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Development of a mobile software application for cardiovascular fitness norms

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ABSTRACT

Mobile software application has become a part of today's lifestyle. This mobile app is designed to help society to be physically active. The application is named UPNM Cardio Fitness, and is developed on the Android platform. The original purpose of the application is to measure and analyze the level of cardiovascular fitness of 18 year old cadets through a 2.4 km run test. The application is based on a data base using Google Fusion Table that stores and analyses the data received. The application consists of two parts: information of the individual and their respective fitness norms that can be accessed either automatically or manually. The classification of the norms is obtained from the fitness norms of 120 male cadets aged 18 years old. The norms are grouped into five categories which are: Excellent, Very Good, Good, Moderate and Poor. The software consists of 5 hyperlinks which are the main page, individual information, test result, file and record. The application is created using MIT App Inventor Software and Windows 7. The creation of the application has enabled researchers particularly in the Science Training program in UPNM to carry out tests as well as to identify the level of fitness of their trainees immediately, accurately, and systematically.

1. Introduction

Information Communication and Technology (ICT) revolves all aspects of technology as the medium of information dissemination such as radios, televisions, smart phones, computers and internet. Rapid advancement in ICT creates a lot of impacts in almost every aspects of life. It is used in broadcasting news, sharing educational knowledge including updates on health issues. The development in the field of technology has changed ways human being learns and work (Sharples, 2000). This is due to the globalization of technology that leads it to be perpetually and continually developed throughout time. Combining the creativity and innovation of the researcher, the mobile app is introduced as something new that has never been created before. This is because technology has been used as a bridge between individual experience and existing knowledge, with new knowledge that is taught and learned through the delivery of mobile application used (Salman, 2010).

The advent of technologies has expedited and simplified the workloads that were previously difficult to carry out particularly in mass production. For example, in car-making, human energy is the first widely used resources in the production of cars in the factory. With the emergence of increasingly sophisticated technology today, robots are programd through computer systems to operate, automatically replacing human labour in the production of cars. Besides that, space exploration is no longer an impossible feat. There are numerous researches that are still ongoing regarding the outer space using modern technologies. There is even a package to travel into outer space provided by Virgin Galactic. The company offers 3 days space trip as an astronaut to experience outer space with the fee of USD 250,000.

Furthermore, new gadgets and gizmos are continuously introduced as can be seen in the latest trends in the market. A particular gadget is chosen by end users because they are handy, portable and convenient to be taken along everywhere. For example, digital single-lenses reflex (DSLR) was previously a camera of choice by many, but has seen its sales dwindled as users find it bulky and expensive and opt for the latest smartphones with high-definition camera which has become the preferred device nowadays.

The development of mobile communication technology through the current application provides various alternatives to connect with people. For

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example, a mobile phone nowadays is no longer limited for the purpose of making calls and sending text messages through short message service (SMS) alone. Cell phones have evolved into smartphones with the addition of functions and features. Smartphones are equipped with amenities such as sending and receiving e-mail, multimedia messaging service (MMS) which is present in the form of a mix of music, images, animated sequences and short video recording. Smartphones also have a navigation tool, high-definition cameras and many other advanced features according to the model and specification issued by companies producing smartphones. Amongst the world's leading company producing smartphones are Apple, Samsung, Blackberry and Asus. In addition, users are able to surf websites provided there is a connection to the internet and utilise various applications. Wireless communication facilities are also provided to enable users using multiple applications that require internet access. It is unsurprising that a smartphone is the most popular mobile devise used by nearly 2 billion people around the globe as it has helped to facilitate everyday task.

Based on the current development in technology, as predicted, smartphones have become an indispensable communication tool for most people, especially youngsters (Shanmugapriya and Tamilarasia, 2011). The prevalence of using mobile technologies especially smartphones has shown a rapid speed in the ubiquities. This is supported by the convenience of the internet infrastructure for high speed internet access and WIFI facilities installed in most buildings. People are compelled to become digital citizens by having smartphones. Apart from the infrastructures provided, mobile application tools have also played a role in the increase use of smartphones. Smartphones are not purely designed to meet basic needs such as socializing using social applications, but it is designed to be more users friendly whereby anyone can use it despite not being IT savvy (Sarwar and Soomro, 2013).

2. Background

Fitness is defined as the condition that allows an individual to lead a perfect life and to deliver his tasks efficiently, and in turn produces useful contributions and services. Fitness consists of five components, which are physical, emotional, spiritual, intellectual, and social fitness. All the five components of fitness need to be adjusted and balanced in order for an individual to get on with his daily life. The sedentary lifestyle of people today has contributed to the declination of an individual's level of physical fitness. From the research Haron and Hussain (2010), majority of Malaysians have not been practicing a healthy and safe lifestyle. The condition is worsening as the decline in the healthy lifestyle increases with age. From the sociological perspective, fitness activities are generally perceived to be less beneficial. According to Kassim and Mokhtar (2015), physical fitness is a component that constitutes total fitness that is constantly being used in acting or in any order form of action. As the condition is inclining to be more serious, the society should be more aware of the importance of doing physical activities.

Previous studies have shown that physical activity is important in an individual's life. Every physical activity can be controlled by the use of fitness norms. Kassim (2012) stated that the important of coaches requiring knowledge in the coaching process are important to build up the quality of fitness level using the norms of physical fitness. Fitness norms refer to a guideline or a range of marks formulated after going through the process of calculating and analyzing a fitness test (Dove-Edwin, 2009). A research on a physical fitness norm has discovered the effectiveness of the program through running a test battery that has the fitness norms. The program was also proven to improve the quality of lifestyle related to health. On the other hand, motor-based fitness refers to the muscle potential and the ability of an individual to carry out physical activity in terms of balance, agility, speed, power, reaction time and coordination.

In addition, physical training is defined as training required preparing players' respiratory, energy, and muscular systems physiologically from aerobic, anaerobic, and strength perspectives (Kassim and Ali, 2015). This is supported by Kassim et al. (2014), fitness is defined as the condition that allows an individual to lead a perfect life and to deliver his tasks efficiently, and in turn produces useful contributions and services. Fitness consists of five components, which are physical, emotional, spiritual, intellectual, and social fitness. Consequently, according to Kassim et al. (2016) cardiovascular endurance is a most important component in the human physiology. It was concluded that trainers should choose and develop the pre-existing training program for it to be more efficient and dynamic. Hence, by being equipped with a device that can track the level of fitness of a person would increase one's awareness to lead a more healthy lifestyle and thus, creating a more productive and healthy society.

According to the fitness norms that have been produced in this research, the questions that arise are how will the norms aid in assessing a certain level of fitness of a person immediately and effectively. Secondly, whether or not the norms produced are able to motivate users to ensure their physical norms are at the most optimum level. The society will definitely want a fast and immediate result that can be obtained realistically. Generally, the process in managing and administrating the fitness norms nowadays is still using the conventional way which is by doing it manually (Wahab, 2011). Practicing these conventional methods does not only weaken the management system but causes various drawbacks such as the use of many forms for students' information, slow attainment of result and susceptible to high risk of

zero errors in the process. Besides that, the absence of physical fitness test information system and the inconveniences in operating the system on the computer are the factors of low usage of computers in managing the physical fitness at university level. The research therefore is aimed to ease the work by creating a mobile software application that can be used at the university level. The application is then downloaded to a smartphone to be accessed and used.

3. Objectives

The objective of this research is to measure and test the cardiovascular endurance level of 18 year old UPNM male cadets using a 2.4 km run test as the instrument. The second objective of the research is to create a cardiovascular endurance fitness norms based on the 2.4 km run test battery conducted. Thirdly, the objective is to create a mobile app through Android system based on the norms obtained.

4. Significance

The translation of data into an application that is being done in the research is something that has not been done before. The app is hoped to aid lecturers and physical trainers in managing as well as administrating a physical fitness test. The new system will inevitably improve the quality of the pre-existing management system. In addition, the creation of the app is crucial in managing the test results as there is no systematic way to save the information thus far. The app which is a computerized system helps other researchers to record, analyze and save the information of the students' physical fitness data to be stored online. The cadets can also find out quickly of their performance or the norms achieved from the test conducted.

5. Instrument

5.1. Cardiovascular endurance fitness norms

In order for the researcher to assess the level of physical fitness of a person in a study, there should be a test that is consistent with the subject matter of the study. The physical fitness test carried out in a study is considered as an instrument. Instruments in a research for a physical fitness test must have high validity and reliability in order for the result to be precise and indisputable (Hashim, 2004). In this study, the chosen instrument is a 2.4 km run test developed by Kenneth H. Cooper in 1968 for the US military (Cooper Institute for Aerobics Research, 2007). The 2.4 km run test has high validity, r=0.92, and r=0.86. After the 2.4km run test is carried out, the results are then analyzed. The cardiovascular endurance fitness norms produced will then be the guideline data to build the mobile software application that uses Android as the platform. The norms are to be accessed via smartphones.

5.2. Smartphone and Mobile Application

The smartphone is a combination of mobile phone and personal digital assistant (PDA). The mobile phone uses an operating system such as Symbian, Windows Mobile, Android, iOS, Palm, and numerous mobile softwares. It comes with internet access and is able to support multimedia applications (Mustafa and Hamzah, 2011). The 2 in 1 concept used in smartphones is useful to many users especially those who are frequently engaged in outdoor activities such as attending seminars or meetings, taking data of patients, retrieving serial number in hardware store, organizing daily routine, finding direction or for navigation purposes and many more. For the PDA to function, smartphones are equipped with a microprocessor and memory chips such as RAM, ROM or flash card (Song et al., 2013).

The operating system of a smartphone represents the producers. The two profound operating systems are Google's Android and Apple's iOS. Both of the operating systems have their own unique characteristics that represent the producer or company. Statistics has shown that smartphones using Android as the platform are more prevalent than others with a market share of 82% worldwide. The chart below in Table 1 shows the differences between Android market and other operating systems.

Table 1: Comparison of operating system market share worldwide

Period	Android	iOS	Windows Phone	BlackBerry OS	Others
2015Q2	82.8%	13.9%	2.6%	0.3%	0.4%
2014Q2	84.8%	11.6%	2.5%	0.5%	0.7%
2013Q2	79.8%	12.9%	3.4%	2.8%	1.2%
2012Q2	69.3%	16.6%	3.1%	4.9%	6.1%

Smartphones using Android as the platform is sold more than Apple products and is gaining popularity amongst consumers around the world as they are user friendly and easily handled (Walker, 2011). Android app is an open source operating system for smartphones powered by Google Corporation, the world's leading search engine company. Most android apps available on the platform provided by Play Store are mostly free and easily accessed (Fig. 1).

6.1. Construction of cardiovascular fitness norms

The research is done through experimental observation. It is designed to use the pre-existing instrument developed by Cooper Institute. Descriptive statistics analysis through SPSS version 20 was used to calculate and interpret the data. The findings have enabled the researcher to describe the frequency, percentage, mean and standard deviation of the existing demographic variable such as sex, race, height and weight. The samples of the study are 18 year old UPNM Foundation Program male cadets for admission in the 2013/ 2014 session. A total of 120 male cadets carried out a fitness run test of 2.4 km representing 30 per cent of the total male cadets in the foundation program.

Fig. 1: More and more users use smartphones to manage their daily affairs (Picture for illustration)

6. Methodology

6.1. Application production

The cardiovascular endurance norms produced are then used as the main data for the production of the mobile application. The method of production of the mobile application is using the System Development Life Cycle (SDLC) model. It is a form of a database system development cycle and operation of the software. According to Kissel et al. (2008), the SDLC model consists of 6 phases, and they are: preliminary investigation, system analysis, system design, system development, system deployment and maintenance phase. These phases are cycles for the working of a process that will identify the strength or weakness of every phase. The first phase which is the preliminary investigation phase is the phase for producers of the app to identify the problems and needs for information systems. In the first phase of this research, the producer has identified and recognized that there is still no application system created specifically in recording, Applications such as Facebook, Instagram, and WhatsApp have become a necessity to be installed in a smartphone. The applications in Android software have inevitably invite, motivate and attract a person to enhance their life such as monitoring daily food intake, physical activities and their movement (Hanafi and Samsudin, 2012). For example, many smartphones users use Android application to organize their daily activities including physical activity, such as the amount of steps walked by a person in a day saving and managing the cardiovascular endurance physical fitness test information of cadets.

The second phase is the system analysis whereby the system analyses new requirements which a specified system needs after the current system is studied in depth. This phase is the most crucial phase because developers can develop the application based only on its needs to carry out the process easily as planned. The hardware required in this study is a computer and a mouse whereas the software required is online MOT Apps Inventor and an internet connection. MIT App Inventor is used because it is done virtually in the cloud by the website *http://ai2.appinventor.mit.edu/* and does not require an installation of the app in the computer system. Problems and needs of the end users will be analyzed in more detail so that the goals can be achieved.

The third phase is the application design phase. There are three main tasks in this phase, and they are: providing alternative application, choosing the best application design, and writing an application design report. The application producer will create more than one design to fulfill the need for information. Required specs from the previous phase will be studied and the application design will be prepared in this phase. The desired feature and operation will be described in detail including screen display, functions, hardware and software.

The fourth phase is the application development phase. In this phase, the application is developed using the software and hardware. The application is then put into work to test its functionality. A test typically takes about 2 weeks especially if it is complex. All feedbacks and responses are taken to ensure all procedures have worked out as planned.

The application deployment phase is the fifth phase which is the installation of the new system. End users will be taught and guided in using the application. Another name for this phase is the application conversion because there are conversion processes or changes from the older system to the new one. End users will be trained to use the new application accordingly.

The last phase is the maintenance phase whereby maintenance begins with updating the application. Evaluation is then made to see whether the application is productive and dynamic (Fig. 2).

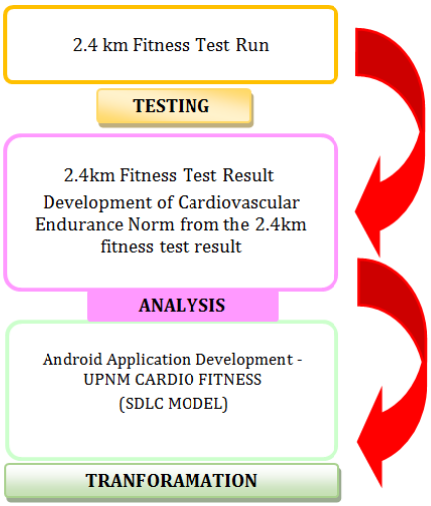

Fig. 2: Research framework

7. Results

7.1. Result and norm production

All respondents were randomly selected for this study. Descriptive statistics showed mean scores and standard deviations for all respondents involved in the 2.4 km run test (M=10.86, SD=0.91). Table 1 shows the test scores of the students in the 2.4 km run test. The minimum and maximum time recorded is 9.17 and 13.13 mins while the median and the skewness showed 11.13 and -0.036. The statistics/ data produce a bell-shaped curve to show normal distribution (Table 2).

Table 2: Descriptive statistics for UPNM foundation program male cadets

Minimum	9.17
Maximum	13.13
Mean	10.8646
Median	11.1350
Std. Deviation	.91960
Skewness	-.036
18 year old Male N	120

Table 3 shows the test result of the norms from the 2.4 km run test conducted on the male cadets. There are 5 predefined classifications in the production of a particular grade of fitness norms, and they are: Excellent (5), Very Good (4), Moderate (3), Satisfactory (2), and Poor (1). According to Hashim (2004), grading a test enables a set of people to be classified according to their abilities and achievement. Every level states the scores achieved starting from the highest to the lowest which is 5 to 1. Norms are also used by the National Physical Fitness Award Singapore (NAPFA). From the table, the highest achievement which is Excellent with the score of 5 starts from 9:40 and below, the next level is Very Good with the scores of 4 is from 9:41 to 10:40, the Good level with the score of 3 is from 10:41 to 11:31, and the satisfactory level with the score of 2 is from 11:31 to 12:24 and lastly, the Poor level with the score of 1 is from 12:25 and above.

Table 3: Cardiovascular endurance physical fitness norms for 18 year old UPNM foundation program male cadets

Category	Score	Duration (mm:ss)
Excellent	5	< 9:40
Very Good	4	9:41 - 10:40
Good	3	10:41 - 11:30
Satisfactory	2	11:31 - 12:24
Poor	1	12:25 >

Note. (mm:ss)=(minutes: seconds)

Table 4 shows the result of the research conducted. A total of 120 respondents have been tested and found there were 2 recorded excellent results. 31 people posted good results, while 37 people are in the medium level (3); for low level (2), recorded a total of 43 people and 7 people for low level (1) after referring to fitness norms cardiovascular endurance.

Table 4: Total cadets for each cardiovascular endurance physical fitness norms level

Cases			
18 Male cadet	Score	Time	N
	5	< 9:40	2
	4	9:41 - 10:40	31
	3	10:41 - 11:30	37
	2	11:31 - 12:24	43
	1	12:25 >	7
N			120

7.2. Application development

The application is named 'UPNM Cardio Fitness'. The app is produced to measure the level of cardiovascular endurance of 18 year old UPNM male cadets. The application is produced using a software program developed by Google which is then taken over by MIT. This software can be accessed through Gmail account via website which is *http://ai2.appinventor.mit.edu/*. The researcher created a Gmail account specifically for this study which is *norm.upnm@gmail.com*. The account is officially dedicated to the construction of the mobile app. Fig. 3 shows the front page of the software used to developed the 'UPNM Cardio Fitness' mobile app.

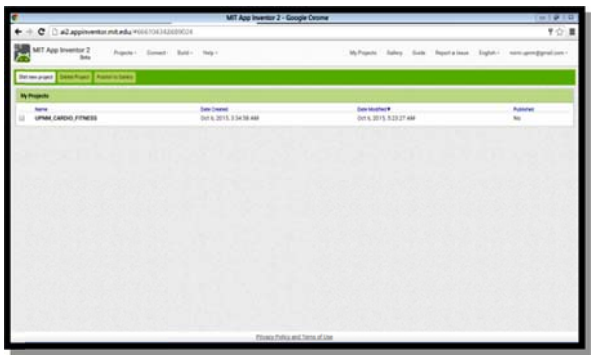

Fig. 3: View of the front page of MIT App Inventor 2 Software used to build mobile application

The researcher was required to create a specific file using .aia format in the process of building the app. By using the format, the application is

developed by following the guidelines in the app's construction framework. Tutorials are provided in building the app by MIT. They have prepared the process and procedure for those who intend to create their own application. The tutorials have facilitated the researcher in building the app. interestingly; MIT App Inventors 2 does not require an Android emulator to run as the application player. The software uses an emulator developed by MIT AI2 Companion itself that can be downloaded straight to the smartphone. Hence, the researcher could run and test the application at the same time (Fig. 4).

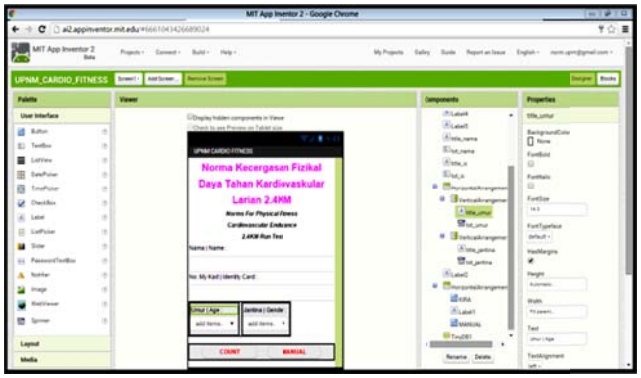

Fig. 4: Interface features of MIT Apps Inventor through the *UPNM_CARDIO_FITNESS*.aia file

The researcher then changed the format from .aia to .apk to test the application. The application is downloaded from the registered account into the smartphone. The smartphone will open the UPNM CARDIO Fitness application. Fig. 5 below shows the UPNM Cardio Fitness app that has been installed into a smartphone.

After the installation process, the app can then be opened. The installation process takes about 1-2 minutes depending on the specs of the smartphone used. The app can be installed on all smartphones running different versions of Android as the platform.

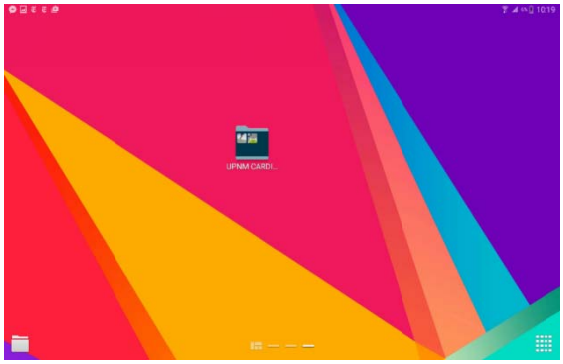

Fig. 5: UPNM Cardio Fitness app installed into a smartphone

Once installed, the icon of the app is selected and the homepage is displayed as shown in Fig. 6. The front page displays the information that needs to be filled, and they are: name, identification card number, age and gender. The information is saved together with the 2.4 km run test result conducted. After the information on the front page is completed, users have the opportunity to use the application by running the 2.4 test and get instantaneous result. Users have two options to choose either 'count' or 'manual' by selecting the icon at the bottom of the page. 'Count' serves to start the 2.4 km run test as the user starts running. The result will be displayed automatically. As for 'manual' icon, the users need to enter the duration in the 2.4km run test on their own, only then the test results will be displayed.

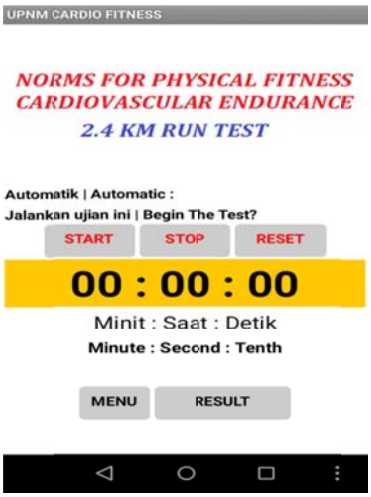

Fig. 6: The front page of the UPNM Cardio Fitness application on MIT App Inventor 2

Fig. 7 shows the front page when 'count' button is selected. The display shows a digital stopwatch that will be automatically activated for the 2.4 km run test carried out by the end user. There are 'start', 'stop', and 'reset' buttons. Users may follow the instructions displayed on the page. 'Result' button is selected to get the run test result immediately. The result is displayed according to the time recorded. A 'menu' button is provided at the bottom of the page to return to the main menu.

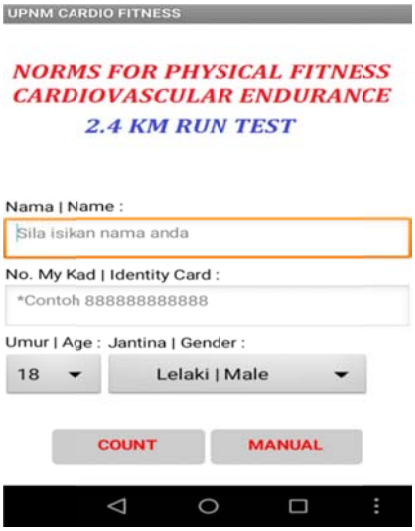

Fig. 7: Display of the front page after the 'count' button is selected

The user selects the 'manual' button to know his or her level of achievement or performance in the run test. The image displayed after the button is selected is as shown in Fig. 8. Users only need to

enter the duration of the run according to the formats used for time. The units according to the formats used for time are minutes, seconds and tenth of a second. Then, the 'result' button is clicked to get the run test result and the level of achievement.

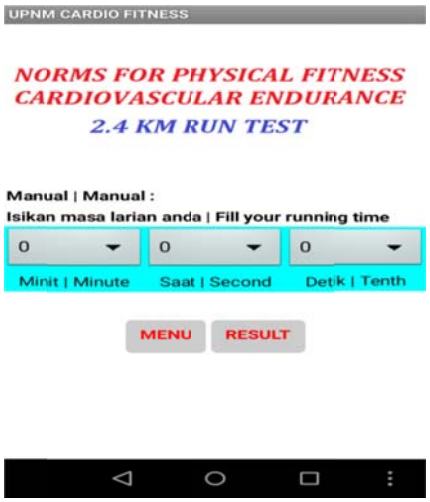

Fig. 8: Front page after 'manual' button is selected

The displayed 'result' page shown in Fig. 9 shows the result in the 2.4 km run test by a user. Users get an immediate result that will be displayed according to the fitness norms uploaded in the application. The cardiovascular endurance fitness norm of an 18 years old male is used as the database in this application. The page shows individual details filled at the home page of the app. The additional feature available on this app is that each recorded time using this app can be stored in the cloud using Google Fusion Table. A 'save' button is provided for storing data in Google Fusion Table.

Fig. 9: 'Result' page displayed after run test is conducted either automatically or manually

When the 'save' button is selected, the data is stored immediately into the Google account via Google Fusion Table. Google Fusion Table is an additional feature to manage data to be stored virtually or online (Gonzalez et al., 2010). Google Fusion Table was launched in June 2009 by Google Inc. The upside of this function is that data can be accessed anywhere by using internet and a Google account. This method makes it easier for researchers to access data and conduct studies for the next data collection (Fig. 10).

Fig. 10: Page displayed when 'save' button is selected

8. Discussion and implication

Developing a system using technology that changes from a medium to another is not an easy thing to achieve, however it is not impossible. Although the UPNM Cardio Fitness application is not as sophisticated app available in the market, it is the first step in developing a more sophisticated and detail-oriented app in the future. The first objective of this study is to measure the level of cardiovascular endurance fitness test through the 2.4 km run test by a group of UPNM cadet officers aged 18 years old and obtain the fitness norms. The level of cardiovascular endurance based on the fitness norms produced guided by the procedure and administration outlined by The Cooper Institute is at the satisfactory level. Based on the analysis, the cadets recorded a passing mark by achieving at least a score of 1 in the run test. The result of this research almost resembles the result that was conducted in the study by (Cooper Institute for Aerobics Research, 2007). Many thought that physical activity and physical fitness are directly related. However, they are defined differently and used in a different context. Physical activities can contribute to physical fitness. Discipline and methods of training must be strictly followed to produce expected results to achieve physical fitness by carrying out physical activities.

The second objective is to build a cardiovascular endurance fitness norm based on the 2.4 km run battery test. The norms were produced from the test conducted on a total of 120 male cadets. The test result is then analyzed to construct a fitness norm. However, the norm is limited to male individuals aged 18 years old only. Data mining and production of norms with age ranging from 17 to 25 years old are needed so that the norms can be compared in the future research.

The third objective is to build a mobile application through Android system based on the

cardiovascular endurance fitness norm produced. The app, called the UPNM Cardio Fitness was successfully produced using the fitness norms as the baseline of the product. The production has created a new dimension of storing and managing information from the transformation of a test result that can now be easily obtained and accessed. The views and ideas from a committed technology expert have helped the researcher in making sure the goals are achieved. The additional functions in this app can be updated and enhanced from time to time as there are many elements of fitness from other sports that can be included into the application. The new app can be shared easily and is user-friendly.

9. Conclusion

The study found that cardiovascular endurance level of 18 years cadets at a moderate level. This is because only 60 % of the total respondents had modest achievements and above. While the rest had a low and weak achievement. Results of this study provide feedback to the Academy of Military Training (ALK) NDUM to devise a new system of physical exercises or modify existing training system for provide more dynamic and vibrant army in future. Same as suggestion by Kassim (2014), applying or translating knowledge into practice, coach should outlining the aims of the season and preparing the necessary plan to achieve them essential and a form part of the organizational skill of the coaches. In the same time, the training should compatible in the whole team and that is important tasks of the coaches.

Overall, the product of this research which is the cardiovascular endurance fitness norms for 18 year old UPNM Foundation Program male cadets can be used as a guideline to measure the overall level of fitness for the reference of many people. With the production of the norms, the level of cardiovascular fitness norm for an 18 year old male can be assessed through the 2.4 km Run Test. The norms measures and determines the level of fitness accurately when the test is done. Generally, the fitness norms benefit a lot of people especially teenagers who fall into the age category of interest. Amongst the benefits are not only to know the level of fitness but also acts as the motivation to create a better lifestyle that is healthy and safe.

Hopefully, the research gives an impact to several parties which are involved in the management of sports team particularly for trainers to harness the privilege of using technology in recruiting the talents especially in sports. Therefore, it is crucial to have full understanding on the efficient training system to produce quality and planned goals for any team or athletes. Consistent with the research conducted by Silverman et al. (2008) that proposed an efficient training system using fitness test procedure, it should have high potential to make it as an interesting experience to attract people involved especially youths. In addition to the technological aspect that gained attention especially the millennial who want to obtain information easily without depriving the quality of the information.

The outcome of this research could be patented as the proprietary of the UPNM and also utilized as a fitness guideline to produce fitness norms for every age and gender in Malaysia.

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