ElecTrack - Mobile Electricity Usage Tracking and Visualizing

By

KELVIN NGU TECK YEUN
Matrix ID: 13096

Dissertation submitted to

Computer Information Science (CIS) Department

Universiti Teknologi PETRONAS

In partial fulfillment of the requirement for the

BACHELOR OF COMPUTER & INFORMATION SCIENCE (Hons)

(INFORMATION & COMMUNICATION TECHNOLOGY)

May 2013

Universiti Teknologi PETRONAS
Bandar Seri Iskandar
31750 Tronoh,
Perak Darul Ridzuan.

CERTIFICATION OF APPROVAL

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Prepared by	Approved by,
_____	_____
(KELVIN NGU TECK YEUN)	(PROF. DR. ALAN OXLEY)

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CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

_____

(KELVIN NGU TECK YEUN)

ABSTRACT

The main objective of this project is to develop an electricity usage tracking application for all mobile Android platform to effectively track their electricity usage over time and hopefully will also help to raise awareness towards the conservation of energy and preserving the quality of the environment. This application features the ability of monitoring the electricity usage, by using the inputs that the users had entered to calculate the total electricity consumption based on the unit Watts (W). Another important feature of this application is the functionality to visualize the overall electricity consumption in various graphical forms as an approach for the users to review the distribution of their electricity consumption.

Researches and studies were done on several articles, research papers and other sources of information related to the subject. A number of previously conducted experimental studies were also used to support the study and development of this project. These sources of references were critically analyzed through an extensive research methodology whereby every key aspects of the information were extracted and used for literature review. The development of this application will be conducted in Java programming language, by utilizing Android Software Development Kit (SDK) to support the development of this application.

The methodology used for the development of this application is Rapid Application Development (RAD) – Prototyping method. The justification for the selection of the above methodology is because of the time constraint for this project. Therefore, this method is the most suitable since it involves fast and interactive development processes of the prototype which will suit this project the best. The prototypes are tested continuously for feedbacks until the final prototype is ready to be released. The final release of the prototype is also tested with potential users for usability and acceptance testing.

The final prototype is able to provide dynamic feedback for households' electricity consumption and by providing tailored information regarding electricity consumption pattern, awareness towards energy conservation can be raised.

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Abbreviations and Nomenclatures

1. GWh – Giga Watts hour
2. OS – Operating System
3. RM – Ringgit Malaysia
4. W – Watt
5. NEP – New Energy Policy
6. MTOE – Million Tonnes of Oil Equivalent
7. CO2 – Carbon Dioxide
8. SESCO – Sarawak Energy Company
9. TNB – Tenaga Nasional Berhad
10. SDK – Software Development Kit
11. NDK – Native Development Kit
12. API – Application Programming Interface
13. RAD – Rapid Application Development
14. SDLC – Software Development Life Cycle
15. WBS – Work Breakdown Structure
16. ADT – Android Development Tool
17. XML - Extensible Markup Language

Chapter 1

INTRODUCTION

1.1 Background of Study

Our quality of living is improving tremendously due to the advancement of Science and Technology. These advancements have brought us various mean of comfort and luxuries. One of the biggest discoveries is the invention and discovery of the use of electricity. Imagine a world where you couldn't switch on the lights, computers, machines and mobile phones. Our lifestyle will be so much different from what we are experiencing today without electricity. Electricity is a form of energy fueled by the electron transfer from positive end to negative end within a conductor. Today, electricity is essential and is used widely in our daily life, such as providing power to buildings, machines and electrical appliances. (Business Dictionary, 2009) Unlike oil and gas, electricity is manufactured through different methods of electricity generation and it is delivered through copper wires to the consumers to where they are utilized. It is the most flexible form of energy and it can be adapted to a huge, growing number of uses and purposes.

Today, we are stepping into an era of mobile phones and portable devices. The popularity and range of mobile devices especially the smart phones and tablets are increasing rapidly in the recent years. During the last decade, mobile phones only serve as a mean of communication. However, from what we observed today, mobile phones had moved beyond just a mode of communication. With the drastic improvements of mobile operating system (OS) as well as mobile hardware, mobile phones are capable of doing more complex tasks. Competition between mobile phone manufactures encourage them to continue to strive and perform by bringing new mobile technologies to the eyes of the world with very affordable prices. Apart of Apple iOS and Windows mobile platform, another popular mobile platform is the Google Android. Android is currently

the most popular operating system for smart phones (Hughes V. , 2012). Android OS is offered in huge range of products with variety of price range since Android OS is offered in various devices manufactured by different manufacturers.

In a nutshell, this project is an effort of developing a mobile electricity usage tracking application for mobile Android platform for the public use to effectively track their electricity usage from time to time and hopefully will also help to raise awareness among public society in reducing the wastage of electricity as a small steps in conserving energy and natural resources. Hopefully, people can gain benefits through this application in lending a hand in energy conservation.

1.2 Problem Statement

It is a true fact that our natural resources are limited and the environmental quality is depleting day by day. There are many factors which contribute in the depletion of environment quality and one of the major root causes is excessive use and wastage of electricity. People nowadays pay very little attention to the electricity usage around them because the cost of electricity nowadays is relatively affordable. The lights are always switched on, fan and air conditioners are running all the time, televisions and computers are switched on without people watching and using. All these practices and behaviors can lead to huge wastage of electricity without us realizing it. People generally take electricity for granted, false-fully thinking electricity can always be regenerated. The fact is electricity is generated and distributed on demand. (Happy Home, 2008) Electricity manufacturing through energy generation methods involving combustion can lead to emission of greenhouse gas, while non-combustion generation methods will cause other environmental issues. If the demands of electricity increased, more power generation plants, for example, hydroelectric plants, nuclear power plants et cetera will need to be constructed. These constructions will certainly inflict other form of damages and pollutions to the environment. For example, the construction of Bakun Dam hydroelectric plants in Sarawak which involves flooding large rivers valley to a total land of 700km^2 can leads to the loss of habitats for animals and plants and disrupting the ecological balance at the same time (Williams & Trush, 1995). Besides, The diversion of water can

also impact stream flow, or even cause a river channel to dry out, degrading both aquatic and streamside habitats. (The Environmental Literacy Council, 2008) There is simply no way to avoid from pollution.

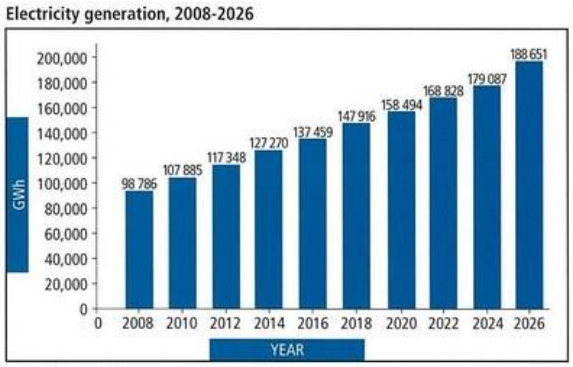

Figure 1: Power generation in Malaysia from 2008 to 2026

Source: http://www.poweroilandgas.com/2011/10/malaysia-power-generation-and.html

The graph above shows the power generation in Malaysia from 2008 up to present (2013) as well as forecast result from present to 2026 in Giga Watts per Hour (GWh). It is very obvious that the total electricity generation is showing a drastic increment. Malaysia is currently relying on multiple sources of electricity generation methods.

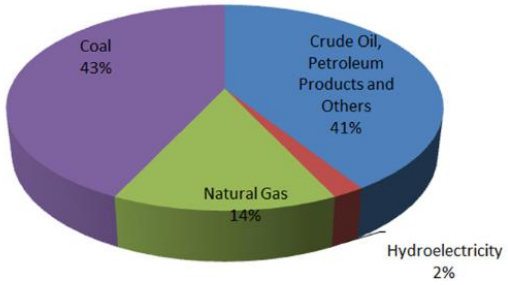

Figure 2: Power generation methods in Malaysia

Source: http://www.globalccsinstitute.com/location/malaysia#overview

As observed in the pie chart above, Malaysia is still relying on fossil fuels (petroleum, crude oil and natural gas) and coals as main power generation methods and only 2% of total electricity generated is generated through hydroelectricity. In short, the root of this problem is that people nowadays are not fully aware of the amount of electricity they are wasting everyday and how their actions will impact the environment, therefore having the tendency to waste electricity unconsciously.

1.1 Objective

1.2.1 General Objective

The main objective of this project is to develop an electricity usage tracking application. This application's focus group will be the public people, focusing on households instead of other sectors, such as industrial and transportation. This application will be developed for Android platform devices such as mobile phones and tablets to assist people in keeping track of their electricity consumption effectively.

1.2.2 Project Objective

- To propose the development of electricity tracking application for Android Platform.
- To develop an effective electricity usage tracking application with the ability to calculate the approximate cost for electrical usage and visualizing the distribution of electrical consumption in various graphical form.

1.3 Project Scope

The scopes of this project are:

- To develop an Android application prototype with the ability to keep track of electrical consumption, calculate approximate cost of electricity usage and visualizing the distribution of electricity usage.
- The target user for this application is the public people, which made up of the majority of the electricity consumer.
- The user interface of the prototype will be using English as its main language.
- The cost of electricity will be calculated in Ringgit Malaysia (RM).
- The measurement used to measure electricity will be Watt (W).

Chapter 2

LITERATURE REVIEW

2.1 Literature Review on "Energy for Sustainable Development in Malaysia: Energy Policy and Alternative Energy"

By,

Abdul Rahman Mohamed and Keat Teong Lee

This paper studies the importance of energy as vital component in economic and social development. Due to this, concentrated efforts are being undertaken to ensure the sustainability of energy resources. Undeniable, energy is the pushing factor which helps to promote continuous development and economic growth. However, due to increasing energy demand, more and more energy production facilities are being constructed to meet the demand. Energy production can contribute to local environment degradation, such as air pollution, global and environmental problems and even climate change. The demand of energy is expected to increase worldwide over the next 24 years, (International Energy Outlook, 2004). In order to meet increasing demand for energy, power industry will need to have an effective sustainable energy policy. The figure below shows prediction for energy demand for duration of 50 years from year 1980 to 2030. From the overall energy forecast, a significant increment of energy demand is observed.

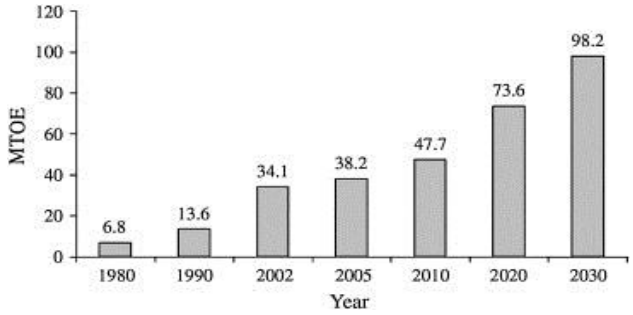

Figure 3: Energy Demand in Malaysia.

Source: APEC (2006)

Throughout the years, Malaysia has formulated numerous energy related policies to ensure long term energy supply to meet energy demand. The various energy policies included The National Energy Policy (1979), National Depletion Policy (1980), and Fuel Diversification Policy (1981, 1999) (MIEEIP, 2002). The Fuel Diversification Policy in Malaysia is continuously reviewed to ensure that the country does not become too dependent on one source of energy. Currently, Malaysia is adopting Five-Fuel Diversification Strategy energy mix which comprises of five main sources, namely natural gas, coal, fuels, hydro and renewable energy (Suhaida Bt Mohd & Dr. Tang Chin Sin, 2011). Apart from that, Malaysia also looks into other possibilities of alternative energy, such as solar, hydrogen fuel cells, landfill gas et cetera.

As conclusion, the paper shows that Malaysian energy sector is still heavily dependent on non-renewable source of energy, such as fossil fuels and natural gas as the main source of energy. These non-renewable source of energy will one day be depleted and also contribute in emission of greenhouse gas. Therefore, government should take proactive approach to promote and use energy generated based on renewable source of energy. (Mitchell, 2004) Energy consumers in the other hand should also play their role in conserving energy to ensure that energy are put to proper use and are not wasted.

2.2 Literature Review on "Analysis of Sectorial Energy Conservation in Malaysia" By

Anwar Al-Mofleha, Soib Taiba, M. Abdul Mujeebub, and Wael Salaha

This research paper describes the sharp increment of electrical energy consumption over the past years and that modern energy efficient technologies are desperately in need to conserve the vast energy consumption as mentioned in National Energy Policy. Based on the research paper, the per capita energy consumption of the majority, especially in developed countries are increasing tremendously. Due to high demand for energy, energy growth is undergoing major development to provide sufficient supply of energy to meet the demand of energy. However, the cost of saving one unit of energy is extremely nominal as compared to the cost of energy production. Hence, it is important to consider all measures for energy conservation. Malaysia has a very diversified energy sources which concentrates mainly on fossil fuels, coal, natural gas and hydro. The 9th Malaysian Plan (2006-2010) emphasizes strongly on the security, reliability and cost effectiveness of energy.

In year 2001, the total energy demand of Malaysia is 31.5 MTOE (Million Tonnes of Oil Equivalent). Transportation and industrial sectors were the two dominating energy consumer at that time and these two sectors consumed over 80% of total energy demand in year 2001. In year 2006, the total energy demand of Malaysia shows a significant increment of 5.3 percent at 40.3 MTOE compared to 38.2 MTOE in 2005. All sectors showed an upward trend in year 2006, except for the transportation sector, whereby 42.1% in industrial sector, followed by 36.7% from residential and commercial sector, 0.6% in agricultural sector and 7.0% in miscellaneous sector. In short, the main focus of energy consumption in Malaysia is within the industrial sector, manufacturing sector, transportation sector and residential and commercial sector.

To summarize the whole research paper, this paper basically describes the distribution of energy within Malaysia into different sectors and how the total energy demand had increased drastically for the past 10 years. This paper also includes several alternatives to help achieving effective energy conservation in various sectors.

2.3 Literature Review on "Eco-visualization: combining art and technology to reduce energy consumption"
By

Tiffany Grace Holmes

This paper attempts to elaborate on how combination of art and technology in information visualization helps to initiate reduction of energy consumption. Combination of art and information that displays the real time usage of key resources, in this case refers to electricity consumption offers a new strategy to assist in energy conservation especially at home and workplace. Real time data visualization can be an intense tool for promoting energy conservation behavior among people (Margolin, 2006). The scope of information visualization may come in several forms, including color, media art and animation to represent quantitative facts and results which are often dynamic, for example, number. By integrating this dynamic information into these urban architectures as public art, this hybrid art and design practice serves as an alternative method of communicating ecologically vital, site-specific data as well as an innovative method to motivate people towards energy conservation (Wattenberg, 2005).

Several behavioral studies proven that most people have are not aware of how much electricity they use on a monthly basis. A research was conducted entitled "Relating attitudes to residential energy use" by a behavioral psychologist, Peter Crabb, proves that people don't use energy directly, in fact, they use products, which indirectly runs on energy. This preliminary study and literature review suggests that by displaying electricity consumption in real time, there is a potential to reveal a visual pattern to consistently reminding people regarding energy conservation consciously and unconsciously.

In short, this paper concluded that energy visualization provides a strategy for localized energy conservation which combines both artistic and scientific information to present dynamic data representation in a much more effective and attractive way. By showing hidden environmental information, such as kilowatts of electricity used, in a more visible way to a resident population, people become more sensitive with the amount of electricity they used daily and thus, becoming aware of energy conservation.

2.4 Literature Review on "Visualizing energy consumption activities as a tool for making everyday life more sustainable"
By

Kajsa Ellegard, Jenny Palm

The purpose of this research paper is to discuss the importance of visualizing household energy consumption to assist in energy conservation. This research paper emphasized that reducing CO2 emission has the highest priority in determining a more sustainable environment. Household sector accounts for nearly one third of global energy usage. Most energy used in household sector is for the purpose of creating a more comfortable lifestyle at home, for example, regulating indoor climate, entertainment value, and conveniences. (Steg, 2008)

Often, energy efficiency advice is too general that households have difficulties relating it to their daily life. Therefore, it is very important to relate information to households' personal energy consumption in everyday life if they were to implement and practice based on energy efficiency advice. Therefore, there is a need to analyze and understand energy consumption in relation to household's activity pattern to achieve maximum energy efficiency in households.

By visualizing the energy consumption activity patterns in households, household member can discover how, where and when and what is the purpose of the energy usage. This will provide a very direct feedback to the household member since visualization is based on their own information and activities. (Lofstrom & Palm, 2008) Case studies were conducted over the research whereby energy consumption pattern is visualize to several households and energy use was successfully reduced when specific information was combined concrete measurement techniques and art.

Visualization model helps to visually display information on a person's behavior patterns in household and facilitates the interpretation of energy consumption level for each household activity in a specific period of time. A better and clearer view on everyday's energy consumption pattern can be obtained helps to provide feedbacks on method of focusing and promoting energy efficient behavior.

2.5 Literature Review on "Emission of greenhouse gases from the use of transportation fuel and Electricity"
By,

M.A. DeLuchi

The main objective of conducting this research is to present the estimate of the emission of greenhouse gases due to the usage of transportation fuel and electricity. The data covers emissions of carbon dioxide (CO2), methane, carbon monoxide, nitrous oxide, nitrogen oxides, and non-methane organic compounds.

Information extracted for use of this project focuses on electricity consumption instead of combustion of transportation fuel. The results for electricity are measured in grams of carbon dioxide-equivalent emissions per kilowatt-hour of electricity consumed by end users and this includes all generating plants powered by oil, natural gas, coal, oil, methanol, biomass, and nuclear energy. For most energy options, emissions of carbon dioxide from fuel combustion are accounted for the greatest percentage of overall total greenhouse gas emissions. Therefore, it is very essential to estimate the two main determinants of combustion emissions of carbon dioxide as accurate as possible. The emission of methane, carbon dioxide, nitrous oxide, nitrogen oxide resulted from both combustion and non-combustion source can be liable for total global warming potential from the use of electricity.

To summarize the entire research, all the factors which affects the overall release of greenhouse gases from energy generation processes strongly depend on political, social, and economic forces, for example the cost of energy, environmental policies, the distribution and availability of land and other resources, government eagerness in discovering new energy technologies, as well as consumer preferences. Further studies and researches on the emission of greenhouse gas from the rise of energy demand should be able to help in refining engineering estimates of energy efficiency and emission factors and at the same time, coming out with alternatives and solutions of cleaner energy source and generation process to address these larger social, political, and economic issues.

2.6 Literature Review on "New approaches for household energy conservation—In search of personal household energy budgets and energy reduction options" By

Rene M.J. Benders, Rixt Kok, Henri C. Moll, Gerwin Wiersma, Klaas Jan Noorman

This journal elaborates that households are the most important focus group apart from industrial and transportation sectors when it comes to energy conservation. The reason for focusing on households is that, compared to other sectors, energy consumption in household shows the most significant increment.

Several approaches for household energy conservation were taken throughout the past 10 years. From several research articles, it can be deduced that information programs on energy consumption is surprisingly effective, provided that the information given is appealing to the energy consumers. Some examples of successful experiments are as below:

- Wilhite and Ling (2005) found that by providing a more thorough information on energy bills more frequently to about 600 households in Oslo, an energy reduction of 10% was achieved as compared to the controlled group (Whiltie and Ling, 2005).
- Brandon and Lewis (1999) show an average energy reduction of 1.36% as compared to 7.78% increase for a controlled group. In this experiment, a group of 120 households receiving different forms of feedback on their energy consumption. (Brandon, 1999)

The above examples can be characterized by approaches in energy reductions through offered information. In these studies, households get only the information which is relevant to them and this information can be the factor which will change the overall household's energy consumption. In general, it is concluded that the energy reduction in households are successful through personalized household energy consumption information (Wood and Newborough, 2003). The information however, needs to be relevant, clear and precise to the household in order to achieve a more successful outcome and result.

2.7 Literature Review on "The effect of tailored information, goal setting, and tailored feedback on household energy use, energy-related behaviors, and behavioral antecedents"

By

Wokje Abrahamse, Linda Steg, Charles Vlek, Talib Rothengatter

A steady increase of greenhouse gases has been witnessed over the last decades, contributing to global warming. Looking at this issue, households are considered one of the most important target groups for energy conservation. This research paper shows that by targeting energy-related behaviors at home, household energy use can be greatly reduced, resulting in a reduction of households' impact on the environment.

Many interventions have been used over years to encourage the energy usage reduction among households. The results however have varying degrees of success. Review shows that energy reduction can be achieved through several approaches such as tailored information, goal setting and feedback. (Linda, Abrahamse, Vlek, & Rothengatter, 2005) Information is used widely as a measure to encourage energy conservation. (Stern, 2002) By providing sufficient information regarding energy related problem, it can help to increase knowledge regarding environmental issues such as global warming, and by providing information about behavioral options for reducing energy use, households can acquire more knowledge about how they themselves can save energy.

Several researches prove that tailored information is potentially an extremely effective method to stimulate behavioral changes. Tailoring is an approach whereby a person's psychology is used frequently as part of interventions aimed to change unhealthy practices into healthy ones for example, the habit of smoking. Essentially, tailoring is an approach making use of data from a given outcome to determine the most appropriate information that meets the objective of the providing tailored information. (Rimer & Kreuter, 2006)

2.8 Literature Review on "Feedback on household electricity consumption: a tool for saving energy?" By

Corinna Fischer

Improved feedback on electricity consumption may serves as a tool to better control energy consumption and ultimately helps to save energy. This article aimed to determine the most appropriate and effective kind of feedback to achieve the best outcome. Relevant features of feedbacks identified that may determine the effectiveness of the feedbacks are frequency, duration, content, medium and method of communication and comparison. For example, piece of information that are given frequently and over a long time and able to provide appliance-specific breakdown, and presented in a clear and appealing way, and uses computerized and interactive tools.

Matthies (2005) has reviewed theory and findings from several researches, studies and findings. Matthies then later integrated them into a heuristic model of environmentally relevant behavior. The model is very useful in explaining why and how feedback on electricity consumption needs to be conducted to achieve energy reduction.

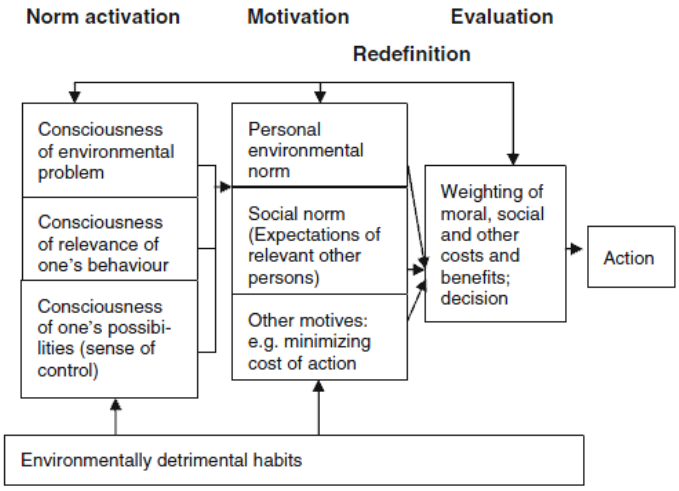

Figure 4: Heuristic Model developed by Matthies

As observed from the figure above, norm activation is made up of three building blocks. First, the person must realize that there is a problem. After realizing that there is a problem, two further steps which are consciousness of relevance of one's behavior and

consciousness of one's possibilities are necessary to complete norm activation whereby the individual must realize that his or her behavior is relevant to the problem. Only then will he or she reflect to change his or her behavior in order to overcome the problem. For example, if a person realizes that his or her monthly electricity bill is too high, he or she will not make a decision on this behavior.

Upon the completion of norm activation, a person will then enter the process of weighting and evaluating different motives to reach decisions to act. The motives, according to the model consist of personal norms, social norms and other motives. Personal norms are personal opinion on how one should act. Social norms are ideas about which personal norms others might hold and finally any other motives that will affect the decision made. Norms may be conflicting with other motives and therefore the evaluation process is required. During this process, motives and norms may be redefined based on any available information and as a result, a decision is achieved and finally, an action is performed. (Matthies, 2005)

In a nutshell, feedback should be based on actual information, given frequently, involves interaction, involves appliance-specific breakdown, given over a long period and presented in the most appropriate way to achieve the highest effectiveness to capture a person's attention and later draw a close link between specific actions and finally activate motives to come out with decisions to act.

2.9 Literature Review on "Using Mobile Phones to Support Sustainability: A Field Study of Residential Electricity Consumption" By

Jesper Kjeldskov, Mikael B. Skov, Jeni Paay, Rahuvaran Pathmanathan

This paper summarizes how usage of mobile phones nowadays can assist to encourage residential electricity conservation. Recent focus on energy sustainability has made energy consumers more aware towards energy conservation, especially the electricity usage. However, this is difficult to achieve with only a meter per household and monthly electricity bills. With advancement and emerging of technology, it is highly possible to make this information accessible digitally and wirelessly. By providing tailored information on electricity usage consistently to an energy consumer via smartphone and tablets, people's awareness towards energy consumption can be raised and finally achieving effect of energy conservation (Darby, 2006).

In recent past, people's interest and awareness towards energy sustainability and environmental impact due to energy generation has shown significant increment. However, people are often unaware about their own household energy consumption. Several studies and researches conducted shows that most consumers rely mainly on their monthly bills to monitor their energy usage. This information is not effective and is insufficient to promote effective management among household. Electricity consumption is difficult to assess for ordinary people without sufficient energy management information. To assess power usage, households need to be able to track consumption systematically and regularly because energy is abstract, invisible and untouchable (Froehlich, 2009).

To conclude this research paper, this paper explores the household energy consumption in residential households by using mobile application to consistently provide feedbacks on electricity consumption. Similar application will serves as a tool to consistently remind people of the level of energy consumption of every household. By making all this vital data accessible for household community, effects are observed from the consumer's attitude towards energy conservation.

2.10 Literature Review on Electricity Usage Charges Calculation

It is extremely important to understand and be familiar with the method for calculating electricity consumption as well as method for calculating the charge for electricity consumption. By knowing how much money are we spending for electricity everyday, it helps to raise our concern on how much electricity are we using or wasting everyday. People will eventually start to conserve energy and save money at the same time by not simply wasting the energy in the first place.

The calculation of electrical charges is usually made based on the unit Watts (W). Normally when we purchased an electrical appliance, the power consumption of it will be stated on the technical specification. In certain occasion, Watts (W) is not stated, but Voltage (V) and Ampere (A) are shown instead. In this case, we can easily calculate Watts (W) from Voltage (V) and Ampere (A) by multiplying them.

$$Watts(W) = Voltage\ (V)\ X\ Ampere\ (A)$$

To calculate the electrical charges, the current calculation tariff rates will be referred. In Malaysia, the tariff rates vary depends on the category of consumers, as well as states. In Peninsular Malaysia, the tariff rates will be provided by Tenaga Nasional Berhad (TNB); in Sarawak, the tariff rates will be provided by Syarikat SESCO Berhad and in Sabah, the tariff rates will be provided by Sabah Electricity Sdn Bhd.

The tariff rates are given in kilowatt hour (kWh) and therefore to convert Watts (W) to kilowatt hour (kWh), the following formula will be used:

$$kWh = \frac{W\ x\ h}{1000}$$

Whereby,

kWh = kilowatt hour

W = Watts

h = Hours

Below are tariff rates provided by different management of different parts of Malaysia for domestic consumption:

Tenaga Nasional Berhad (Peninsular Malaysia)

	TARIFF CATEGORY	UNIT	RATES
1.	**Tariff A - Domestic Tariff**		
	For the first 200 kWh (1 - 200 kWh) per month	sen/kWh	21.8
	For the next 100 kWh (201 - 300 kWh) per month	sen/kWh	33.4
	For the next 100 kWh (301 - 400 kWh) per month	sen/kWh	40.0
	For the first 100kWh (401 - 500 kWh) per month	sen/kWh	40.2
	For the next 100 kWh (501 - 600 kWh) per month	sen/kWh	41.6
	For the next 100 kWh (601 - 700 kWh) per month	sen/kWh	42.6
	For the next 100 kWh (701 - 800 kWh) per month	sen/kWh	43.7
	For the next 100 kWh (801 - 900 kWh) per month	sen/kWh	45.3
	For the next kWh (901 kWh onwards) per month	sen/kWh	45.4
	The minimum monthly charge is RM3.00		

Figure 5: Tariff rates provided by TNB

Source: http://www.tnb.com.my/residential/pricing-and-tariff/tariff-rates.html

Syarikat SESCO Berhad (Sarawak)

TARIFF CATEGORY	RATE PER UNIT
TARIFF D - DOMESTIC	
For the first 100 units per month	34 sen
For the next 300 units per month	29 sen
For each additional unit per month	33 sen
Minimum monthly charge	RM 5.00

Figure 6: Tariff rates of Sarawak Energy

Source: http://www.sesco.com.my/

Sabah Electricity Sdn Bhd (Sabah)

TARIFF CATEGORY	RATES	UNIT
Tariff DM – Domestic Tariff		
For the first 100 kWh (1-100 kWh) per month	17.5	Cent/kWh
For the next 100 kWh (101-200 kWh) per month	18.5	Cent/kWh
For the next 300 kWh (201-500 kWh) per month	33.0	Cent/kWh
For the next kWh (501 kWh onwards) per month	34.5	Cent/kWh
The Minimum Monthly Charge is RM5.00		
Note : Domestic consumers whose monthly consumption are 350 kWh and below will be given an adjustment so that there will be no increase impact on their monthly bills.		

Figure 7: Tariff rates of Sabah Electricity

Source: http://www.sesb.com.my/index.php?option=Itemid=120

2.11 Literature Review on Android Application Development

The Android operating system is a Linux-based operating system which is designed for smartphones and tablets. It is developed by the Open Handset Alliance, led by Google, and other companies. Google releases the Android code as open source, under the Apache License (Wikipedia, 2012). Since its introduction, Android is swiftly emerging to become the most popular and widely used operating system for smartphones and tablets. Android has a large community of developers writing applications that extend the functionality of the devices. Developers write primarily in a customized version of Java.

The architecture design of Android is sophisticated whereby various components of Android are arranged in stack, with "Application layer" aligned on the topmost stack of the architecture, whereas "Linux layer" at the lowest layer. The Application layer of Android consist of all core application, such as email client, messaging client, contact client, browser clients et cetera. Directly below the application layer is the Application Framework Layer. This layer is designed whereby the reuse of components and the capability of republishing of an application in another application are simplified. Below the Application Framework layer is Android Libraries. Android is also equipped with C and C++ libraries which are used by various processes and runtime in Android system. Therefore, the Android Runtime is aligned on the same layer as the Android Libraries. Every Android application runs independently on its own process with its own Dalvik virtual machine. This virtual machine will run classes compiled by Java language compiler. The Dalvik virtual machine functions by relying on the underlying Linux kernel below the Android Libraries and Android Runtime layer. Linux layer serves as the root for Android's core system service. It acts as a kernel to manage Android core system services, such as security, memory management, process management, network stack and driver model (Androwiki, 2010).

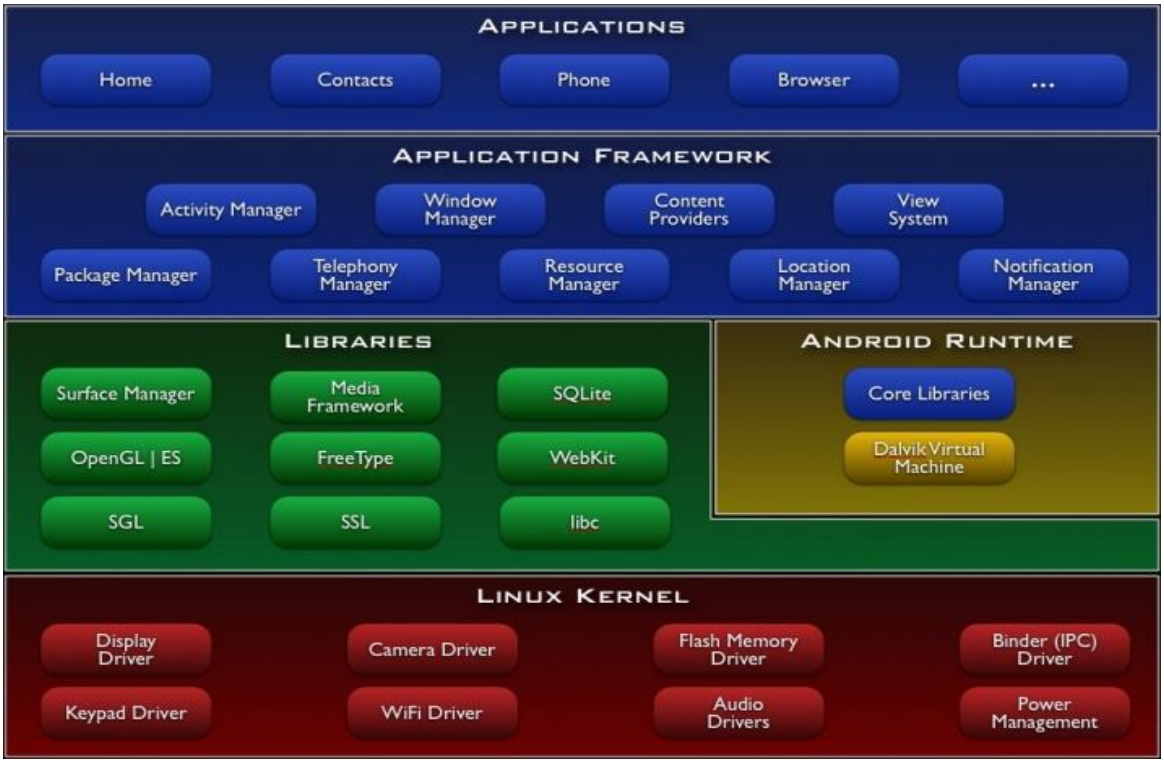

Figure 8: Overall architecture of Android provided with permission for open source use

Source:http://elinux.org/images/c/c2/Android-system-architecture.jpg

The figure above shows the overall architecture of Android as provided by Android with permission for open source use. The architecture of Android consists of Application, Application Framework, Android Libraries, Android Runtime and Linux Kernel.

Android is a software bunch comprising of not only operating system, but also middleware and key applications. The main development tools for Android applications are Android Software Development Kit (SDK) and Native Development Kit (NDK). Android SDK is a very comprehensive development kit which provides the necessary tools and Application Programming Interfaces (API)s for the Android applications development. Android NDK in another hand is a useful tool that allows the developers to embed the native code such as C or C++ language into their Java-based Android application. In other words, the developers can develop parts of their Android application using code other that Java. The developed applications can be tested on a real device or Android emulator.

Android applications can be downloaded from third-party sites or through online stores such as Google Play (formerly Android Market), the app store run by Google. In October 2011, there were more than 500,000 apps available for Android, and the estimated number of applications downloaded from the Android Market as of December 2011 exceeded 10 billion. Android was listed as the best-selling smartphone platform worldwide in Q3 2012 by Gartner with over 122,480 thousands units of Android devices being sold to end users worldwide in Q3 2012, from June 2012 to September 2012. The total market share for android OS rose from 52.5% in Q3 2011 to 72.4% in Q3 2012 which is 19.9% in duration of only 1 year. (Gartner, 2012)

Worldwide Mobile Device Sales to End Users by Operating System in 3Q12 (Thousands of Units)

Operating System	3Q12 Units	3Q12 Market Share (%)	3Q11 Units	3Q11 Market Share (%)
Android	122,480.0	72.4	60,490.4	52.5
iOS	23,550.3	13.9	17,295.3	15.0
Research In Motion	8,946.8	5.3	12,701.1	11.0
Bada	5,054.7	3.0	2,478.5	2.2
Symbian	4,404.9	2.6	19,500.1	16.9
Microsoft	4,058.2	2.4	1,701.9	1.5
Others	683.7	0.4	1,018.1	0.9
Total	**169,178.6**	**100.0**	**115,185.4**	**100.0**

Source: Gartner (November 2012)

Figure 9: Worldwide market share of mobile OS

Source: Gartner (November 2012)

Chapter 3

METHODOLOGY

3.1 Rapid Application Development – Prototyping

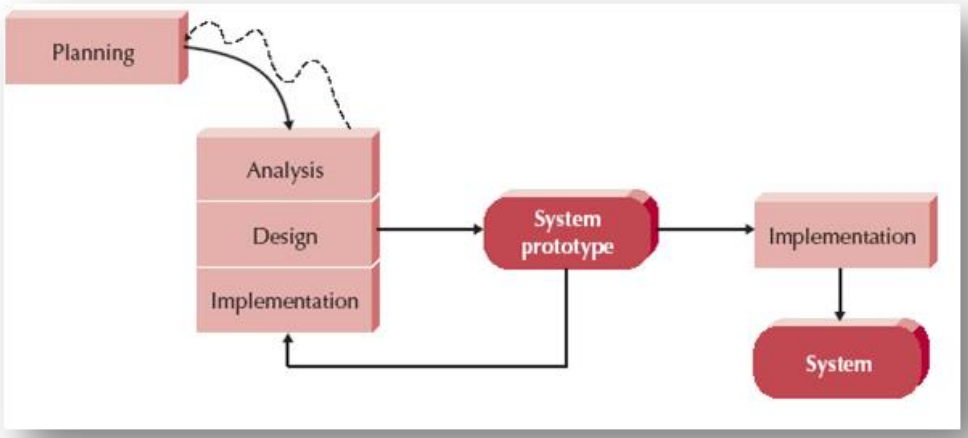

Figure 10: RAD - Prototyping Methodology

Source: http://www.slepi.net/slepi/wp-content/uploads/sdlc_ta_prototype.gif

Methodology is essential in the software development as a means of project management during any software development process. It is usually used as a framework to structure, plan and control the process of development of IT projects. (Wikipedia, 2012) It aims to improve the management and control of the software development life cycle (SDLC). In this project, the main methodology to be used is the Rapid Application Development (RAD) – Prototyping. The justification for the selection of the above methodology is because of the time constraint for this project. This project development processes are panned out for a duration of 6 months which is rather short. Therefore, this method is the most suitable since it involves fast and interactive development processes of the prototype which will suit this project the best. Besides that, it is also the best development method to deliver high quality outcome with a relatively low development cost. (Wikipedia, 2012)

There are several advantages of selecting Rapid Application Development – Prototyping method. First of all, it is extremely flexible and allows amendment and improvement to be made even during development phase. In general, a workable prototype is developed quickly during the development phase and it will be exposed to the users and supervisor to obtain feedbacks that will be essential for improvements and amendments. Secondly, this method can also help to promote user acceptance at early stage since this development method involves user participation along the development phase. Thirdly, RAD prototyping method also realizes the reduction risk of overall project failure. This is because amendments can be done directly upon detection throughout the development phase. (Magarand & Prashant, 2012)

3.1.1 Planning

This phase combines the elements of system planning and study of Software Development Lifecycle (SDLC). Planning phase is one of the most important phases since it involves the understanding of objective, project scope, constraint and system requirements before proceeding to the development process. The overall of the planning phase can be broken down into the following components:

- Research on similar project
- Research on electricity calculation method in Malaysia and Android platform.
- Identify system requirements and scopes
- Determine Project milestone
- Produce an effective Work Breakdown Structure (WBS)
- Methods for data collection
- Propose model evaluation method

Project Planning is a crucial part of project management, with a close relationship with the use of schedules such as Gantt charts and Work Breakdown Structures (WBS) in order to plan as well as monitoring the overall progress of the project to ensure that the project is delivered within designated period.

3.1.2 Prototyping Building

In general, a prototype which represents the overall or partial of the actual system will be constructed based on the initially proposed architecture and development methods. The prototype will be presented to users as well as supervisors for feedbacks and improvements from time to time throughout the development phase. All of the feedbacks will be collected and studied in order to improve the prototype. This process will be repeated throughout the software development lifecycle until the users and supervisor are satisfied with the prototype and that the prototype is in the most presentable way.

a) Analysis

In this stage, main activities involved are venturing into more research on the proposed system such as the system requirements, time constraint and feasibility. The Analysis phase is to define the technical requirements in detail for implementation later on. These requirements should be based on the application requirements as defined in project scope and project objective.

Main activities in this phase include:

- Requirements gathering from users and supervisor.
- Construction of the flowchart and project milestone.
- Research and studies on the subjects related.

b) Design

In this stage, the requirements that we acquired from the Analysis stage will be translated into detailed designs of the systems. In this Design stage, a visual outlook will be designed to show how the project outcome will look like in general. The design and data will be used and transformed into the actual design of the application that will be implementing in the next stage.

c) Implementation

In the Implementation stage, the main goal is to build the application based on all the data and designs created in the previous stage. At the end of the Implementation stage, we will have a working product that will be called prototype at this stage, ready to be lab-tested and user-tested.

Main activities in this phase include:

- Coding and combination of software functions

3.1.3 Implementation

Lastly, the implementation phase is where the all of the functionalities will be put together and an application is actually built. The outcome of this phase will be an application that is compliment to the system requirements and workable.

3.2 Project Activities

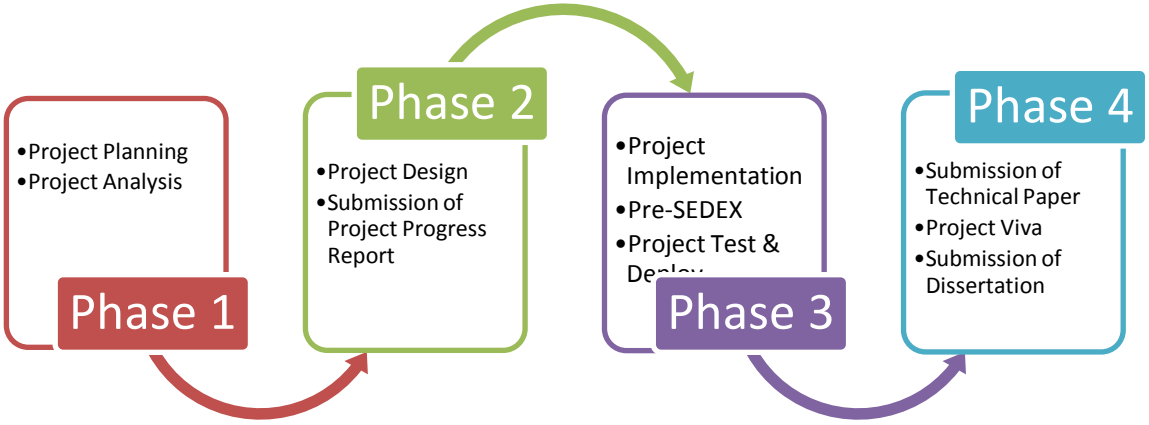

Figure 11: Project Activities

The FYP2 project activities are divided into mainly four stages. It will start with Phase 1, whereby the overall project development is planned as continuation of project planning in FYP1. At the end of the project planning phase, a more precise milestone and Gantt chart for the project development will be produced and it will be used as benchmark to measure the overall progress of the project. Following the project planning phase will be the project analysis phase whereby the main activities involved are venturing into further research and studies on the proposed system. The final outcome of project analysis will be beneficial in which it assists in the overall

application development phase which will be conducted in the next phase. By the end of phase 1, the overall project planning will be done and a more precise milestone and Gantt chart will be produced and used to measure the project progress. Further outcome from project analysis will also facilitate the next project development phases.

Phase 2 kicked off with project design which involves the design of interface, architecture, behaviors, and activities. In order to improve the design of the project, similar products are downloaded and obtained as references to assist the designing process of the project. By studying similar products in the market, we are able to explore the current products' features to further tune our project design. Before proceeding to the phase 3 of the project, a copy of project progress report will be submitted to Computer Information System (CIS) Department as requirement of the FYP2 course.

Phase 3 mainly concentrated entirely on the implementation and integration of all functional parts of the project to assemble a complete product. At the end of this phase, the first functional prototype of the product will be produced. The product however will undergo project testing to determine flaws and bugs of the product. The first draft prototype will be presented to testing group to obtain feedbacks as means of improvements for the product. Phase 3 also involved Pre-SEDEX whereby the project is verbally presented to examiners and evaluators through the poster designed. This is an assessment to assess the extent to which the author understands the project itself. Another important process in this phase is the project testing, followed by the deployment of the project.

In Phase 4, the project will focus on fulfilling other course requirement of FYP2. Phase 4 begins with the submission of dissertation. Following the submission of technical paper, will be project viva which is another verbal assessment. Phase 4 ends with the submission of final dissertation and technical paper to the department as final deliverables for FYP2.

3.3 Research Methodology

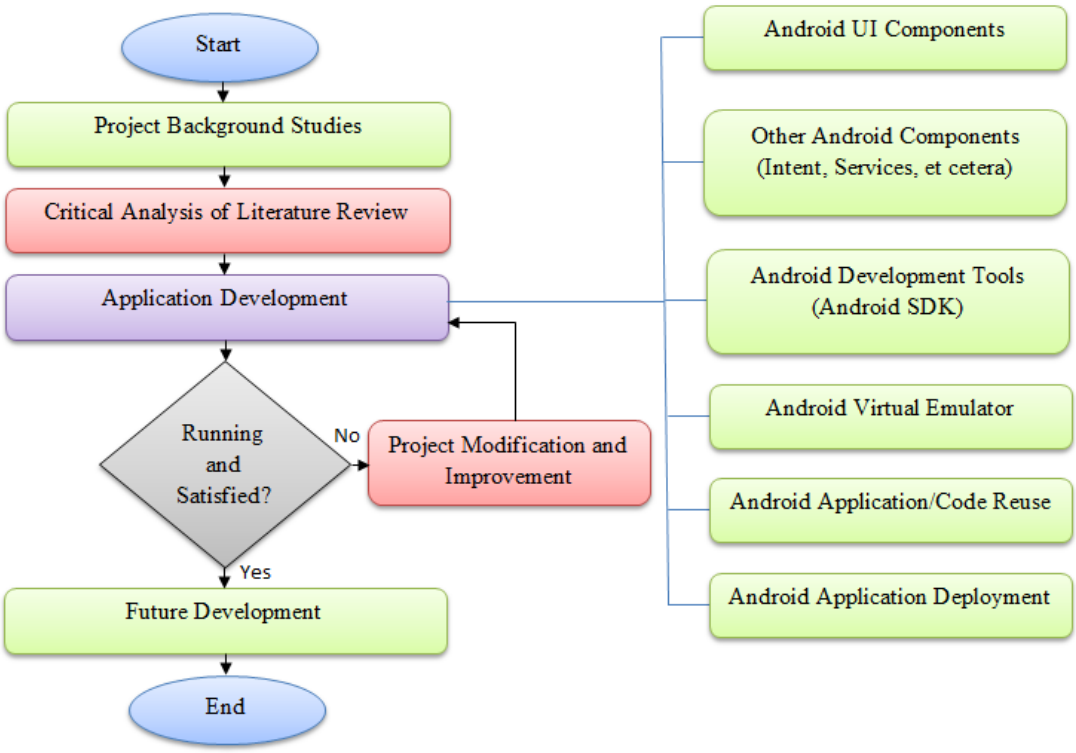

Figure 12: Research Methodology

3.3.1 Project Background Studies

Background Studies refers to the access of the collection of previously published and unpublished information about a specific subject. Background studies also serve as the establishment of the research area and to provide a context for the research subject. (Latif, 2010)

3.3.2 Critical Analysis of Literature Review

Literature review is a systematic, explicit and reproducible method for identifying, evaluating and interpreting the existing body of reproduced work by researchers, scholars and professionals (Fink, 2008). Critical analysis of literature review is the ability to engage and assess the logic and rationale of arguments to effective synthesis the required information from literature reviews. This process also involves the ability to recognize, analyze and evaluate the reasoning and forms of argumentation in the texts and articles (Hughes C. , 2009).

3.3.3 Android Application Development

Android UI Component

Activity

Activity is the visual representation component of Android application. Activity uses Views components and Fragments components to create user interface to allow interaction between user and the application. An android application can have multiple activities. Activities are defined with different layouts and these layouts can be selected based on several factors, for example, the display size of a device. (Android Developers, 2013)

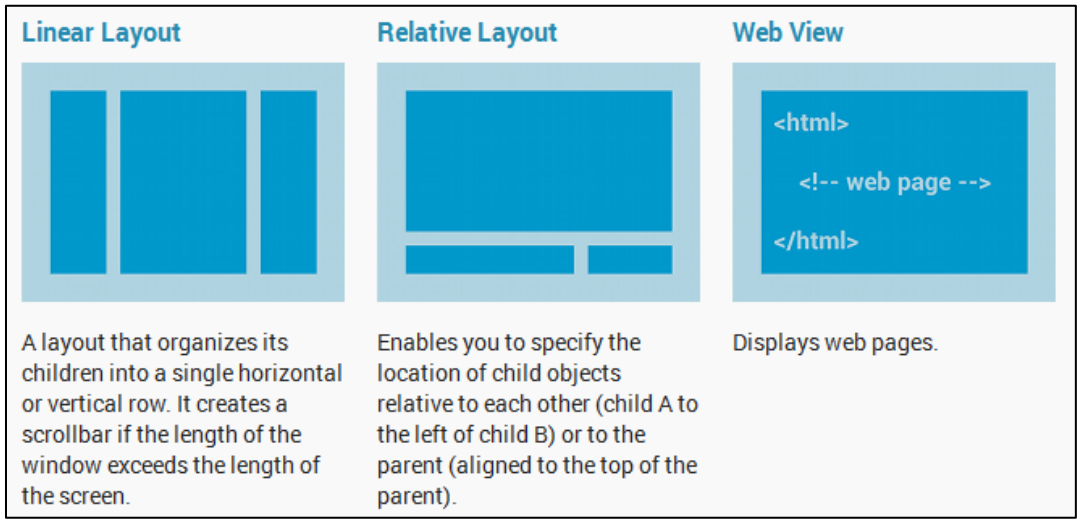

Figure 13: Types of Android layout

Fragments

A fragment represents a particular operation or interface running within a larger activity. Fragment generally, a group of user interface with its own life cycle in the context of Activity. Fragments enable more modular activity design, making it easier to adapt an application to different screen orientations and multiple screen sizes. Fragment components encapsulate application code so that it can be reused and to support devices with different size. (Android Developers, 2013)

Figure 14: Android Fragment

Views and ViewGroup

View is the component used for design of user interface widgets, which includes the buttons or text fields. It is a set of pre-built design that can be used to construct a user interface. Typical examples include standard items such as the Button, CheckBox, ProgressBar et cetera. The base class for all Views is the android.view.view class. View has the attributes which can be used to customize their appearance and behavior. (Android Developers, 2013)

Other Android Components

Intents

Intents is another component for android development which allow the application to request functionality from other components of the Android system, e.g. from services or activities. An application can call a component directly (explicit Intent) or ask the Android system to evaluate registered components based on the Intent data (implicit Intents). In brief, it is an intention to execute an action. (Android Developers, 2013) For example, by referring to Figure 15 below, by using intents, when button "Send SMS" is tapped, intent allows the execution of message sending functions which will deliver the SMS to its recipients.

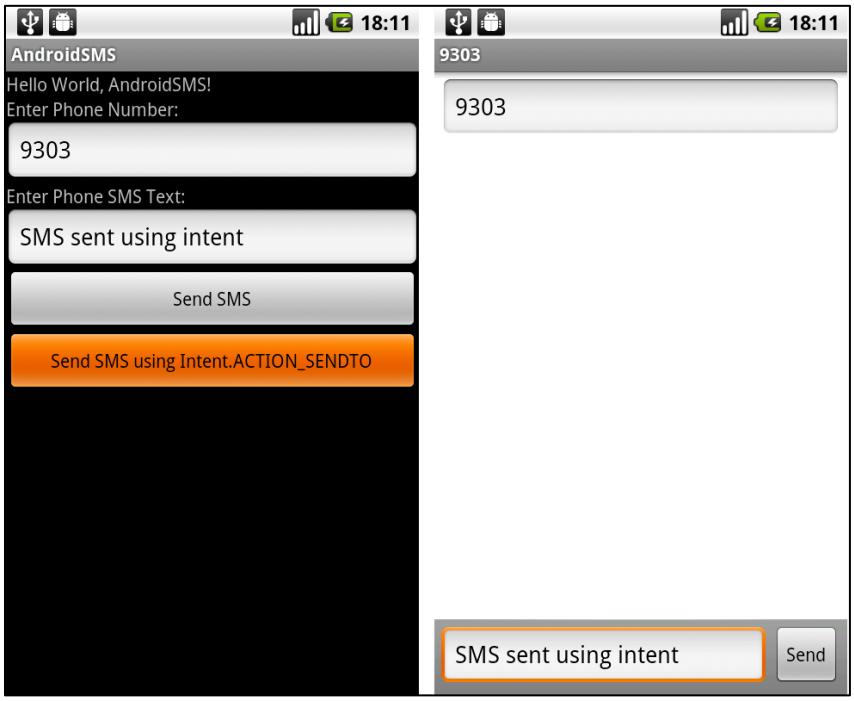

Figure 15: Android Intents

Services

Services are android application component which allows the performing of an application's background tasks without providing a user interface. In other words, it allows application to run in background even when the application is minimized. However, they can prompt notification via notification framework in Android. (Android Developers, 2013) For example, by referring to Figure 16 below, the running of "Google Services" allows all Google applications to be running in background even when the application is minimized.

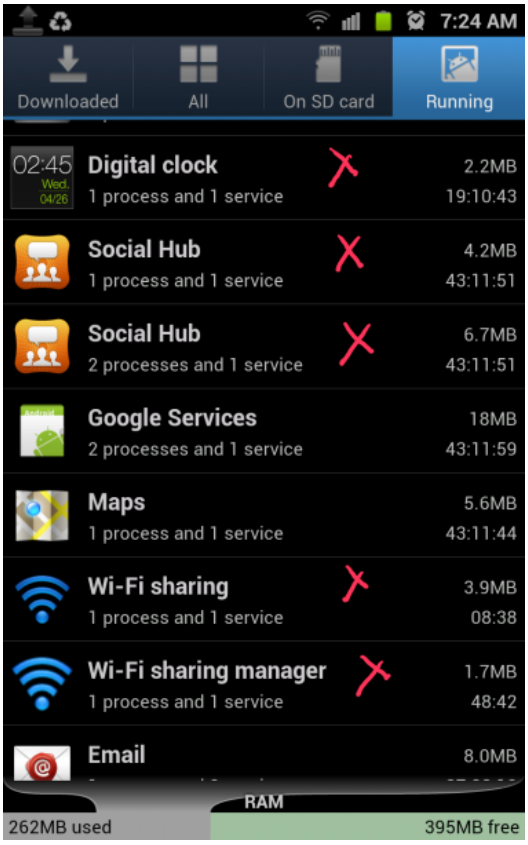

Figure 16: Android Services

Android Development Tools

Google provides the Android Development Tools (ADT) to develop Android applications with Eclipse. ADT is a set of components (plug-ins) which extend the Eclipse IDE with Android development capabilities. ADT contains all required functionalities to create, compile, debug and deploy Android applications from the Eclipse IDE. ADT also allows creating and starting AVDs. The ADT provides specialized editors for resources files, e.g. layout files. These editors allow switching between the XML representation of the file and a richer user interface via tabs on the bottom of the editor. (Android Developers, 2013)

Android Virtual Emulator

The ADT also features an emulator to run an Android system. The emulator behaves like a real Android device and allows testing of application without having a real device. The emulator can be configured to run with different version of Android system, with different screen resolution and other relevant settings. These devices are called Android Virtual Device and you can start several in parallel. (Android Developers, 2013)

Figure 17: Android Emulator

Android Application/Code Reuse

The idea of code reuse is to reuse partial codes written at one time that can be reuse in another program written at a later time. The reuse of programming code is a common technique which attempts to save time and energy by reducing redundant work. (Wikipedia, 2012) Android allows the reuse of its codes of Android Software Development Kits (SDK). The code of existing Android application can also be acquired by using reverse compilation technique, in other word, is a process of decompiling a compiled android application to obtain the application's source codes.

3.3.4 Android Application Deployment

Upon the completion of an Android application development, the application will be deployed. The application can be deployed directly via the compiler, which is the Eclipse. Android development tools will automatically deploy the application to devices if there is one or more devices connected and no emulator running.

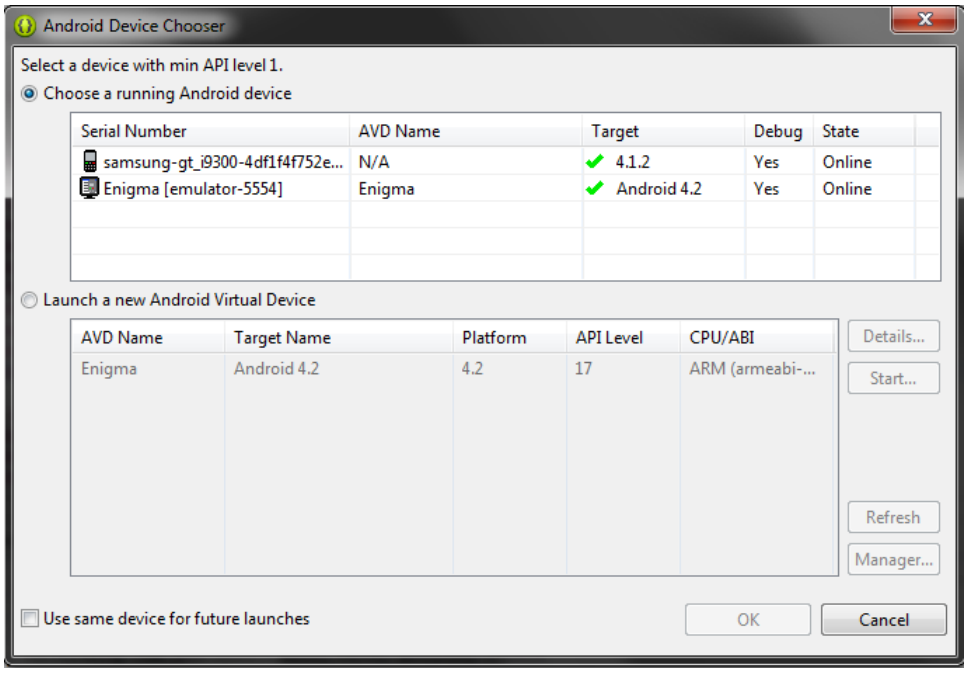

Figure 18: Android Deployment option in Eclipse

3.3.5 Project Testing and Modification

This is the process whereby the prototype will be presented to a specific testing group to assess the quality of the application. Any flaws and bugs will be recorded and amendments will be made to ensure the best quality of the prototype. Any recommendations and feedbacks will also be taken into strong considerations as an approach to improve the prototype.

3.4 Tools Required

Below are the equipment and tools which are required throughout the development phase.

- Hardware Required:
- Laptop/Desktop Computer (Windows 7)
    - Coding and development of prototype
    - Designing for all graphical requirements of the application.

- Android device with version 4.0 (Android Ice Cream Sandwich) or later
    - Testing purposes

- Software Required:
    - Eclipse Java EE IDE (Galileo)
    - Android SDK
    - SQLite
    - Emulator for Android
    - Notepad++ (text editor)

3.5 Project Design

3.5.1 Basic Application Flowchart

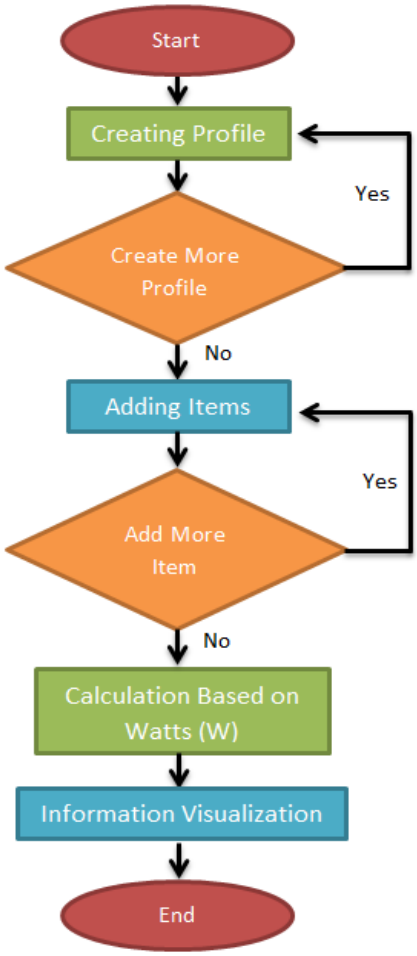

Figure 19: Basic Flowchart of Application

The flowchart above describes the basic process flow design for the application to be delivered. The final product which refers to the application will be delivered as a single independent application, which is capable to run on all Android devices. This is the simplified version of the process flow design which will be improvised continuously during the development in FYP II.

1. Program begins
2. User will need to create profile. Instead of creating user profiles, user will be creating item profile. (e.g: Kitchen, Living room, Study room etc) User will be able to create as many profiles as possible.
3. Upon creating profile, user will need to enter domestic appliances into the profiles in order for the application to work. (e.g: Air-conditioner, Television, Computer etc) Details of items will need to be populated before the item can be entered. User can choose to enter the item into whichever profiles created earlier.
4. The calculation methods will be carried out with the data entered into the database. The calculation will be made based on Watts (W).
5. The final result will be visualized in several graphical forms to represent the result.

3.6 Key Milestones & Gantt Chart

The total duration allocated for the development and implementation of this project is 28 weeks. The process starts with project planning, followed by continuous project development phase, while at the same time fluffing all the deliverables to fulfill the course's requirements. Gantt chart is constructed and will be used as a baseline to measure the progression of the project. Float or slack time in the schedule will also be calculated to identify the possible amount of delay for each task to prevent impact on the final delivery period. Once established and approved, the plan will become the baseline to evaluate the progress of the project. The project progress will be measured throughout the development phase by referring to this baseline. Process of analyzing and measuring the project progress by comparing to the baseline is known as earned value management. The documentations and materials to be used as inputs for project development are the Project Requirements, the Project Schedule, and the Project Management Plan. The final output of the project will be the prototype itself, Project Poster for Pre-SEDEX and Viva, Project Technical Paper and Project Dissertation.

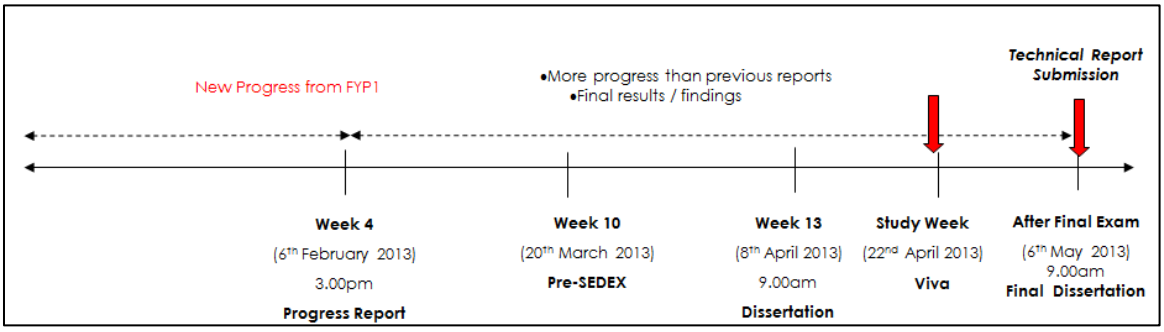

Figure 20: Key Milestones of FYP II

Source: http://elearning.utp.edu.my

3.6.1 Gantt Chart

Task Name	Duration	Start	Finish	Predecessors	Resourc
FYP2	**81 days**	**Mon 1/14/13**	**Mon 5/6/13**		
Project Development	**55 days**	**Mon 1/14/13**	**Fri 3/29/13**		
Planning	16 days	Mon 1/14/13	Mon 2/4/13		
Analysis	10 days	Tue 2/5/13	Mon 2/18/13	3	
Design	9 days	Tue 2/19/13	Fri 3/1/13	4	
Implementation	16 days	Mon 3/4/13	Mon 3/25/13	5	
Test & Deploy	3 days	Tue 3/26/13	Thu 3/28/13	6	
Project Delivery	1 day	Fri 3/29/13	Fri 3/29/13	7	
Submission of Project Progress Repor	1 day	Wed 2/6/13	Wed 2/6/13		
Pre-SEDEX	1 day	Wed 3/20/13	Wed 3/20/13		
Submission of Technical Paper	1 day	Mon 4/8/13	Mon 4/8/13		
Project Viva	1 day	Mon 4/22/13	Mon 4/22/13		
Submission of Final Dissertation	1 day	Mon 5/6/13	Mon 5/6/13		

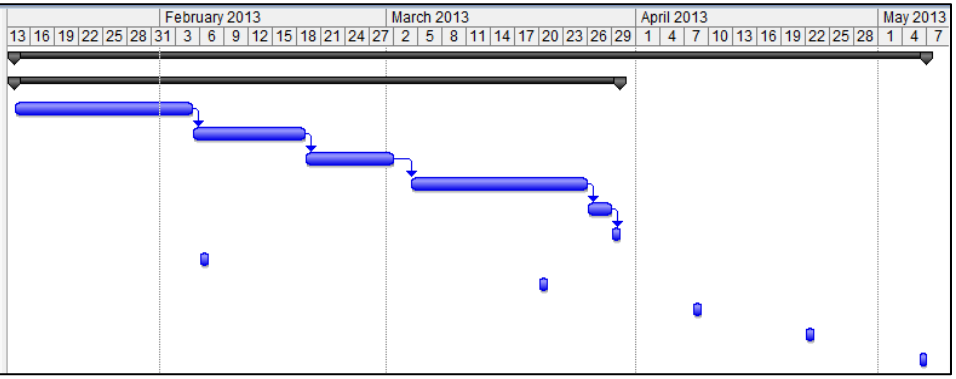

Figure 21: Gantt chart on Microsoft Project

Chapter 4

Result and Discussion

4.1 Data Gathering

As an effort of gathering data for the conduct of study towards the usefulness, acceptance and feasibility of the project, a survey has been conducted at AEON Ipoh Station 18 targeting a total of 30 respondents, which compromises of a mixture of respondents of different age, income et cetera. The survey was conducted through the distribution of hard copy survey forms to potential respondents and the completed survey forms were acquired upon completion. This method will allow the author to obtain both qualitative and quantitative information which will be crucial to the subject of studies.

The survey form is carefully constructed to ensure that it achieves its goal which is to gather information for every key aspect to aid the research and study process. The survey consists of 14 Multi Choice Question (MCQ) to acquire quantitative data and an open question for qualitative feedbacks from respondents. The example of survey form is attached at the appendices section. Upon the completion of this survey, feedback on the key aspects below can be achieved:

- Study on Average Electricity Consumption
- Study on Awareness towards Electricity Charges Calculation
- Study on Responsibility towards Energy Conservation
- Study on Effectiveness of Application

The quantitative outcome from the Multiple Choice Question (MCQ) of the survey will be tabulated in Microsoft Excel and subsequently, presented in various graphical forms, such as pie chart and bar chart to illustrate the result of the overall survey better. The qualitative feedback from the open question will be taken as means to facilitate the development phase and further improve the final outcome of the project.

4.2 Result Analysis

4.2.1 Study on Average Electricity Consumption

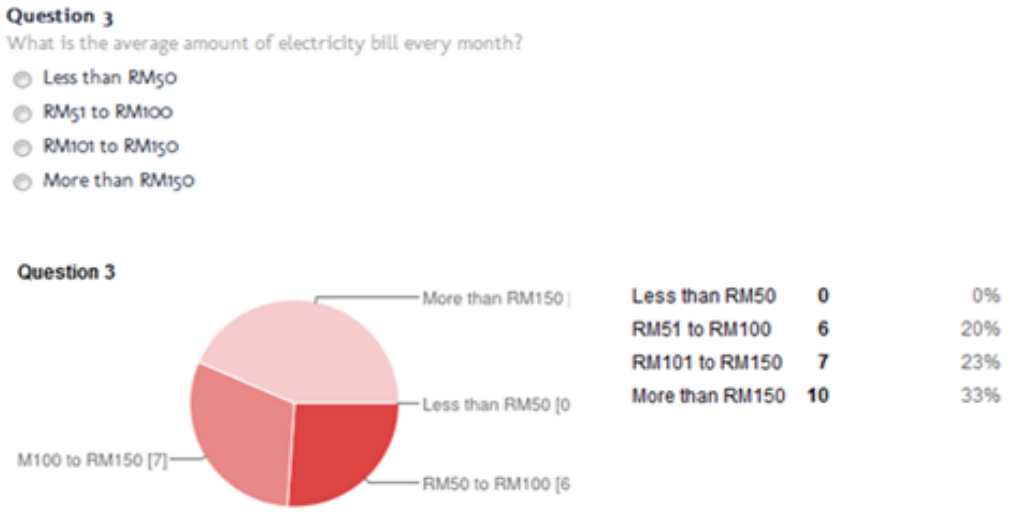

Figure 22: Result of the study on average electricity consumption

Through the analysis on the result obtained through the survey, we can conclude that people nowadays consume a vast amount of electricity. According to the pie chart above, 46% of the total respondents respond that they spend more than RM150 every month in average, 30% spending between RM100 to RM150 whereas the remaining 24% paying between RM50 to RM100 for monthly electricity usage. As mentioned in Chapter two, the world energy demand is increasing rapidly. Economies and populations are increasing rapidly and so will the energy demand. According to a study by Exxon Mobil, the energy demands by residential and commercial (all buildings that are not residential, industrial or agricultural) will show the most significant increment of 30% in year 2040 from 2010. (Exxon Mobil). This increase is highly driven by developing countries, whereby more people are shifting from rural areas into the cities and the increasing electricity supplying network to rural areas. Other than that, the rapid growth of population and increased wealth also contribute to the drastically increase of energy demand. The population growth increases the energy consumption through the increment of energy consumption per head. In brief, bigger population means bigger energy demand. As people get wealthier, people purchase things to make their lives more comfortable and most of these things require electricity to perform their functions.

4.2.2 Study on Awareness of Calculating Electricity Charges

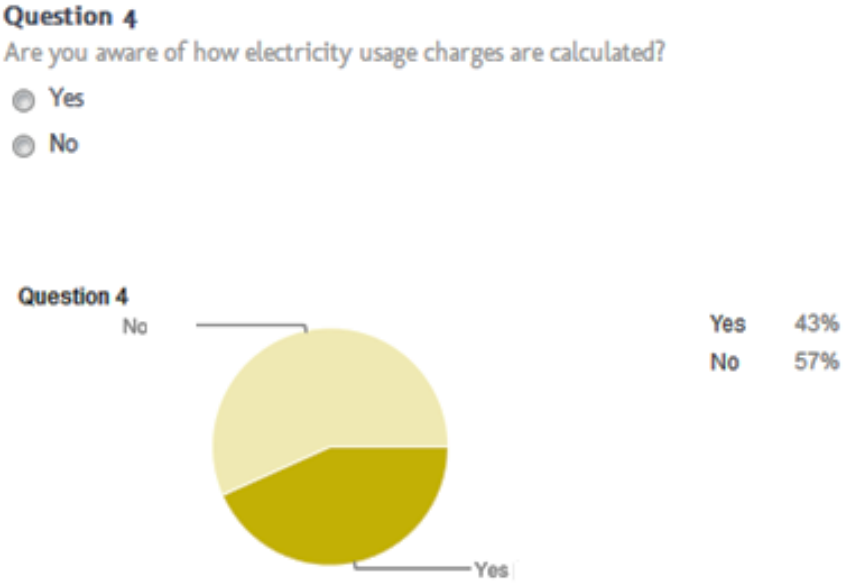

Figure 23: Result of the study on awareness of calculating electricity charges

This question aimed to study the awareness of the respondents on the method of calculating electricity charges. As observed from the result above, only a percentage of 43% of the overall respondents actually know the calculation method of electricity charges. The possible justification of the above phenomenon might be due to the lack of exposure on the calculation method. Although the tariff rates of the relevant electricity suppliers are provided on their respective websites, the calculation instructions are maybe too difficult to understand. By understanding the calculation method of electricity, we can calculate the approximate cost of electricity charges, which can indirectly help to raise awareness towards electricity conservation. The existence of the product of this project will be able to overcome this issue.

4.2.3 Study on Responsibility towards Energy Conservation

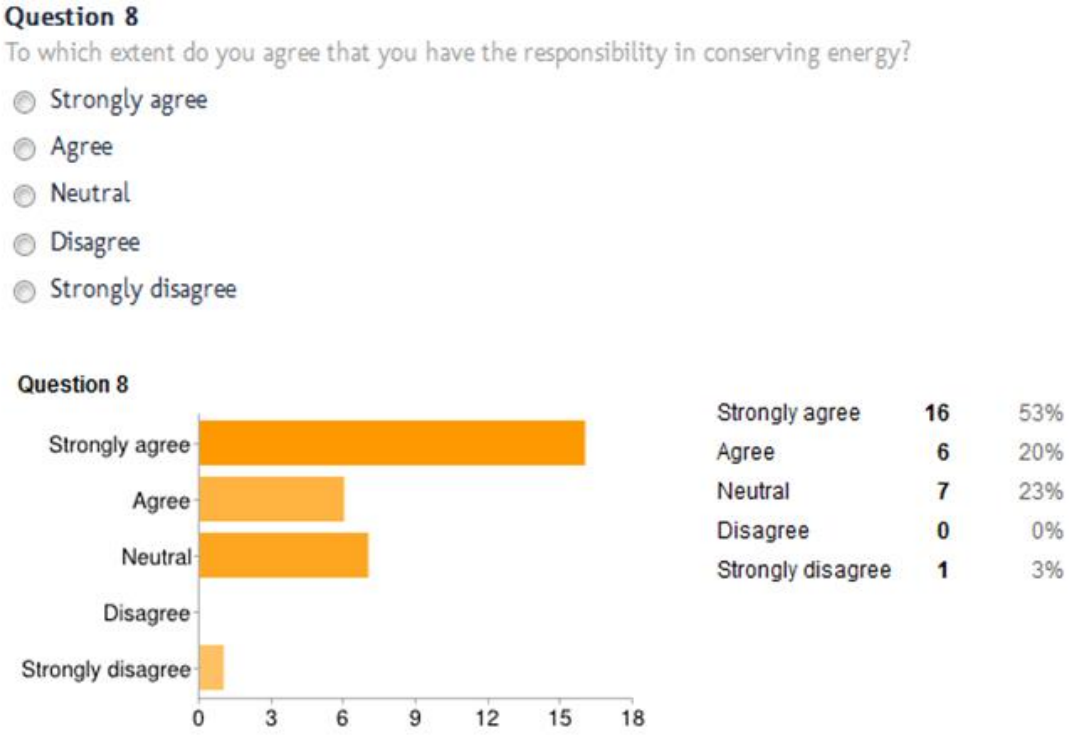

Figure 24: Result of the study on responsibility towards energy conservation

According to the study on the respondents' opinions towards energy conservation, a total of 53% of the respondents strongly agree that they have responsibilities for energy conservation, whereas another 20% agree that they have responsibility, making a total of 73% of respondents who are positively disposed towards energy conservation. Undeniable, people nowadays are more favorable and drawn towards the idea of energy conservation. More and more green initiatives have been taking in recent years to promote more energy efficient technology, such as hybrid car, energy efficient devices, power saving features for mobile devices et cetera. Besides, government sectors as well as many Non-Government Organizations (NGOs) also strongly promote and communicate the idea of energy conservation to the society. As an occupant of our mother earth, every man possessed the responsibility of conserving energy for a better environmental qualities as well as better future for the next generation. (Rock Ethics Institution, 2008)

4.2.4 Study on Effectiveness of Application

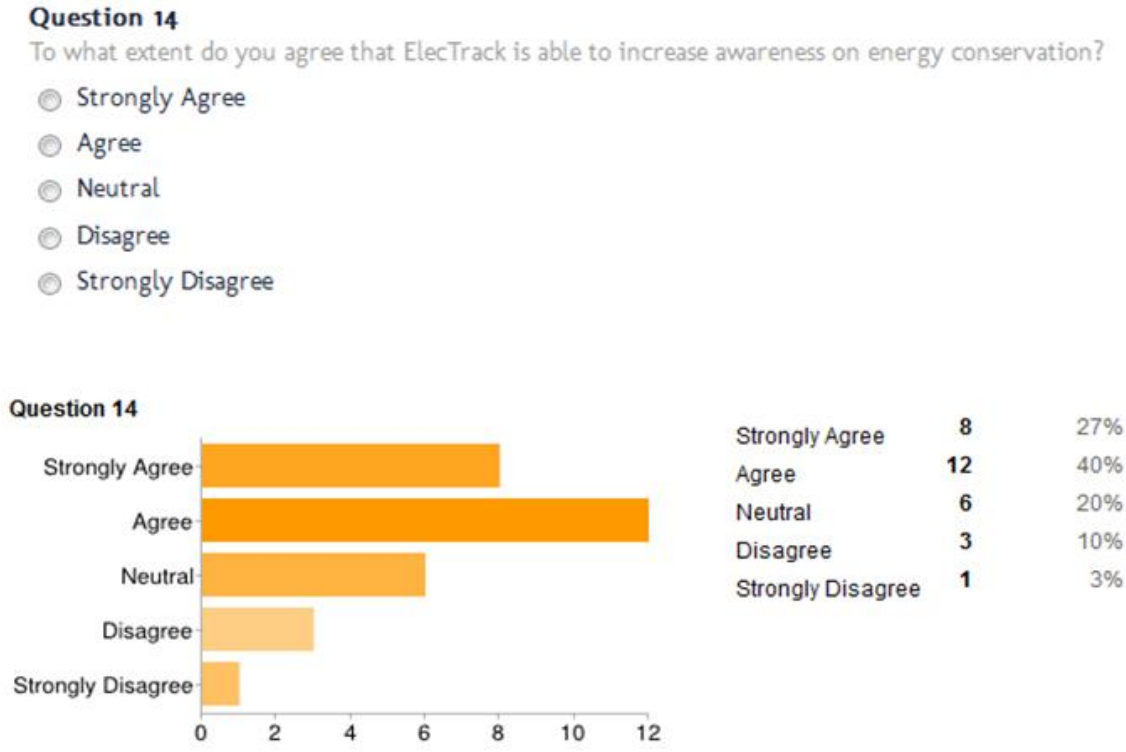

Figure 25: Result of the study on effectiveness of application

Another key aspect being study through the survey is on the respondents' opinion towards the potential effectiveness of the application. The result however is not very satisfying whereby only 27% of the respondents strongly agree that the application will be effective whereas another 40% agree with the above statement. The possible justification for this will be because of the lack of descriptions and details of the application for the meantime. In order to improve the application, respondents are encouraged to provide their opinions and feedbacks on the application in the open question. A number of respondents responded that the application itself should be costless in order to encourage the use of the application. Besides that, some of them also state the importance of the attractiveness of the user interface as an attracting factor. Some other feedbacks are such as integrating with social media such as Facebook, Twitter et cetera, the application need to be user friendly, and easily available for download. Majority of respondents are looking forward to the end product of this project and they are willing to try the product.

4.3 Development Environment

Eclipse IDE for Java Developer

The application is developed by using Eclipse IDE as the main compiler. Below are screenshots of compiler with some source codes of the application.

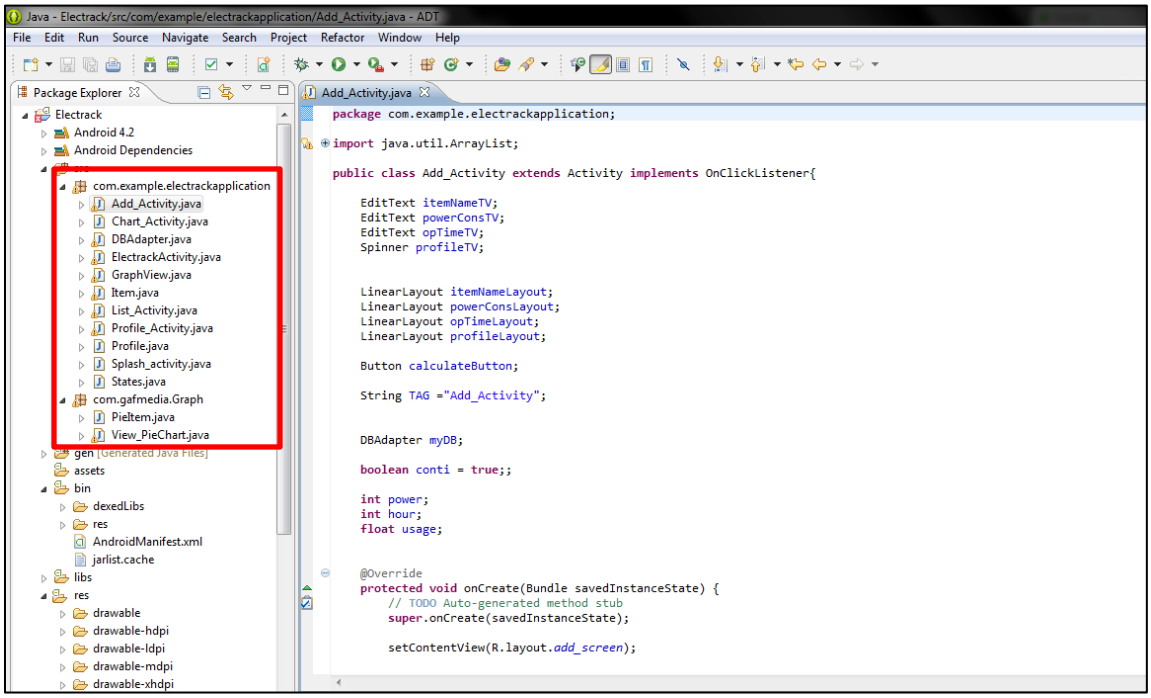

Figure 26: Screenshot of Eclipse showing classes of application

The figure above shows the interface of Eclipse with the classes of the application highlighted. The application is developed with the use of 13 main classes. The classes can be viewed on Eclipse compiler on the following directory: *Electrack/src/com.example.electrackapplication*

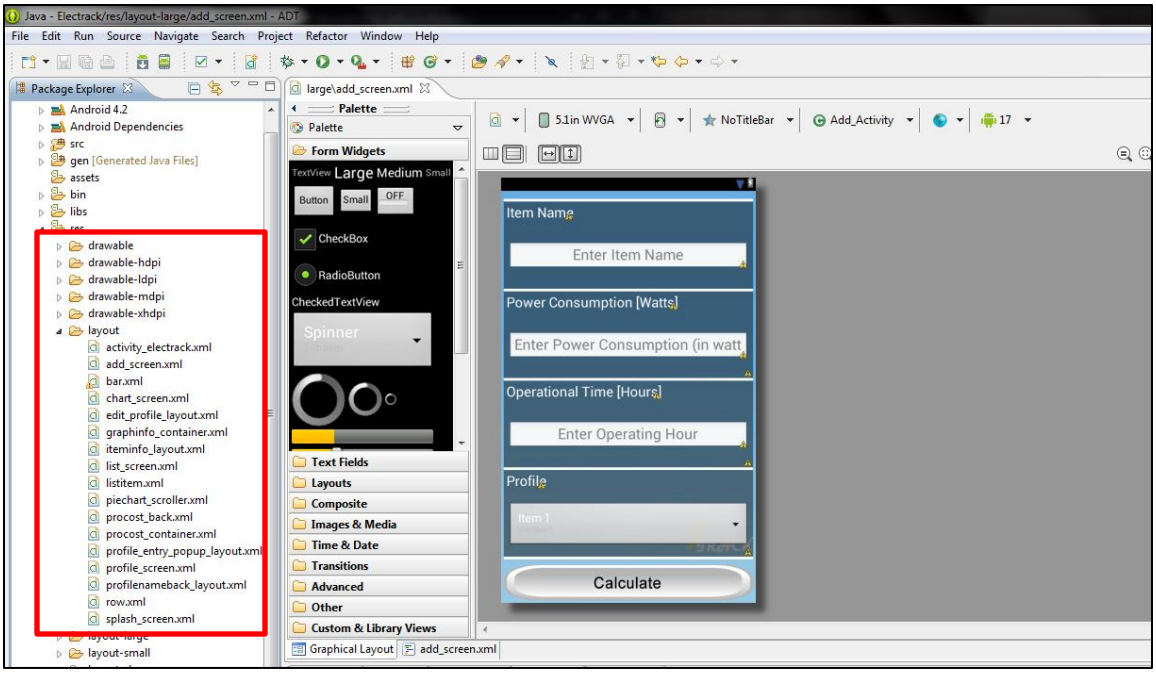

Figure 27: Screenshot of Eclipse showing interface layouts of application

The figure above shows the interface of Eclipse with the interface layout of the application highlighted. The application is developed with the use of 17 main interface layouts. The classes can be viewed on Eclipse compiler on the following directory: *Electrack/res/layout/*

4.4 Final Prototype

Designing

To achieve the highest user experience satisfaction and interaction between user and the application, the overall user interface of the application needs to be design by taking every possible factor into consideration, for example the font, font size, color, layout and interface structure.

Interface 1: Splash screen

The first interface when the application is started from the application menu is as shown in Figure 28.

This splash screen is programmed for a 2 seconds screen delay after the application is started.

Figure 28: Splash screen

Interface 2: Profile screen

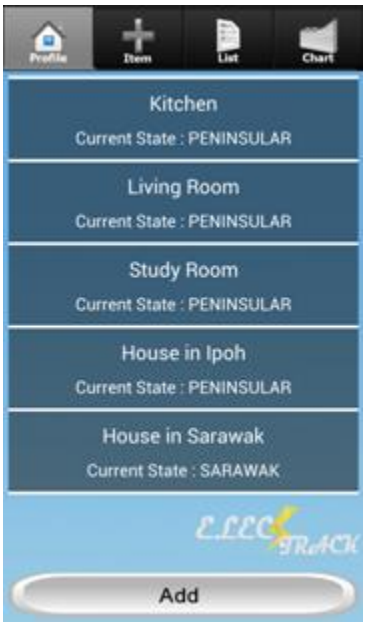

Figure 29: Profile screen

The second interface is the interface right after the splash screen, which can also be known as the profile interface as shown in Figure 29.

The first step to take before using the application is to create at least one profile to enable the application to proceed. To add a new profile, tap on the "Add" button at the bottom of the screen.

Once tapped, a new window will appear to prompt user to enter profile name and selecting current state to determine different methods of calculating approximate cost of electricity.

Figure 30: Popup for "Add" button

When the "Add" button is tapped on the first interface, the window will pops out as shown in figure 30.

Basically the function of this window is to receive the profile name from user and selecting calculation method based on tariff rates of "Peninsular", "Sarawak", and "Sabah".

Interface 3: Item screen

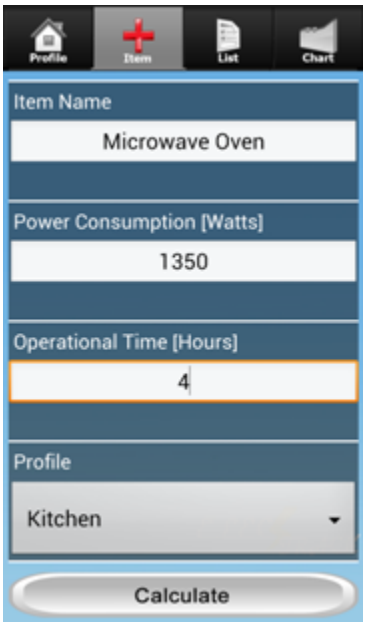

Figure 31: Item screen

The third interface as shown in figure 31 is the Item interface, which functions to add item into profiles created earlier.

After creating profiles in the previous interface, user can proceed to adding item into profiles being created.

To add item into profiles, fill in all the details:

- Item Name
- Power Consumption in watts
- Operational Time in Hours

Interface 4: List screen

Figure 32: List screen

The fourth interface is the List interface as shown in figure 32, which functions to show all items added to each profiles earlier.

The List will display the "Item Name", "Date" and the calculated cost of each item based on the correct tariff rates.

User can also select which profile to display by tapping on the "Profile Name" dropdown list.

Figure 33: Popup for deleting item

In the List interface as shown in figure 33, user is also able to delete/remove items from profiles.

In order to delete an item, user can tap on a selected item and a smaller window will pops out as shown in the screenshot on the left prompting for confirmation to delete item.

Interface 4: Graph screen

Figure 34: Graph screen

The fourth interface, which is the Graph screen as shown in figure 34, is the interface whereby all the items entered into the each profile will be visualized.

Two types of visualization methods are available in this application, which are visualization in pie chart and bar chart. User can select different types of visualization method by tapping on the "Pie" and "Bar" button.

4.5 Testing and Experimentation

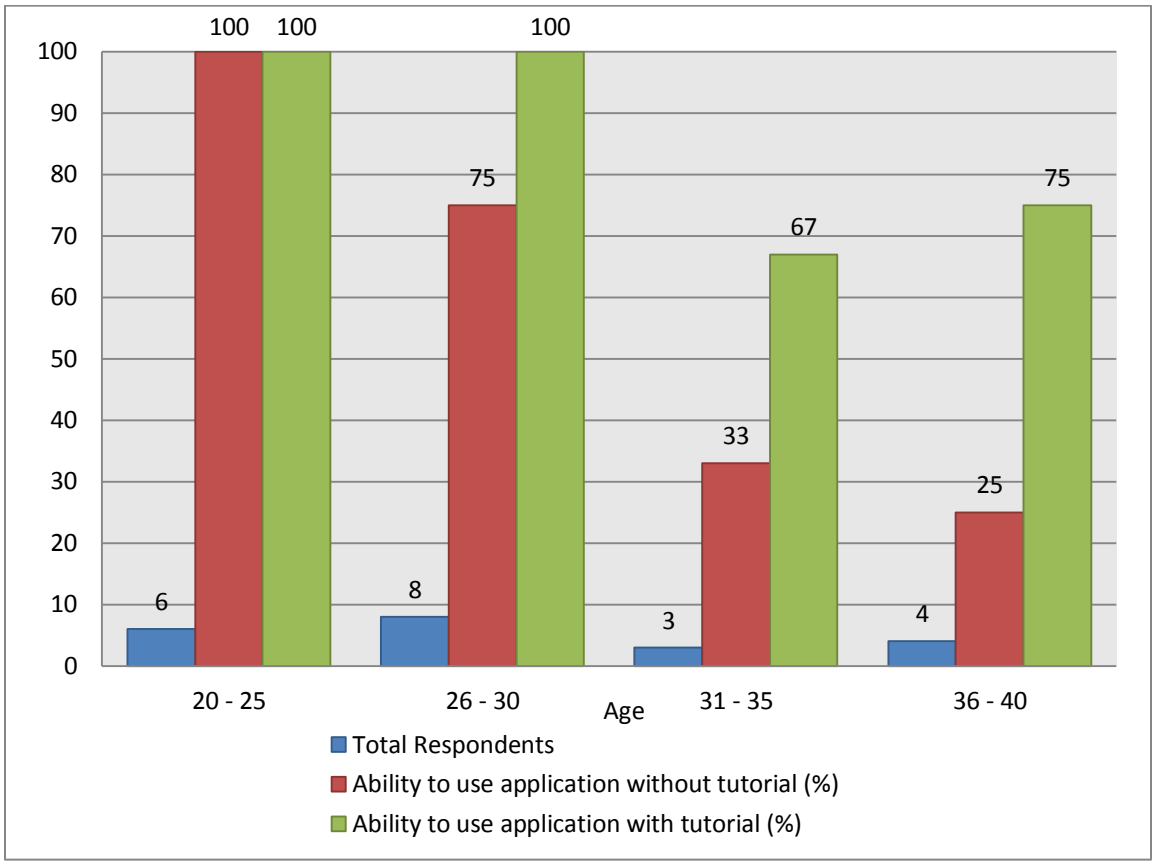

Figure 35: Bar chart showing the results of testing

In order to study the usability and Human Computer Interaction (HCI) of the application, a testing has been carried out in Ipoh Parade, Greentown, with testing group consisting of 21 users with their age ranging from 20 to 40. The participants are distributed to four main groups according to their age according to the table below:

Table 1: Distribution of respondent groups

Age Group	Total Respondents
20 – 25	6
26 – 30	8
31 – 35	3
36 – 40	4

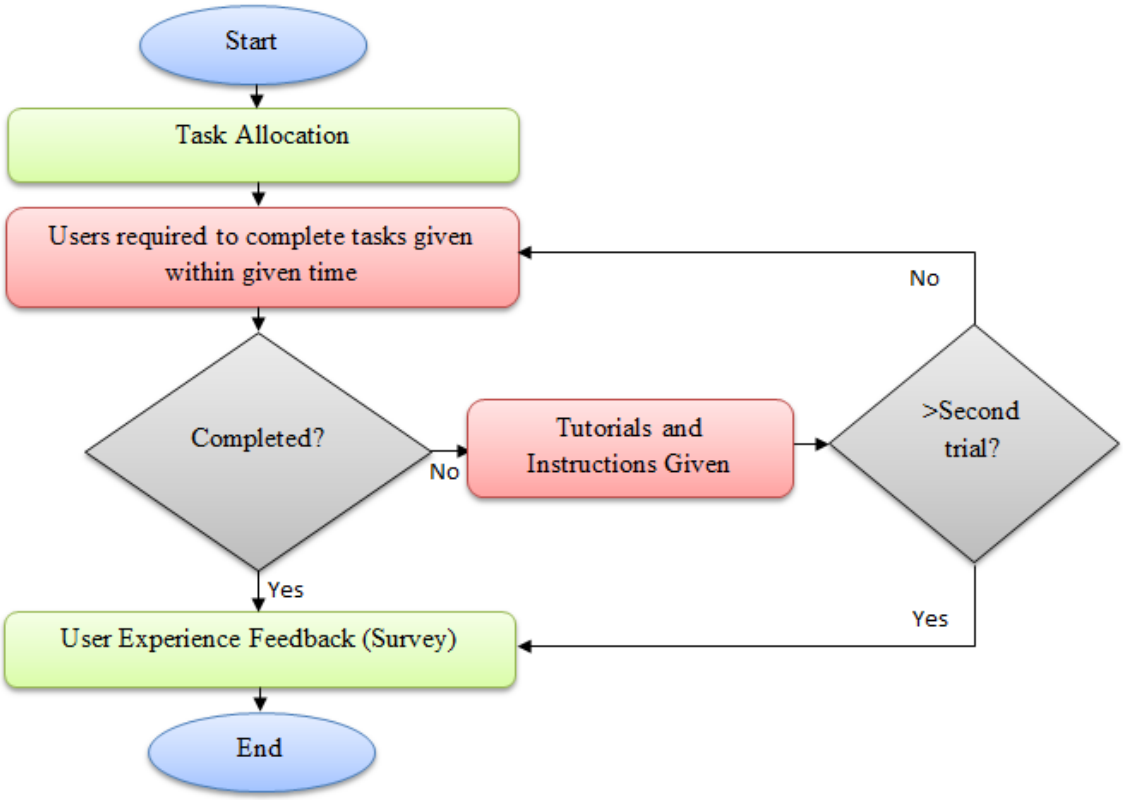

Figure 36: Flowchart of user testing on application

To conduct the study, respondents are first given a device with fresh installation of the application. Respondents are required to complete several tasks in a given time on the application without proper tutorials or instructions. Total numbers of respondents who are able to complete all the tasks given within given time are recorded. For respondents who are unable to complete the tasks within the time given will be given tutorials and instructions on using the application. They are required to complete the tasks given for the second time. Every participant is given a maximum of 2 trials to complete their task. Total numbers of respondents who are able to complete all tasks within given time after given tutorials and instructions are recorded. The result of the testing are collected and visualized into charts to better present the results of the testing. Upon completion of the above steps, participants are required to complete a survey to obtain their user experience feedback on the application.

Below are the overall results of the user experience feedback survey form. The survey is conducted through distribution of hardcopy survey and the results are entered into Google spreadsheet. The results of survey are visualized into pie chart to present the data better.

4.5.1 Feedback on usability of application

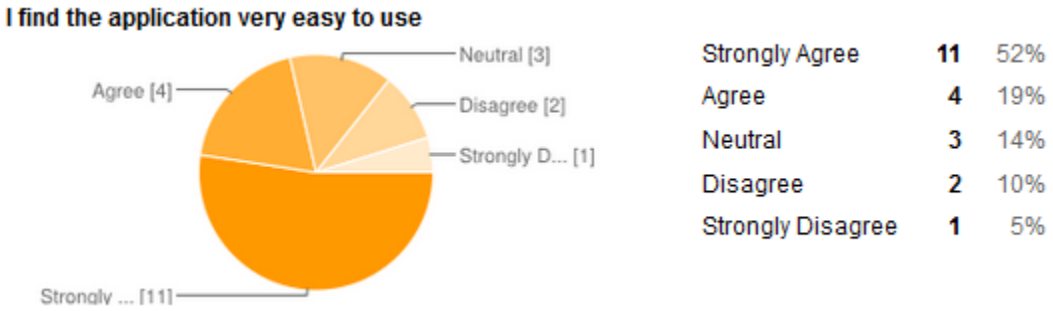

Figure 37: Result of the study on usability of application

This question aimed to study the usability of the application to its users. The outcome shows that the application is very easy to use whereby a total of 52% of the overall participants strongly agree and another 19% agree that the application is easy to use. This can also be proven whereby most of the respondents are able to use the application without tutorials and instructions given.

4.5.2 Feedback on design of application

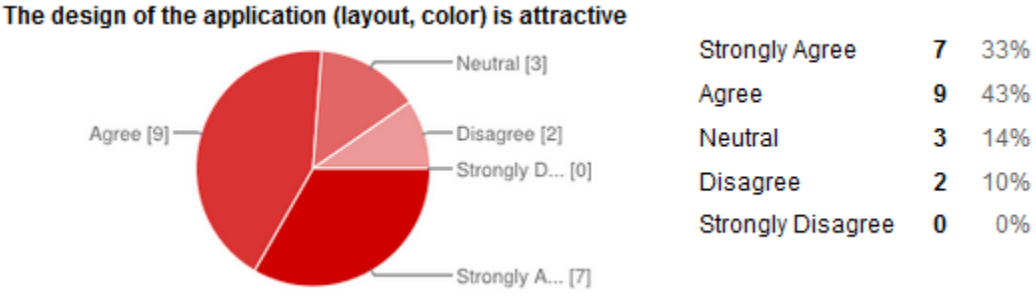

Figure 38: Result of the study on design of application

The majority of participants of the testing group also agree that the design of the application, which includes the layout of the application, color selection of the application, layouts and colors are attractive, whereby 33% of the participants strongly agree and another 43% agree that the application is attractive enough to the users.

4.5.3 Feedback on demand towards application

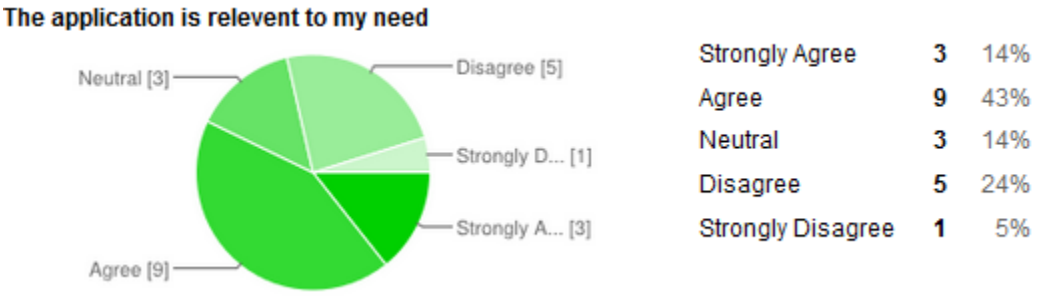

Figure 39: Result of the study on relevance of application

This aim of this question is to study the demand towards the application. As mentioned before, ElecTrack is an android application with the ability to track electricity consumption, visualize electricity consumption distribution as well as calculating the approximate cost of electricity based on data entered. The outcome of this survey proves that there is a demand and need for such applications to assist in tracking electricity consumption and cost. This is supported by the 14% of participants answering strongly agree and another 43% stating that they agree.

4.5.4 Feedback on purpose of application

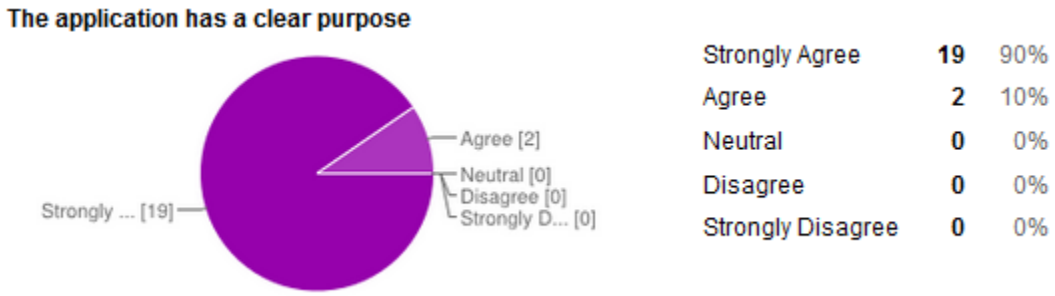

Figure 40: Result of the study on the purpose of application

One of the important aspects of testing is to ensure that users understand the purpose and the use of the application. The testing participants are able to understand the purpose of ElecTrack only by exploring the application without any explanations given. This proves that the development of ElecTrack is based on a clear purpose which is to assist users to track electricity consumption and calculate the approximate cost of electricity use. This is proven whereby all the participants of the testing agree that the application has a crystal clear purpose.

4.5.5 Feedback on satisfaction towards application

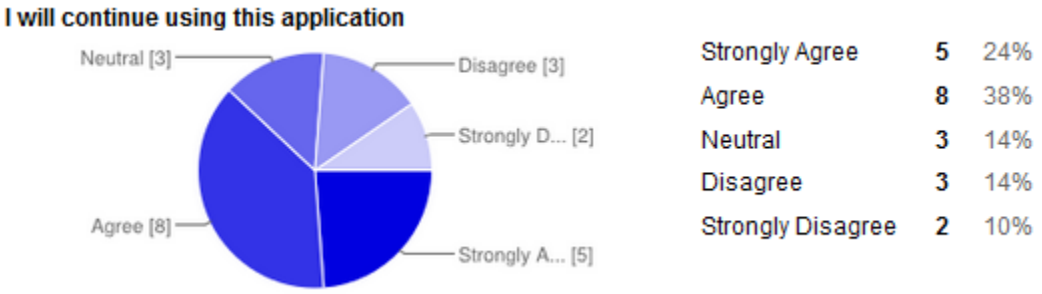

Figure 41: Result of the study on user satisfaction on application

At the end of the testing, participants of testing are asked whether they are satisfied with the application and their opinions towards continuing using the application in their daily life. Although not every participant states that they are willing to continue using the application, a percentage of 62% of the participants will be willing to continue using the applications. Qualitative feedbacks from participants are also taken as an approach to improve the application in the future.

Chapter 5

Conclusion and Recommendations

5.1 Conclusion

The issue of excessive electricity energy usage and wastage need to be addressed in the most proper manner before the problem continues to become more severe. Due to easy accessibility to electricity energy at a relatively affordable cost, people tend to become neglected and pay very little attention to the amount of electricity they are using everyday. Due to the drastically increasing of energy demand worldwide, more and more electricity generation facilities will need to be constructed. This is irreversible because once a power generation plant has undergone full operation, it is impossible to halt the power generation process of the power plant. Construction of power plants are not overall environmental-friendly as the negative impact inflicted on the environment is massive and certain. Hence the only effective solution to address this issue is to raise the awareness in everyone towards energy conservation. Each as individual, we do have impact on the energy wastage, and all these actions might seem hasty, but in long term, the effect can be capacious. Our earth is populated by over 7 billion people today. If everyone is neglecting all these small actions, the impairment resulted on the earth will be beyond our dreams.

This project targets the public, focusing on households which are the major consumer group of electricity, hoping that it will be able to raise the awareness of people nowadays towards energy conservation by using the concept of tailored information and dynamic feedback. Every individual have the responsibility to contribute in the quality preservation of our planet. As quoted by Chief Seattle, “We do not inherit this early from our ancestors, we borrow it from our children.” It is our responsibilities to ensure that the quality of the environment is preserved so that our next generation can witness the beauty creation of God Almighty.

5.2 Recommendations

Although the final product of this project will feature all the main usable functionalities, there will still be room for improvement and expansion to the application. First of all, this application only calculates on an estimate basis meaning that the final calculation and figures might not be very accurate. However, through more research on the related subject, the application can be improvised to produce more accurate calculations based on inputs. Besides that, the user interface should also be improved from time to time to continuously improve the user's experience. A major improvement which is needed is expansion of the application itself. As mentioned in the project scope, currently this application is only designed for use by Malaysians because the tariff rates used for calculations is based on the energy supplier companies in Malaysia only. If the scope can be expand for a larger target user, a better result and outcome will be able to be achieved, whereby a larger group of users can benefit through the product. Besides that, this application should also be made available not only for android platform, but also other platform, such as iOS, RIM and Symbian because these are several mobile OS with high potential and relatively large user group. By expanding through other platform, more people can be benefited through the use of this application. Finally, the interfaces, features and functionalities should be improvised every now and then to cater with ever changing user requirements and improving user experience continously.

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Appendices

Tasks to be completed by participants of usability testing

Tasks
1 Start the application from menu. 2 Create at least 3 profiles. 3 Enter at least 3 data into each profile. 4 View the item list for each profile. 5 Delete and edit any profile created earlier. 6 Delete any item from each profile entered earlier. 7 View data visualization in both bar chart and pie chart. 8 Exit the application.
Time: 4 minutes