, secure, efficient that provides HTTP services to sync with the current HTTP standards

CHAPTER 7

PROJECT PLAN

7.1   Purpose of Plan

The Mobile Application for Anxiety Disorder using HRV Project Plan will be providing on how will the project going to be achieve by following the milestones set by myself through month by month. There will be goals and objectives of the project that will be includes as well in the project which had reached an agreement in between:

- Supervisor and Co-supervisor
- Project Developer

In this project plan, it should include following elements:

- Roles and Responsibilities
- Project Budget
- Project Timeline

7.2   Roles and Responsibilities

a) Supervisor: Dr Lee Poh Foong

Will provide advises in the anxiety disorder issues and suggestion related to it. Suggestion will be given for the methods to testing anxiety disorder as well as how to methods to be used for attention training. Moreover, constantly supervise to report on the progress of the project and the comment on overall of the mobile application that developing.

b) Co-supervisor: Miss Chean Swee Ling

Will provide advises in technical issues while developing mobile application as well as monitoring on whether there is any progress of the project.

c) Project Developer: Ong Ming Chen
- Will be managing on the entire project
- Understand and provide the necessary requirement for the system
- Develops the product
- Communicate with supervisor to make sure the product create will be on track
- Assure that the quality of the product produced will meet with the goals and objectives
- Will be solving the technical issues faced in the project when developing process.

7.3   Project Assumptions

There are several assumptions that will be consider while constructing the project plan which is:

a) There will be user on the market that will used the mobile application.
b) User will shared out their anxiety disorder result before and after the attention training.
c) Assume that users have a smartphone device that have camera, flashlight and also using android operating system Kit-Kat 4.4.2 and above.

7.4   Project Tools

Developing tools   :   Asus Laptop A555L, Android Studio

Testing Tools   :   Android Studio emulator, Samsung Galaxy J7 (2016)

Internet Connection   :   Unifi 30mbps package, Hotlink mobile data

Server   :   Asus Laptop A555L

7.5   Justification

Asus Laptop A555L have two usage which are for the development process as well as for the server side functioning during development. It have 8GB RAM and Intel i7 up to 3GHz that are sufficient enough for it to run the developing process smoothly, as during developing process, Android Studio Emulator may require a lot of CPU performance for the testing usage. Moreover, Asus Laptop A555L also contain hard disk storage up to 1TB to act as the server which it will be used to gather the raw data from user.

Next for the testing tools, during the process of developing, Android studio emulator will be used for interface design and development instead of the real time smartphone device, as it will only take up several seconds for the installation to be done within the computer itself, while for Samsung Galaxy J7 (2016) will be used during development that involve camera as well as final testing phase which is to make sure that all functions as well as the user interface are running smoothly on the actual smartphone device.

While for the internet connection, I will be using Unifi 30mbps package for the data feedback collection testing. With the high speed internet connections, there will not be a trouble for data feedback to be corrupted or disconnected during the process of sending the raw data to the server. Since the mobile application need to be convenience to user, so that user can use the mobile application anywhere anytime, hence, I will be using Hotlink mobile data for the raw data feedback testing as well.

7.6   Gantt Chart

7.6.1   Planning and Design

ID	Activity	Date Start	Date Done	Plan Start	Plan Duration (days)	Actual Start	Actual Duration (days)
1	Executive Summary	06/05/16	06/06/16	06/05/16	1	06/05/16	2
2	Problem Statement	06/08/16	06/11/16	06/08/16	2	06/08/16	4
3	Scope	06/10/16	06/11/16	06/09/16	3	06/10/16	2
4	Objectives	06/10/16	06/12/16	06/11/16	2	06/10/16	3
5	Proposed solution	06/13/16	06/13/16	06/12/16	1	06/13/16	1
6	Justification	06/15/16	06/15/16	06/15/16	1	06/15/16	1
7	Literature Review	06/18/16	06/23/16	06/18/16	6	06/18/16	6
8	Fact Finding	06/26/16	06/29/16	06/26/16	4	06/26/16	4
9	System development methodology	06/29/16	07/02/16	07/02/16	2	06/29/16	4
10	Research methodology	07/04/16	07/05/16	07/04/16	2	07/04/16	2
11	Technology involved	06/17/16	07/04/16	06/30/16	5	06/17/16	18
12	Project Plan	06/26/16	07/04/16	06/10/16	5	06/26/16	7
13	Development tools	07/05/16	07/08/16	07/05/16	5	07/05/16	4
14	System Design	07/13/16	08/03/16	07/01/16	10	07/13/16	21

Figure 7.1 - Gantt Chart planning and design

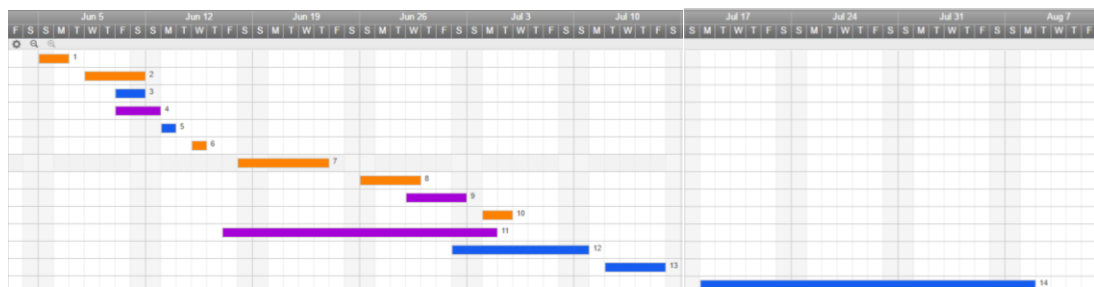Table 7-1 Gantt Chart Table planning and design

Start on plan date

Start beyond plan date

Start early than plan date

7.6.2   Development Phase

|	Developing phase	01/16/17	03/14/17	Completed	42d
	Create all mobile application interface	01/16/17	01/23/17	Completed	6d
	link all the fragment that created	01/24/17	01/24/17	Completed	1d
	Create SQLite databases for the mobile application	01/27/17	02/02/17	Completed	5d
	Register and login activity	02/02/17	02/03/17	Completed	2d
	Camera and Flashlight Connection	02/06/17	02/09/17	Completed	4d
	Image Processing implementation	02/10/17	02/13/17	Completed	2d
	Redesign the Stress Measurement Fragment	02/15/17	02/17/17	Completed	3d
	Implement the HRV with IBI	02/17/17	02/21/17	Completed	3d
	Preparing Perceived Stress Scale (PSS) Questionnaire	02/21/17	02/22/17	Completed	2d
	Attention Training Activity	02/23/17	02/24/17	Completed	2d
	History activity that list view all stress data	02/24/17	02/28/17	Completed	3d
	HRV calculation with Sdnn	03/01/17	03/03/17	Completed	3d
	Post All Stress Data to server	03/03/17	03/07/17	Completed	3d
	Display and allow edit on profile	03/07/17	03/09/17	Completed	3d
	Beautify the mobile application interface	03/09/17	03/10/17	Completed	2d
	Create web display for data gather	03/10/17	03/14/17	Completed	3d

Figure 7.2 Gantt Chart Development
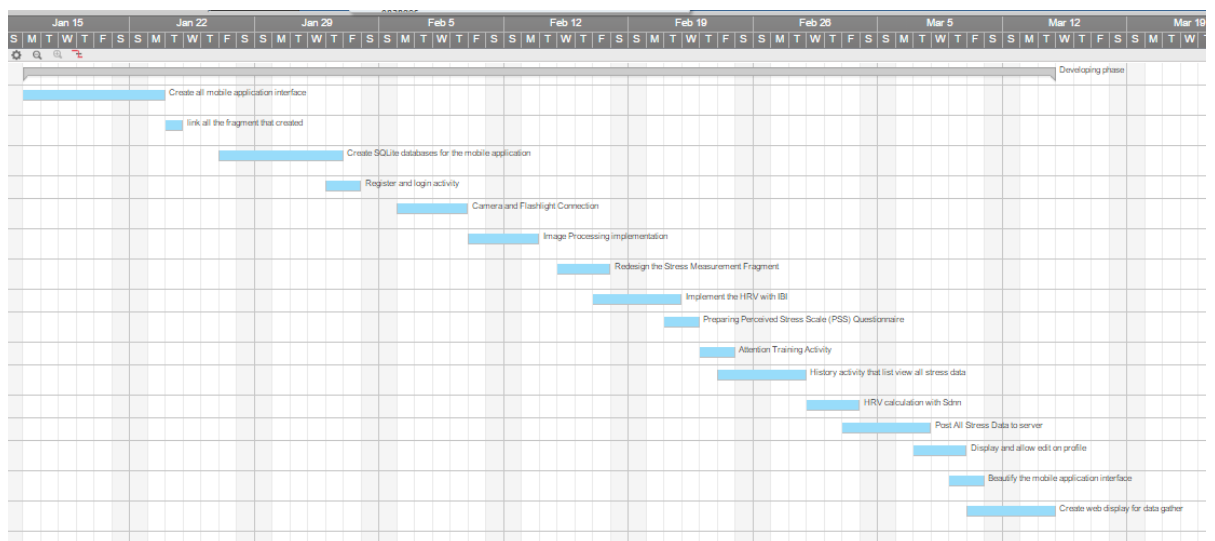
Table 7-2 Gantt Chart Table Development

7.6.3 Testing Phase

Testing	03/15/17	03/28/17	Completed	10d
Unit Testing	03/15/17	03/21/17	Completed	5d
Integration Testing	03/21/17	03/24/17	Completed	4d
System Testing	03/24/17	03/27/17	Completed	2d
User Acceptance Test	03/27/17	03/28/17	Completed	2d

Figure 7.3 Gantt Chart Testing
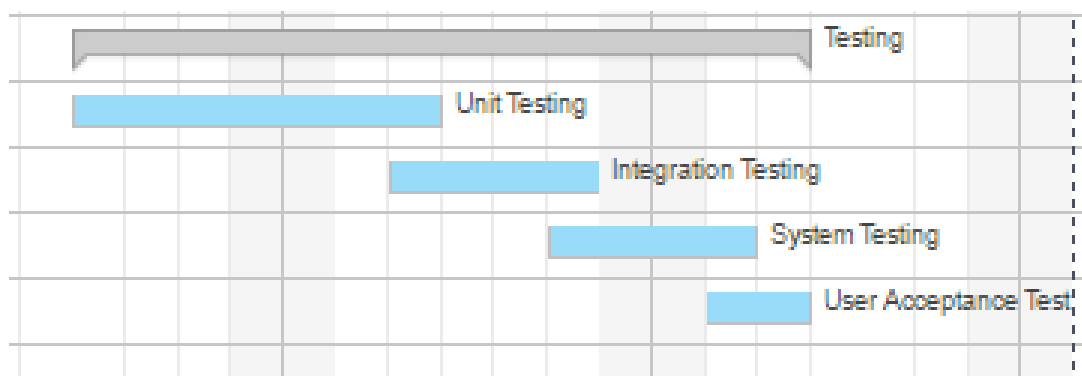
Table 7-3 Gantt Chart Table Testing

7.6.4 Documentation

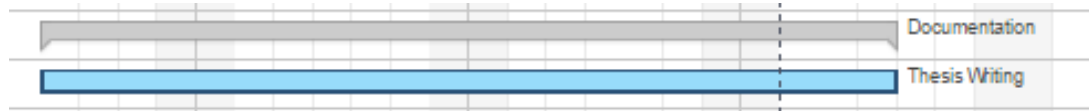| Documentation	03/15/17	04/05/17	Completed	16d
Thesis Writing	03/15/17	04/05/17	Completed	16d

Figure 7.4 Gantt Chart Documentation

Table 7-4 Gantt Chart Table Documentation

CHAPTER 8

SYSTEM DESIGN

System design phase is the phase that can be considered as the most important part of the project development. A good design can allow the process of the development smooth with lesser uncertainty. And this is the system design for mobile application for anxiety disorders test using HRV.

8.1   Use Case Diagram

Figure 8.1 Use Case Diagram

8.1.1 Use Case Description

Use Case ID :	1
Use Case Name :	measure with questionnaire or not
Actors :	User
Description :	User can choose to measure with answering questionnaire or not
Precondition :	--
Post-Condition :	--
Normal Flows :	1. Once login successfully, user can make two choice which is measure with questionnaire or not 2. If user click button Measure with Questionnaire, then Perceived Stress Scale(PSS) will need to be answer, then only proceed to Heartbeat Stress Measurement 3. If user click button Measure without Questionnaire, then it will proceed to Heartbeat Stress Measurement
Alternative Flows :	

Use Case ID :	2
Use Case Name :	Scan for Heartbeat
Actors :	User
Description :	User scan their heartbeat
Precondition :	User's finger must put softly on the mobile camera
Post-Condition :	--
Normal Flows :	1. User's finger put on the mobile camera 2. User have to make sure that the screen are on red colour and graph are showing that are heart beating 3. Time count down will be start which are 2 minutes 4. Heartbeat scan done after 2 minutes 5. During measurement time, user can check on their real-time heartbeat per minutes
Alternative Flows :	

Use Case ID :	3
Use Case Name :	View Previous Record
Actors :	User
Description :	User can view all their records on the history activity
Precondition :	--
Post-Condition :	--
Normal Flows :	1. User choose the history activity 2. User can scroll and choose on the list that show the date and time. 3. User click the view button 4. Stress result recorded at that particular time and date will be shown

Use Case ID :	4
Use Case Name :	Send Stress Result feedback
Actors :	User, Admin
Description :	User can share their stress level result with the admin for future improvement on the system
Precondition :	--
Post-Condition :	--
Normal Flows :	1. After the scanning is done, it will move to History activity that send stress result automatically 2. Whenever user click on History preview with internet connection on, then all the stress result will be resend to server and record the stress data if there are non-existing stress data

Use Case ID :	5
Use Case Name :	View Profile
Actors :	User
Description :	User can check and edit their own profile
Precondition :	--
Post-Condition :	--
Normal Flows :	1. User move to the profile page 2. User can view username, email, age, gender, country, race, weight and height 3. User can edit the their details by clicking on the edit button 4. User sign out the device by click sign out button or back button

Use Case ID :	6
Use Case Name :	Login mobile application
Actors :	User
Description :	User require to login every time before using the mobile application
Precondition :	--
Post-Condition :	--
Normal Flows :	1. User tap on the mobile application icon which will start up the mobile application 2. User insert username and password 3. User click the login button to login

Use Case ID :	7
Use Case Name :	Register Profile
Actors :	User
Description :	User require to register for the first time before using the mobile application
Precondition :	--
Post-Condition :	--
Normal Flows :	1. User tap on the mobile application icon which will start up the mobile application 2. Click on the register account link 3. User register by providing their username, email, password, gender, country, race, age, weight and height. 4. User click the register button for registration to be complete

| Use Case ID :	8
Use Case Name :	Interact with attention training
Actors :	User
Description :	User can choose attention training after login
Precondition :	--
Post-Condition :	User will have to retake the stress level measurement after the attention training
Normal Flows :	1. User tap on the mobile application icon which will start up the mobile application 2. User can click on attention training first then measurement 3. Or User run the stress test measurement 4. Then attention training 5. Attention training will be provided as a deep breathing video 6. User will have to run the stress level measurement again after the end of the attention training.

8.2   Context Diagram
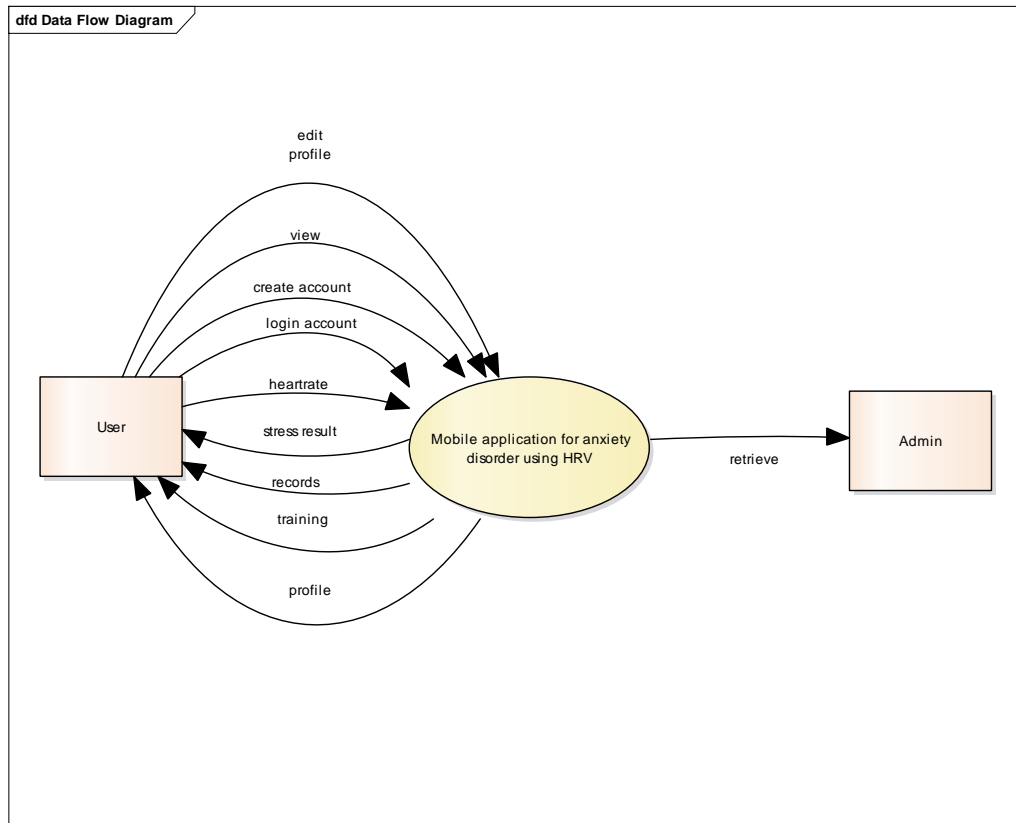
Figure 8.2 Context Diagram

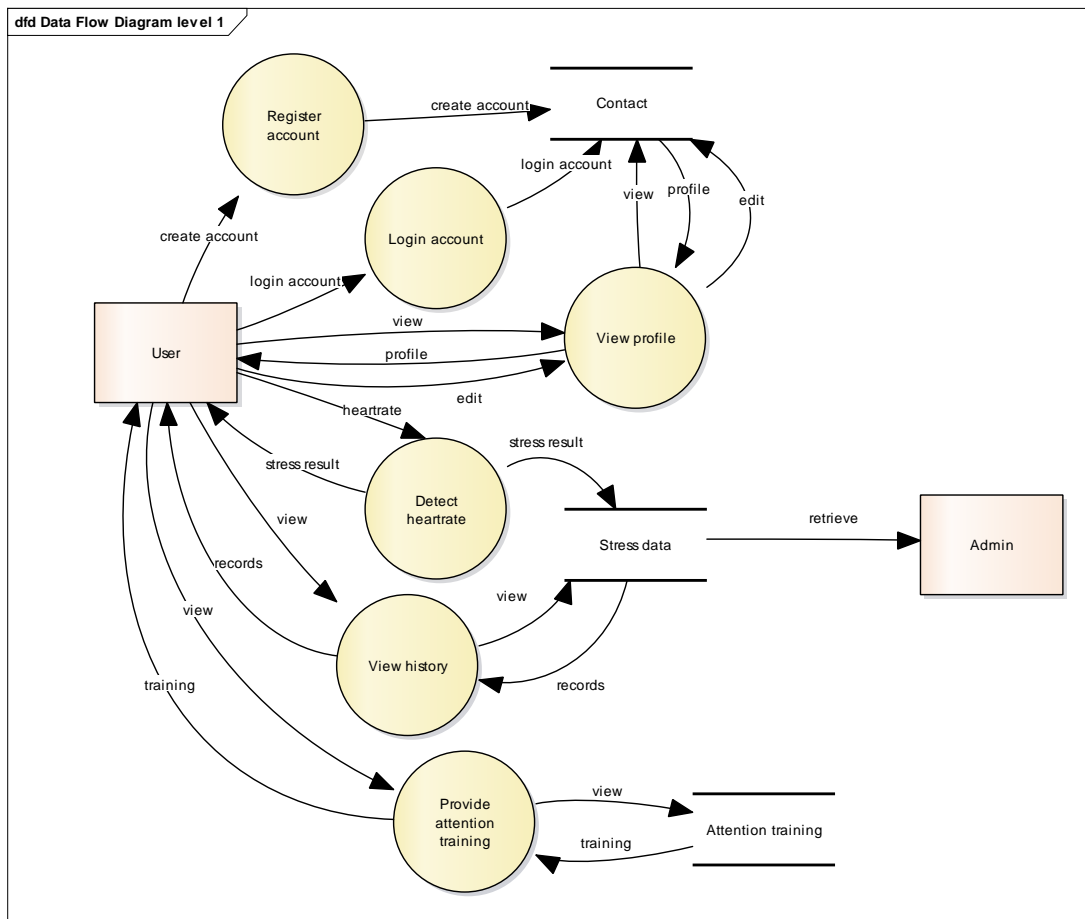### 8.2.1 Data Flow Diagram Level 1

Figure 8.3 Data Flow Level 1 diagram
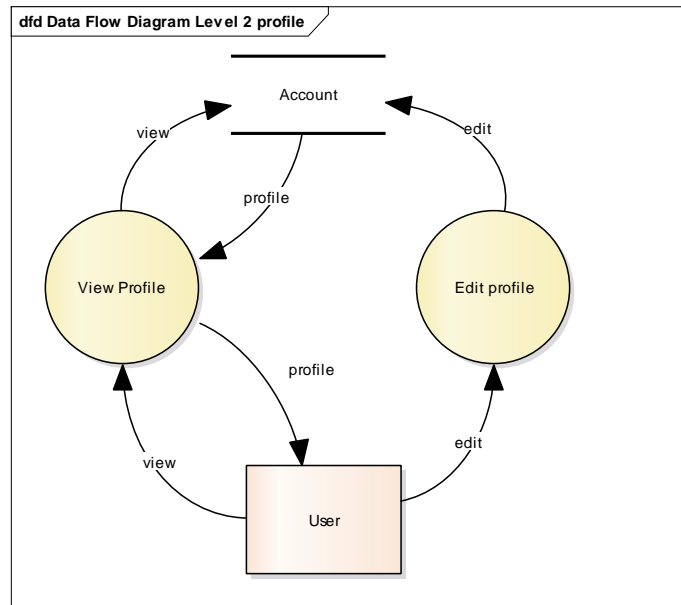
8.2.2 Data Flow Diagram Level 2

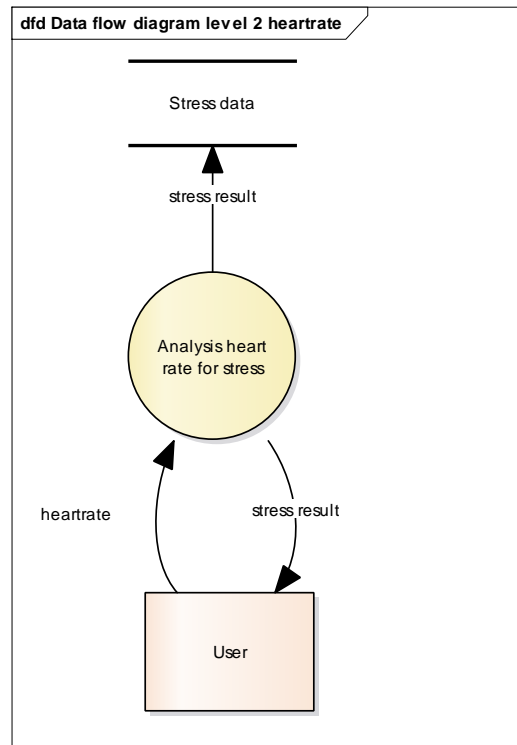Figure 8.4 Data Flow Level 2 diagram Profile

8.2.3 Quantitative

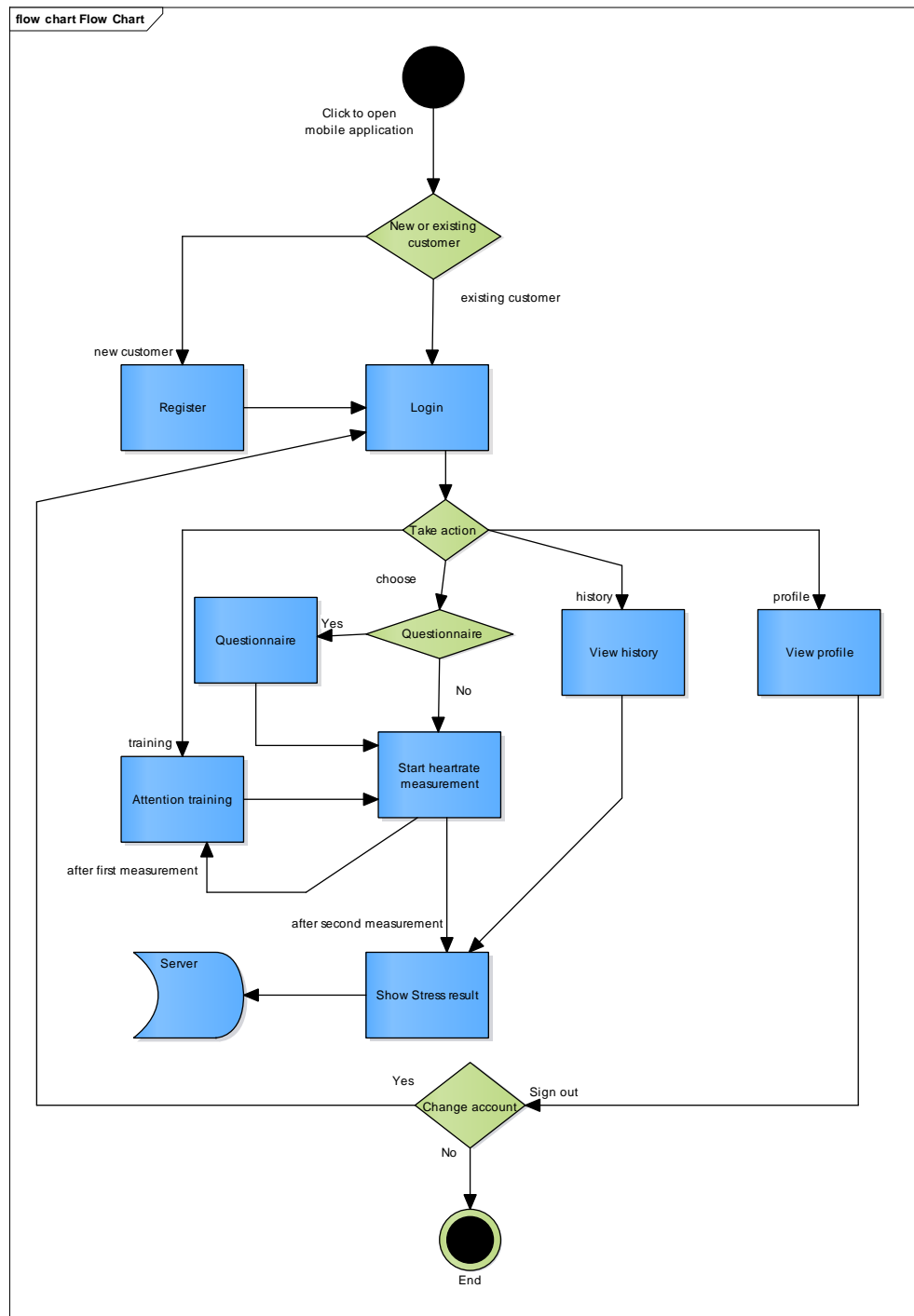Figure 8.5 Data Flow level 2 diagram Heartbeat

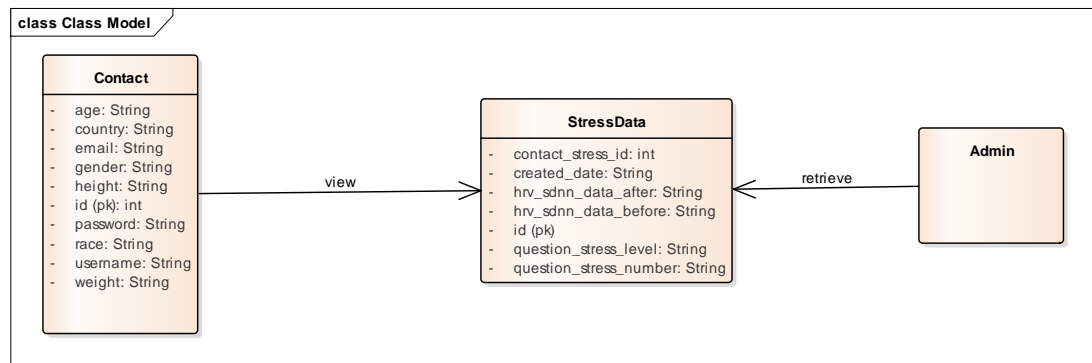## 8.3   Flowchart

Figure 8.6 Flowchart

8.4   ERD diagram

Figure 8.7 ERD diagram

8.4.1   ERD description

Table Name: Contact

Column Name	Description	Data Type	Primary Key?	Foreign Key?	FK referenced table
ID	Unique identification for the user	Number	Yes	-	-
Age	User's age	String			
Country	User's country	String			
Email	Will be used to contact with the user	String	-	-	-
Gender	User's gender	String			
Height	User's height	String			
Password	Password that will be used for login	String			
Race	User's race	String			
Username	Username of the user that will be used for the login	String	-	-	-
Weight	User's weight	String	-	-	-

Table Name: StressData

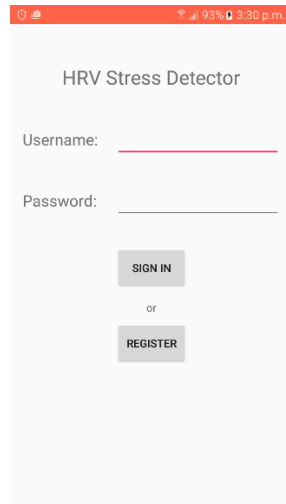| Column Name	Description	Data Type	Primary Key?	Foreign Key?	FK referenced table
id	Unique identification for the stress data	Number	Yes	-	-
Contact_stress_id	Stress id for a particular user	int	-	Yes	Contact id
Created_date	The date and time that a particular stress data that created	String	-	-	-
Hrv_sdnn_data_after	HRV stress data after attention training	String	-	-	-
Hrv_sdnn_data_before	HRV stress data after attention training	String	-	-	-
Question_stress_level	Stress status from questionnaire	String	-	-	-
Question_stress_number	Marks calculated from questionnaire	String	-	-	-

8.5 Class Diagram
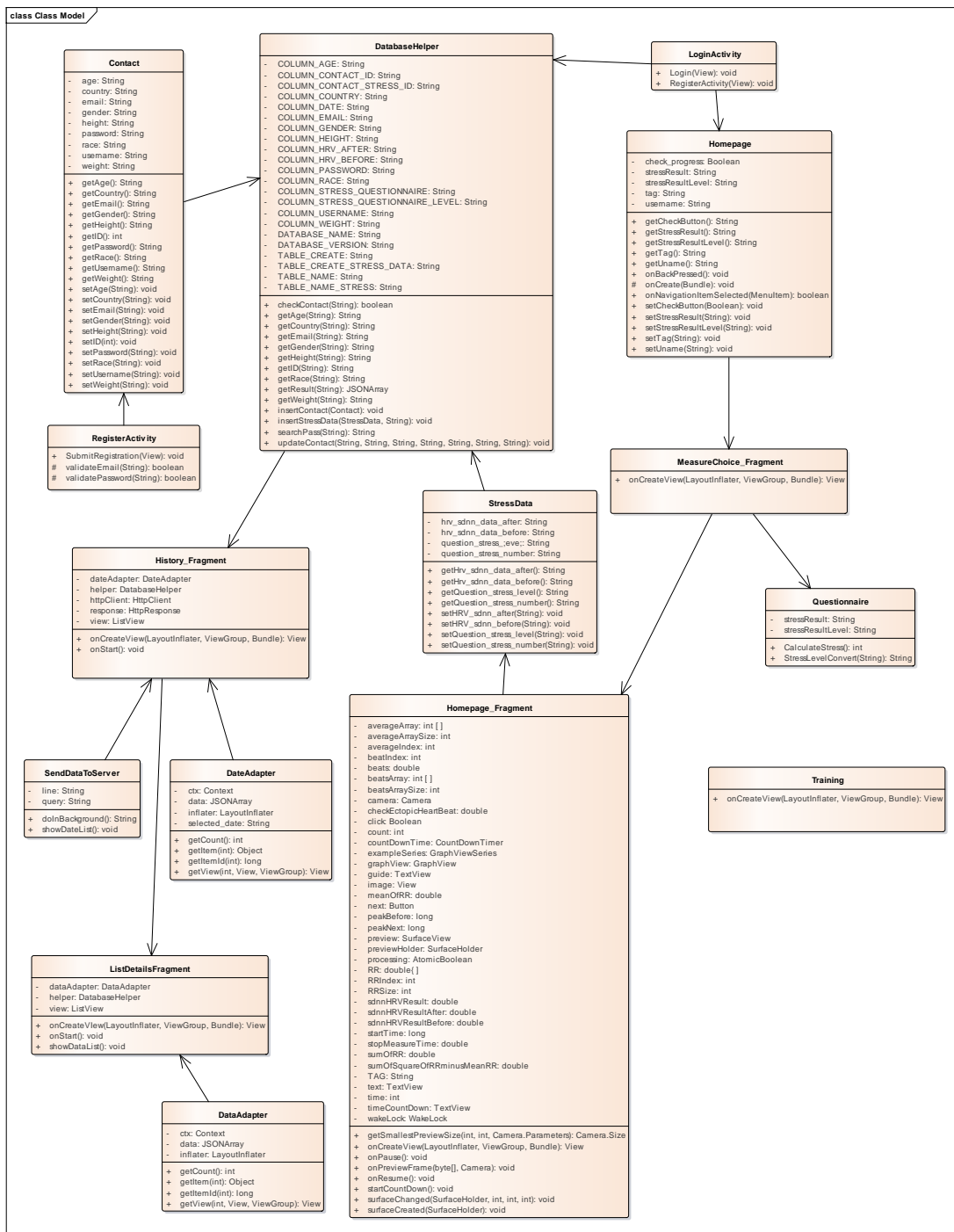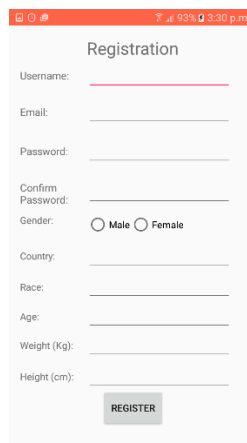

Figure 8.8 Class diagram

8.6 User Interface

8.6.1 First Activity (LoginActivity)

Figure 8.9 LoginActivity

8.6.2 RegisterActivity

Figure 8.10 RegisterActivity

8.6.3 Drawer of Mobile Application
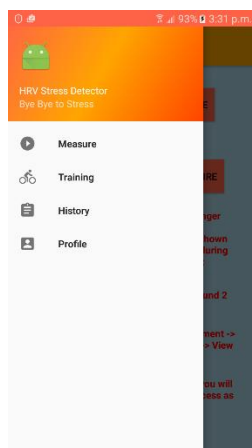
Figure 8.11Drawer

8.6.4 Measurement choice fragment
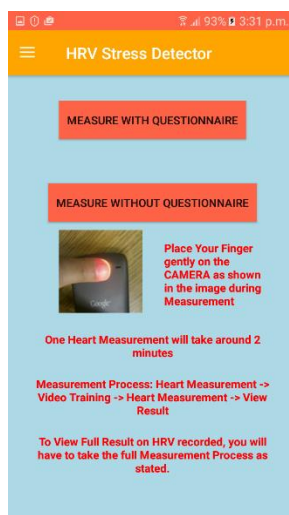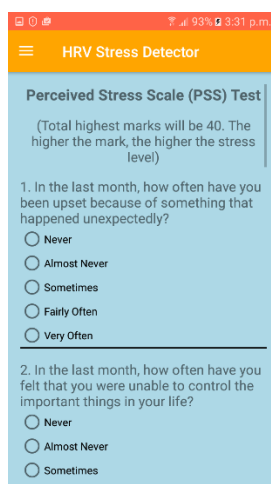
Figure 8.12 Measurement Choice Fragment

8.6.5   Questionnaire Fragment

Figure 8.13 Questionnaire Fragment

8.6.6   Heartbeat Measurement Fragment
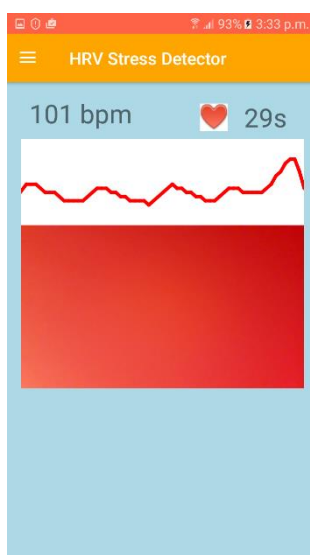
Figure 8.14 Heartbeat Measurement Fragment

8.6.7   Training Fragment
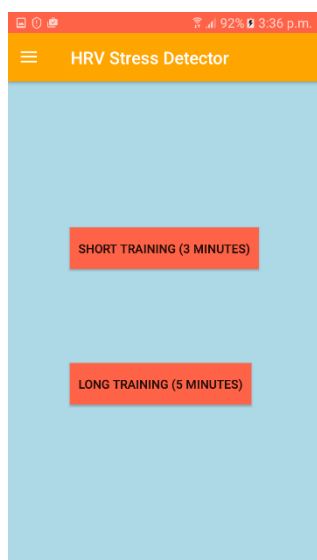
Figure 8.15 Choose Training Fragment
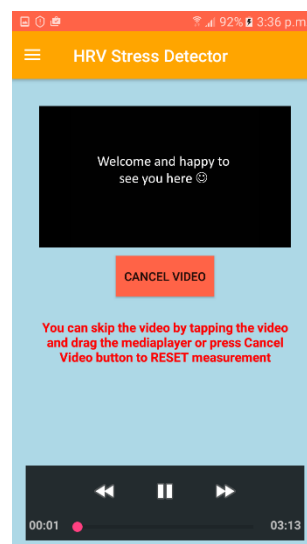
Figure 8.16 Training Video Fragment

8.6.8   List Activity
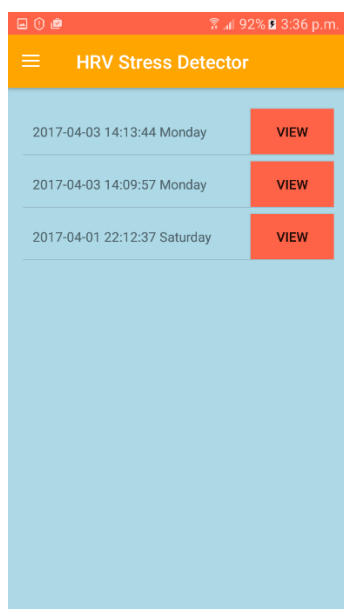
Figure 8.17 List By Date
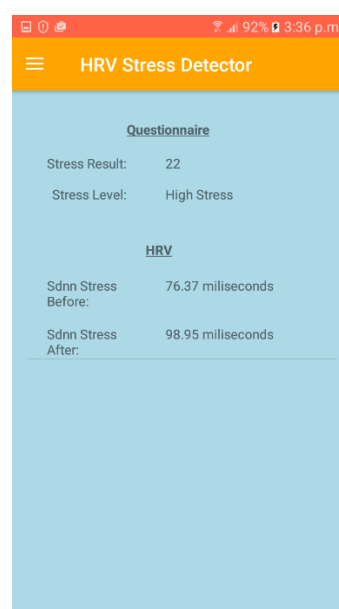
Figure 8.18 List Selected Details

8.6.9 Profile Activity
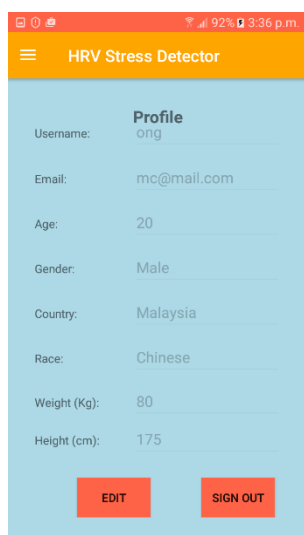
Figure 8.19 Display Profile
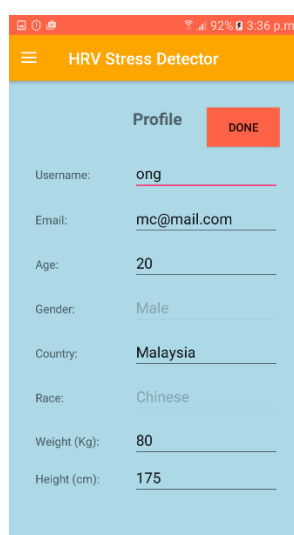
Figure 8.20 Edit Profile

8.6.10 Web server display data

1. ID: 732
   Age: 23
   Country: malaysia
   Race: chinese
   Gender: Male
   Weight: 88 kg
   Height: 178 cm
   Questionnaire mark: 0 No answer questionnaire
   Questionnaire Stress Level: 0 No answer questionnaire
   Sdnn HRV Before: 77.29 miliseconds
   Sdnn HRV After: 118.7 miliseconds
   Created Date: 2017-04-05 08:26:38 Wednesday

2. ID: 716
   Age: 20
   Country: Malaysia
   Race: Chinese
   Gender: Male
   Weight: 80 kg
   Height: 175 cm
   Questionnaire mark: 22
   Questionnaire Stress Level: High Stress
   Sdnn HRV Before: 76.37 miliseconds
   Sdnn HRV After: 98.95 miliseconds
   Created Date: 2017-04-03 14:13:44 Monday

3. ID: 713
   Age: 20
   Country: Malaysia
   Race: Chinese
   Gender: Male
   Weight: 80 kg
   Height: 175 cm

CHAPTER 9

IMPLEMENTATION & TESTING

9.1 Implementation of Application

9.1.1 Collection of IBI

On every peak of the heartbeat, a milliseconds of time will be collected, and the next peak milliseconds of time will be used and minus with the previous milliseconds time. The result will be the Interbeat interval (IBI). Then these results will be store in an array for further calculation

```
TYPE newType = currentType;
if (imgAvg < rollingAverage) {
    newType = TYPE.RED;
    if (newType != currentType) {
        //To get the latest beat peak time
        peakNext = System.currentTimeMillis();

        RR[RRIndex] = (peakNext - peakBefore) / 1000d;
        RRIndex++;

        //RR[i-1] = RR[i] which will be use to calculate ibi for sdnn HRV calculation later on
        peakBefore = peakNext;

        //When is RED, then beats will be increase by one;
        beats++;
        time++;
    }
}
```

Figure 9.1 IBI calculation

9.1.2 HRV calculation

When time reach 2 minutes, the camera measurement will stop and start the calculation of HRV. Before the calculation start, the first four IBI collected will be ignore, as there might be some inaccurate result due to the movement of finger. Moreover, there might be some Ectopic beats that might be collected during the IBI calculation. Hence, the removal of Ectopic beats are essential in order to get a better accurate of SDNN HRV result. The SDNN formula is then will be apply to calculate the HRV result.

```java
//stop measure when time reach 2 minutes and calculate HRV
if (stopMeasureTime >= 120){
    camera.setPreviewCallback(null);
    camera.stopPreview();
    camera.release();
    camera = null;

    guide.setVisibility(View.VISIBLE);
    next.setVisibility(View.VISIBLE);
    preview.setVisibility(SurfaceView.GONE);

    //get sum of RR interval
    for (int i = 4; i<RR.length;i++){

        //To remove Ectopic Heartbeat from involve in the calculation
        checkEctopicHeartBeat = Math.abs(RR[i]-RR[i-1]);
        if(checkEctopicHeartBeat<=1.5 && RR[i]!=0 && RR[i] > 0.6 && RR[i] <1.1) {
            sumOfRR += RR[i];
            count++;
        }
    }

    //mean of RR interval
    meanOfRR = sumOfRR / count;


    for (int i = 4; i < RR.length; i++){

        checkEctopicHeartBeat = Math.abs(RR[i]-RR[i-1]);
        if(checkEctopicHeartBeat<=1.5 && RR[i]!=0 && RR[i] > 0.6 && RR[i] <1.1) {
            //to get the (sum of square of RR interval) - (Mean of RR interval)
            sumOfSquareOfRRminusMeanRR += pow(RR[i] - meanOfRR, 2);
        }
    }

    //final sdnn HRV result
    sdnnHRVResult = (sqrt(sumOfSquareOfRRminusMeanRR / (count-1)))*1000d;
    sdnnHRVResult = Math.round(sdnnHRVResult*100)/100d;

}
```

Figure 9.2 SDNN calculation

9.2 Unit Testing

Unit testing will be performed during the development phase to make sure that defects are found and solve. Unit testing is carried out by testing on individual program units or methods to ensure that they are functioning as intended.

9.2.1 RegisterActivity

Test Case	Test Execution Steps	Expected Result	Pass/Fail
Empty Field Validation	1. Click Register with all empty fields	Register fail with warning to fill out all empty fields	Pass
Check Username	1. Register using existing username	Register fail with warning username already taken	Pass
Check Password	1.Register with different password in both password and confirm password	Register fail with warning password not match	Pass
Check Password	1. Register with password less than 8 characters	Register fail with warning length of password must at least 8 characters	Pass
Email Validation	1. Register with incorrect email format	Register fail with warning invalid email	Pass
Register	1. Register with all correct format	Register successfully	Pass

9.2.2   LoginActivity

Test Case	Test Execution Steps	Expected Result	Pass/Fail
Login validation	1. Login with empty or incorrect username or incorrect password	Login fail with incorrect username and password	Pass
Login	1. Login with correct username and password	Login successfully	Pass

9.2.3   Questionnaire Fragment

Test Case	Test Execution Steps	Expected Result	Pass/Fail
Questionnaire validation	1. Not fully answer all the questionnaire	Submission fail with warning fill up all the questions	Pass
Submit questionnaire	1. Submit with all fields checked	Submit questionnaire successfully	Pass
Check on the questionnaire result	1. Console check the stress marks and stress level that had been calculated	Marks calculated correctly with stress level correct as well	Pass
Check stress data set on homepage	1. Console check stress data successfully set in Homepage activity	Stress Data set correctly in Homepage Activity for database storing afterward	Pass

9.2.4 Heartbeat Stress Measurement

Test Case	Test Execution Steps	Expected Result	Pass/Fail
Display of interface	1. Move to Homepage_Fragment	No Crashing while accessing Homepage_Fragment	Pass
Countdown Time	1. Check on countdown time	Count down start with 120 seconds (2 minutes) and show done after 2 minutes	Pass
Heartbeat display	1. Check on heartbeat display	Average heartbeat should be shown every 10 seconds	Pass
Graph Display	1. Graph should be display as the heartbeat beating	Graph display as expected	Pass
IBI recording	1. Console check the IBI that are recording in the background	0.2-2.5 milliseconds of time recorded in an array	Pass
SDNN calculation	1. Measure heartbeat for 2 minutes 2. After 2 minutes, check on console 3. Check IBI array and length of the array after remove ectopic beats 4. Check mean of IBI 5. Check the SDNN result	IBI collected should be within 0.6 – 1.1 milliseconds, while for SDNN result is 40 milliseconds to 170 milliseconds, depends on the finger put on the camera	Pass

9.2.5   DatabaseHelper

Test Case	Test Execution Steps	Expected Result	Pass/Fail
Check database	1. Create getResult to return jsonarray of the data stored in database 2. Check the console	All data stored in the database should return in the jsonarray	Pass

9.2.6   History_fragment

Test Case	Test Execution Steps	Expected Result	Pass/Fail
Check getResult	1. Check on console whether is return in JSONArray format	Return in JSONArray format	Pass
Check sorting	1. Check console for sorted JSONArray	Return JSONArray in descending order based on created_date	Pass
Check tag	1. Click View button on one particular date 2. Check console on the tag on created_date for list details	Tag display the particular created_date once button clicked	Pass
Check Post Data to server	1. Check on the console once history_fragment activated	JSONArray should post successfully, with string builder returning successful connect to the server side	Pass

9.2.7   ListDetailsFragment

Test Case	Test Execution Steps	Expected Result	Pass/Fail
Check JSONArray of selected created_date	1. Check on console whether return JSONArray of selected created_date	Return correct JSONArray result	Pass

9.2.8   Profile_Fragment

Test Case	Test Execution Steps	Expected Result	Pass/Fail
Check required data	1. Check on console on whether return required data from one particular user	Data from a particular user are return correct and successfully	Pass
Validation of edit profile	1. Type incorrect email format, and empty fields 2. Click done button	Warning will be shown to indicate wrong email format or empty fields	Pass
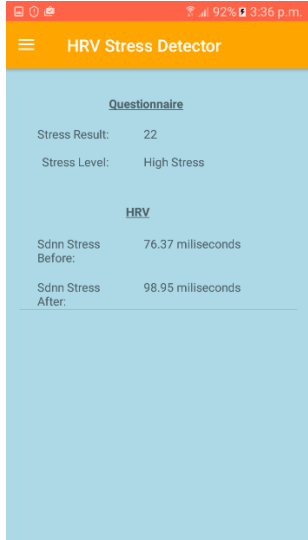
9.3   **Integration Testing**

After unit testing is done, integration testing will be proceed. Integration testing are used to test the error when all the modules tested in the unit testing were integrated.

9.3.1   **Register and Login**

Test Case	Register account and successfully login
Test Procedure	1. Click Register button 2. Fill all the required fields 3. Submit the details 4. Login in with username and password that just register
Expected Results	Login successfully with the newly registered account
Pass/Fail	Pass

9.3.2 Measure heartbeat stress with questionnaire

Test Case	Choice measurement with questionnaire
Test Procedure	1. Click Measure with Questionnaire button on the homepage 2. Checked all the questions 3. Submit the questionnaire 4. Measure heartbeat and HRV stress for 2 minutes 5. Do attention training that after measurement 6. Redo heartbeat and HRV stress measurement 7. Check the questionnaire and Stress result on History
Expected Results	Stress result from Questionnaire, heartbeat measurement before and after attention training will be display in History
Pass/Fail	Pass

9.3.3 History display and Web server data display

Test Case	Stress result display on History and web server
Test Procedure	1. Connect to internet 2. Click on History on the drawer or access History after a full heartbeat stress measurement is done 3. Click on the View Button and check the Questionnaire stress result and HRV stress result 4. Visit hrvstressdetect.000webhostapp.com and check the display data
Expected Results	Data on history should be successfully display on the webserver side
Pass/Fail	Pass

9.4   System Testing

When integration testing is done, then system testing are essential, as it will make sure the system function perfectly when all the modules and integrated parts were combined together

9.4.1   Testing Equipment Specification

Device Name: Samsung J7 (2016)

- OS: Android 6.0 Marshmallow

Test Case	Full process with Measure with Questionnaire
Test Procedure	1. Register and login 2. Click Measure with Questionnaire button 3. Answer all questions 4. Put finger at the camera before Submit button is clicked 5. Wait 2 minutes for HRV Stress Measurement 6. Proceed to Attention Training 7. Restart HRV Stress Measurement for 2 minutes 8. Check stress result on History 9. Click Profile on Drawer, edit some of the fields 10. Click Done button
Expected Results	• Register and successfully login, • Fully answer questionnaire can be submit, • 1st measurement will take 2 minutes, and proceed to attention training, • 2nd measurement will start right after attention training. • After 2nd measurement, it will proceed to History and send stress data to server. • Check stress data for both questionnaire and HRV measurement • Check stress data submitted to the web server (FOR Admin) • View and Edit User's profile successfully
Pass/Fail	Pass

Test Case	Full process with Measure without Questionnaire
Test Procedure	1. Register and login 2. Put finger at the camera before Click Measure without Questionnaire button 3. Wait 2 minutes for HRV Stress Measurement 4. Proceed to Attention Training 5. Restart HRV Stress Measurement for 2 minutes 6. Check stress result on History 7. Click Profile on Drawer, edit some of the fields 8. Click Done button
Expected Results	• Register and successfully login, • 1st measurement will take 2 minutes, and proceed to attention training, • 2nd measurement will start right after attention training. • After 2nd measurement, it will proceed to History and send stress data to server. • Check stress data for both questionnaire and HRV measurement • Stress data for questionnaire will be 0. • Check stress data submitted to the web server (FOR Admin) • View and Edit User's profile successfully
Pass/Fail	Pass

CHAPTER 10

CONCLUSION & RECOMMENDATION

10.1   Contribution of the application

This mobile application may have a huge contribution for the community, as by using smartphone which are so convenience and portable, it will encourage people to determine their HRV stress level anywhere anytime. These HRV stress measurement only need to take just around 10 minutes with attention training provided during the measurement phase, hence it only take quite a small time to determine the HRV stress level and at the same time lower the stress level through the attention training.

This application not only determine the HRV stress level, it also provide heartbeat per minute measurement, hence it not just providing one function. Both of these HRV stress and heartbeat measurement can be determine in the offline state, which is another benefit of these application.

Moreover, all the stress data will be post to the web server for storage and analyse, where these stress data might be used as a HRV research which may help contribution in the future stress understanding. Hence, these mobile application not just providing convenience for the user, but also allow users to participate in research on HRV stress for a better medication treatment on stress in future.

10.2   Limitations of Application

During the camera HRV stress measurement, there might be some noise recorded where these noises may cause the inaccurate of the result. These noise might be caused by the finger's background movement or hand vibrating or insensitive of the mobile's camera. Moreover, this mobile application are using SQLite database, where user's stress data will be store in the local mobile device only. Hence, this is another limitation of this mobile application.

10.3   Future Enhancement

- Provide more attention training in the mobile application
- Have a better and comfort user interface design

10.4   Publish Mobile Application to Google Play Store

Mobile Application already successfully published on the Google Play Store for other users to download.
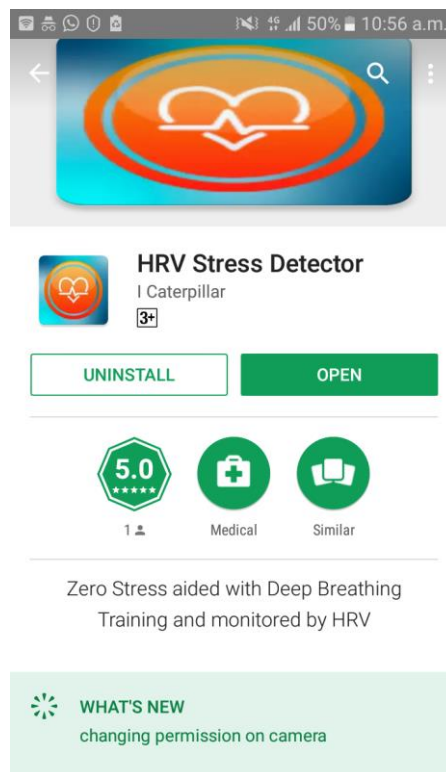
10.5   Conclusion

This project has been developed for over 6 months, since the starting of submission proposal, gather requirement, designing the mobile application, developing the mobile application, and testing on the mobile application developed. And most of the process were done according to the Gantt Chart stated above.

For the requirement gathering, it is gather by using Questionnaires that had been answered by people from different age groups. The result gather from the Questionnaire were analysed to generate functional and non-functional requirement. Research also one of the method that had been used to gather the requirement as well.

While for the design phase, rough prototyping had been developed with storyboard provided as well, to discuss with supervisor for a better design. Moreover, Use case diagram, ERD diagram, DFD diagram and flowchart also designed at the design phase.

During development phase, the implementation of camera and flashlight of smartphone had been completed with Android Studio. Then calculation of heartbeat per minute, Interbeat Interval (IBI) and Standard Deviation of normal-to-normal intervals had been calculated using Java Programming in Android Studio. Creation of functionalities like database, listing view, and user interface are implemented using Android Studio as well.

Testing phase were conducted during the development phase. Testing like unit testing, integration testing and system testing had been done in order to make sure that the mobile application are free of bugs and function as expected. Moreover, testing also have another purpose which is to make sure the project fulfilled the requirements and objectives of the project.

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APPENDICES

APPENDIX A: Questionnaires

1. Age *

_____

2. Gender *
Mark only one oval.

◯ Male

◯ Female

3. Current position *
Mark only one oval.

◯ Student

◯ Working

◯ Retired

◯ Other: _____

4. Salary:
Mark only one oval.

◯ RM 0 – 1999

◯ RM 2000 – 3999

◯ RM 4000 – 5999

◯ RM 6000 ++

5. How old are you when you start up your first career? *
Mark only one oval.

◯ Not yet start up my career

◯ 10-19 years old

◯ 20-29 years old

◯ 30-39 years old

◯ 40-49 years old

◯ 50 and above years old

6. When do you think was the most difficult and stress time you ever had in your life *

Mark only one oval.

- ◯ When studying at school
- ◯ When working for other people
- ◯ When starting up your own new business
- ◯ When you are maintaining your own business
- ◯ When you are retiring
- ◯ Other: _____

7. In your own opinion, did you think that you can handle the stress that you had stated above? (Please specify reason) *

_____

_____

_____

8. In your own opinion, did you think that stress are benefiting you or not? (Please specify reason) *

_____

_____

_____

9. Which part of you had been affected because of the stress problem?

Mark only one oval.

- ◯ Physical
- ◯ Mental
- ◯ Both
- ◯ Other: _____

10. What is your ways of handling your stress issues? *

Check all that apply.

- ☐ Through entertainment (watch movies, hangout with friends, playing games and etc)
- ☐ Share out your issues with trustworthy people
- ☐ Seek for online stress release training
- ☐ Meditation
- ☐ Seek for professional medication treatment
- ☐ Other: _____

11. If there is a stress detector and attention training that may help you relief stress, and it is in the form of mobile application, will you consider of using it? (Yes or not, and please state reason) *

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12. Are you willing to share out your stress data with the mobile application developer for future improvement if the mobile application above exist ? (Yes or not, and please state reason) *