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Dynamic Energy Consumption using Current and Power Reading Detector with Appliance Indicator

Nur Haziah Naim[1], Tamil Selvan Subramaniam[1]*, Azmanirah Ab Rahman[1], Normah Zakaria[1]

[1] Faculty of Technical and Vocational Education,
Universiti Tun Hussein Onn Malaysia, Parit Raja, 86400, Johor, MALAYSIA

*Corresponding Author Designation

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Abstract: In Malaysia, the uses of excessive loads or electrical appliance on sockets is increasing because of user habit and behaviour. This has a negative impact on consumers where this can threaten the safety of consumers who use electrical appliances and cause damage to appliances. Therefore, Current and Power Reading Detectors with Appliance Indicators were developed to help users detect the reading of current and power on electrical appliance before use on a socket. The project developed is a tool that detects the current and power readings of an electrical appliance using the Blynk application via mobile phone as well as electrical appliance indicators. This project is intended as a safety measure to help users overcome the problem of excessive load consumption on sockets either in residential homes or buildings that use a voltage not exceeding 240V and a current not exceeding 20A. This device uses ACS712 current detector as detector while Node MCU is used as micro controller and Arduino IDE as system controller. The development of this detector will display current, voltage and power readings on the LCD display and on the Blynk application display. While the LED serves as an indicator for the output of the received power reading and the display of the equipment indicator. The development of this project uses the Engineering Design Process (EDP) design model as a guide to develop a project that includes eight key steps. In conclusion, this device is tested to detect current and power readings from electrical appliance well and has good safety features to help users use electrical appliance safely.

Keywords: Current, Power, ACS712, Blynk.

1. Introduction

Electricity is one of the essential necessities of daily life. Electricity is an important element in the operating system of residential and commercial buildings. The lack of electricity makes this system

*Corresponding author: tselvan@uthm.edu.my

unable to function and at the same time affects the activities of consumers and their needs. (Hussain, Ismail, Noh, 2013).

The electricity supply used by consumers is increasing from time to time. This is due to the load applied to the source of high electricity supply. The higher the electricity consumption, the higher the load borne on the power supply source. Excessive load applied to a source of energy supply can threaten safety and cause accidents. Safety is defined as the absence of danger, the absence of space that helps create an atmosphere of danger, a level of protection and conditions that do not involve risk (Isa, 2020).

Therefore, to ensure that consumers can manage electricity consumption properly and help consumers avoid accidents, a tool development is needed to detect the current and power readings required for an electrical appliance. Measures to emphasize safety against electrical hazards are needed to prevent accidents or injuries to consumers. If safety measures are not implemented, then accidents cannot be curbed properly.

1.1 Background of study

Statistics on electricity consumption in Malaysia show that an increase occurs every year (Energy Commission, 2017). Table 1 shows the statistics of electric power consumption from 2015 to 2017.

Table 1: Statistics of electricity consumption from 2015 to 2017

Type of Consumers	Electricity Consumption (Million Kwh)		
	2015	2016	2017
Residential	714.26	744.50	914.83
Commercial	974.56	975.36	1,250.19
Industrial	1,762.06	1,770.10	2,298.99
Agriculture	58.58	59.65	89.68
Public Lighting	48.03	55.25	70.82
Total	3,557.49	3,604.86	4,624.51

Based on Table 1, the statistics show an increase occurs each year from five different types of consumers namely residential, commercial, industrial, agricultural and public lighting. This increase occurs as a result of several causes such as incorrect use of electrical equipment, use of excessive load on sockets and use of additional sockets. Based on the causes, there are negative effects that arise as a result of the situation such as accidents, injuries, damage and others. This can threaten the safety of users (Sidek et al., 2017).

One of the causes of excessive consumption of electrical energy is from the use of inappropriate electrical equipment. Most users, especially students and housewives, use excessive load on a socket. This is because the user does not know the value of the load that can be accommodated by a socket. Most users use more load than they should. For example, a user uses an additional socket on a socket where the socket can be used for certain equipment or loads only. The use of additional sockets to turn on many electrical appliances and uncontrollably inevitably leads to the occurrence of excess load current on the sockets which can result in accidents (Bin et al., 2016).

In the meantime, another cause of excessive load on the socket is due to the use of electrical equipment that uses high power simultaneously on a socket. Among the electrical appliances that use high power are such as water heaters, rice cookers, refrigerators, burners, vacuum cleaners and so on. These devices require high power when operating. This situation can be identified, often occurs in residential houses, especially kitchen and room areas due to the limited socket facilities in the space. This causes users to use the equipment simultaneously on the same socket using additional sockets

when doing cooking and cleaning work. According to Hussain et al. (2013), this style of use of electrical equipment certainly opens-up more space for electrical accidents to occur in turn threatening life and property damage. This happens because the user does not know the amount of load that is the power required on an electrical equipment. So, the user uses electrical equipment without knowing the ability of the socket to accommodate the load (Anantama et al., 2020). Therefore, a project needs to be developed to help users read the value of the current used on an electrical equipment so that they can use the electrical equipment in the right way and avoid any accidents.

1.2 Problem of study

Based on the background of the study that have been discussed, there are several problems that can be researched and focused on in this project. Some of the problems discussed are related to the excess load current on the outlet socket causing electrical accidents. According to Berita Harian newspaper quote dated 10th-January 2016 entitled "Short circuit is like a silent killer" shows that overload is one of the 13 main causes of electrical failure that can cause fire (Mokhtar, 2017). This article had issued of fires that destroyed the second floor of the Intensive Care Unit of Sultanah Aminah Hospital Johor Bahru caused by electrical failure. This indicates that users do not follow the recommended safety measures so as not to use excessive electrical equipment on a socket. This is because consumers are unaware and not sensitive to the ability of a socket to accommodate the load value of electrical equipment. Therefore, a device needs to be developed which can help users make current and electrical power readings detector required for a device before using the device on a socket. In addition, accidents can be avoided when using the correct electrical equipment. The objectives of this project were to:

i. develop current and power reading detector with appliance indicator.
ii. analyse current and power reading detector with appliance indicator.
iii. test the functionality of a current and power reading detector with appliance indicator.

2. Methodology

Engineering Design Process, (EDP) is a repetitive process used to guide in problem solving. This model is chosen because it is suitable for developing this project. This model has eight steps which is started with identify the problem and end with redesign (Hua, 2016). Each model shows different elements in the process. Figure 1 shows the engineering design process used for this project.

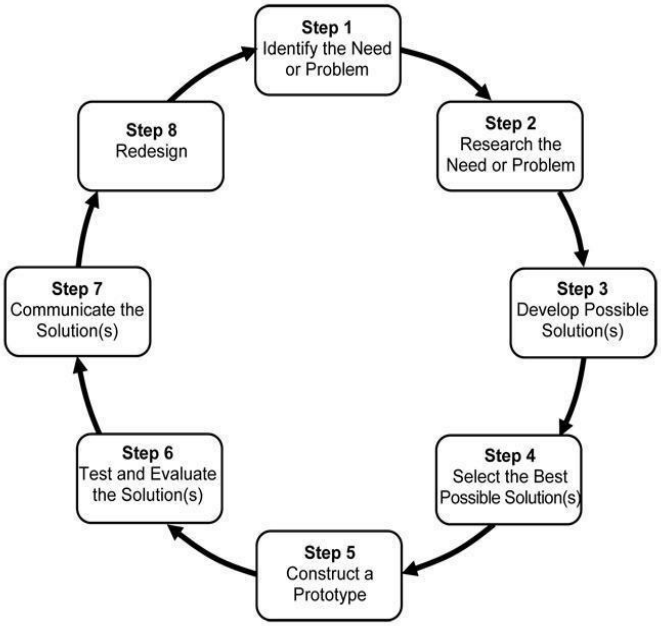

Figure 1: Engineering design process

2.1 Identify the problem

In this phase, the developer identified several problems based on research and observations of the environment and society covering the fields of electrical and electronics. Through these steps, the developer has clearly defined the problem. In the early stages, the problems obtained by the developers were somewhat less clear and vague. However, this problem can be focused by the developer through the information collected. As the key to problem solving, developers have translated the problem into a clear statement. Based on the statement, the focus or purpose of development can be determined. Based on observation, in this phase of EDP, identified problem was get problems that arise from situations that have happened to the community, namely accidents and damage while using electrical equipment due to the use of excessive load on the socket. Through this problem, the developer implements the next step which is to study the problem to be addressed with the development of a product.

2.2 Research the problem

After the problem identification phase, the developer gathers the information that has been obtained for study in detail. Several questions were developed to obtain various additional information for use by the developer. Preliminary research is important to obtain a wider range of information to produce a good product. In this project, the problem faced by users is that they do not know the value of current and power used by electrical equipment to be accommodated by a socket. If the load installed on the socket exceeds the capacity of such a socket, then accidents and property damage occur. Therefore, the problem is studied more carefully to develop a solution to address the problem. At this stage, the title and objectives of the project begin to be constructed to set the exact focus or purpose of the study.

2.3 Develop solution

The next phase is the solution construction phase. Through the information obtained based on the problem study and based on the set objectives, several solutions to the problem were constructed to help develop the project. This is done in a number of ways such as brainstorming ideas, questionnaires and based on past studies. Based on this phase, creativity can be developed, and innovative ideas can be generated. The developer lists the appropriate components to make the right and appropriate selection to develop the project. Among the proposed components are the Arduino UNO, Raspberry Pi, Node MCU and Current Sensor ACS712. Developers have built several types of circuits to be tested and selected according to the function of the circuit and the suitability of the objectives that have been set.

2.4 Choose the solution

Once the solution construction is implemented, the developer needs to analyze the best solution method to develop a project. The developer ensures that the solution selection decision made is the best to produce a good project. Through this phase, the developer sets the right components to be used, the system and the design for developing the product. The developer has specified the use of the Node MCU component as a micro controller for the entire circuit. The MCU node was chosen over the Arduino UNO because the component also provides internet connection to the component compared to the Arduino UNO. The Arduino IDE software was selected as the system operating controller while the Blynk application was selected as the final product. This shows that this phase is important for developing a better and simpler project.

2.5 Construct a prototype

Once the selection of the best solution has been determined, the developer performs prototype construction by designing the project based on the appropriate criteria. Among the criteria that need to be met are such as the tendency to innovation, creativity, originality of design, strength and marketability. The construction of the prototype aims to give an initial overview to the developer and to make an initial assessment in the next phase which is the testing and evaluation phase. The prototype building here for the developer is a test of the circuit that has been built and the application that has been developed. The operation of the circuit plays an important role in ensuring that the prototype works as planned. The developer has made the connection of the selected components to form a complete circuit which serves to measure the current and power readings on electrical equipment. In the meantime, the operation of the system is developed to complete the functions of the Current and Power Reading Detector and Equipment Indicators. Figure 2 shows the PCB layout for the current and power circuit of the project as the prototype in this project.

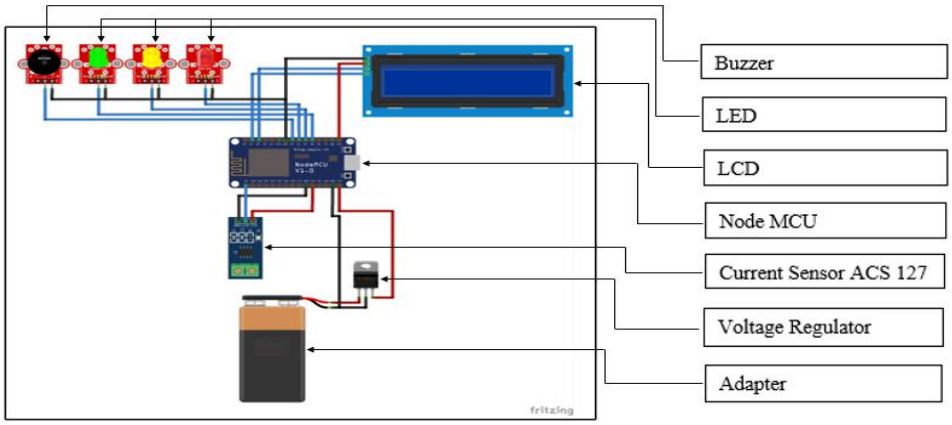

Figure 2: PCB layout of the circuit

2.6 Test and evaluate

After the completion of the prototype construction, the testing and evaluation phase was carried out. Developers do tests for hardware and software to test whether tools and applications work well or otherwise. Testing and evaluation are intended to ensure that the product produced can function properly according to the set plan. The focus of the developer's testing and evaluation is to test the current and power readings detected on electrical equipment through the detector circuit. Figure 3 show the current and power reading circuit of the project that had been tested. Readings for current and power are displayed on the display on the LCD and the Blynk app as output. Testing was performed on five types of electrical appliances, namely electric rice cookers, ovens, fans, water heaters and irons. At this stage, the constructed project is ensured to function properly before moving on to the next stage.

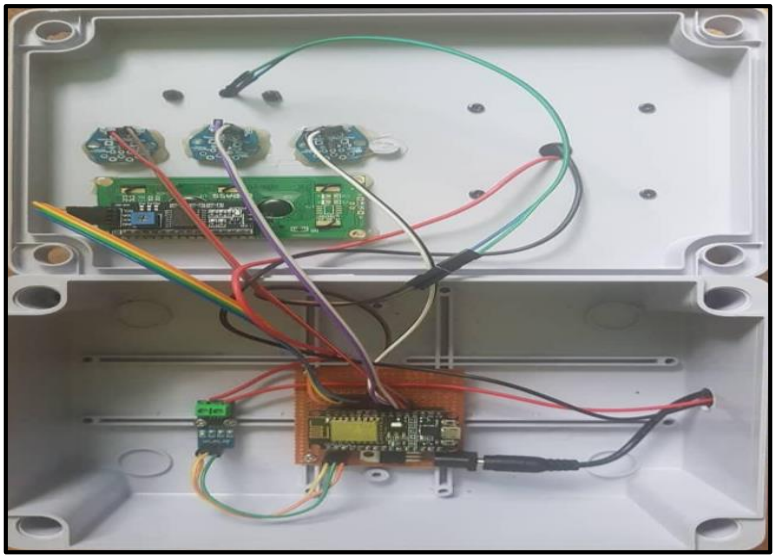

Figure 3: The current and power reading circuit of the project

2.7 Communicate the solution

Through the solution communication phase, prototypes that have been completed and tested and evaluated need to obtain expert views and validation to ensure that the product meets the set standards. Additionally, it aims to improve the prototype prior to the design reconstruction. This aims to ensure that the product will be built well and can function well as well as suitable and safe to use by users. The developer has sought feedback and suggestions for improvement from three experts or individuals who are skilled and knowledgeable in the field. The selected experts involved a university lecturer in the field of electricity, a vocational college lecturer in the field of electricity and the electronics industry. This phase is important before the final phase is carried out to complete the project development process

2.8 Redesign or improvement

The final phase of the engineering development model is the redesign or improvement phase. Once testing and evaluation as well as solution communication is implemented, the developer implements the product redesign process based on evaluation, opinions and recommendations from experts. The product needs to be improved to ensure the final product produced in accordance with the set objectives and quality. Figure 4 and Figure 5 shows the final product of the project that had been produce by the developer.

Figure 4: The current and power reading detector

Figure 5: The output of Blynk

3. Results and Discussion

Tests are performed to test the current and power readings detected on five different types of electrical appliances. This is to ensure that the developed tool works properly. Testing is done in two attempts to get the average value for the device. Equivalent value calculations are measured on displays received from LCD and Blynk Applications.

Table 2: The results testing on the Current and Power Reading Detector with Appliance Indicator

Electrical Appliance	Test	LCD		Application of Blynk		Percentage % of reading similarity between LCD and Blynk applications	
		Current (A)	Power (W)	Current (A)	Power (W)	Current (A) %	Power (W) %
Rice Cooker	1	1.61	387.39	1.614	387.387	99.75	100
	2	1.63	387.39	1.631	387.387	99.94	100
Fan	1	0.17	40.31	0.168	40.306	98.82	99.99
	2	0.17	40.31	0.168	40.306	98.82	99.99
Iron	1	4.01	962.87	4.012	962.869	99.99	99.99
	2	4.0	960.63	4.003	960.630	99.92	100
Water Heater	1	2.63	631.46	2.631	631.463	99.96	99.99
	2	2.63	631.46	2.631	631.463	99.96	99.99
Oven	1	5.40	1296.51	5.402	1296.515	99.96	99.99
	2	5.40	1296.51	5.402	1296.515	99.96	99.99

Based on the table 2, the test shows that the project works well and can detect readings correctly. The display received on LCD and Blynk applications has a high percentage of similarity value which indicates that the readings received for both outputs are accurate.

4. Conclusion

In conclusion, the development of the Current and Power Reading Detectors with Appliance Indicator had achieved the objective as planned. In future, the development of this project can help the users to use the electrical appliance in a good way and to avoid from an accident or the damage of electrical appliance.

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