Homestay save rent method through consumer self-management of electricity power consumption

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Article Info

ABSTRACT

The rapid growth in the number of homestays and hotels, competition has increased among them. Homestay that is a relatively newcomer in this business should find the way to become competitive. One way is to make rental fees more affordable. In this paper a method to reduce the homestay rental fees are proposed. This is done by separating the component of the electricity cost from the whole rental fees. Then it requires the consumer to pay their own electricity used and also gives opportunity to them to manage their own electricity used how much they need. This mechanism is implemented by equipping the homestay with the coin kilowatt hour (ckWh) meter. The consumer can plan how much they will use the power since they stay by inserting the certain amount of coin into the ckWh meter. After insert the coin the electricity sources will on and ready to use. The main components of this ckWh meter consist of the Arduino Uno microcontroller as a brain of the device, the coin acceptor where the coin will insert, and kilowatt hour meter. Besides that, it also equipped with liquid-crystal display (LCD) to show the amount of money currently available. The experimental test shows that the device develop work well and can control the used of the electricity related to the amount money that has been inserted.

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1. INTRODUCTION

The Malaysia among the top 10 countries receives foreign tourists every year. This high volume is closely related to Malaysia's diversified tourism products. Among the products being developed are homestay [1]. Homestay businesses grow rapidly not only in the city but till to the village. The main purpose is for tourism, university areas and stay at village program. Based on statistic by Ministry Tourism and Culture of Malaysia, 5604 rooms of 203 homestays have been registered and the possibility of this amount will increase [2-4]. According to reports from the Minister of Tourism, Arts and Culture Minister Datuk Mohammadin Ketapi said there were 8.47 million who came to Malaysia in 2018, some of them chose to live in homestays. This numbers continue to increase every year, providing well opportunities for the homestay business [2-8].

There are several logic reasons why the visitors prefer homestay for accommodation, among other: comfort factor, safety factor, wider space, flexible check-in time, strategic location, unique design, there are many basic amenities under one roof, more privacy and no need to share, it feels like home, can provide your own food and etc [4]. Along with the rapid growth of homestays, at present hotel entrepreneurs have begun to

expand their business to remote areas. Of course this will be other rival for the homestay beside rivalled by themselves [9]. For this condition the homestay should look any other way to promote and attract customers. One way is by minimizing the rent fees. Usually customers will look at the rent fees and facilities first before making their choices and booking [10, 11].

There are several electrical equipment provided to provide consumers comfort in a rental house, including lights, television, rice cooking utensils, refrigerators, air conditioners, washing machines, electric stoves, etc. Sometimes due to forgetfulness, consumers forget to turn off the equipment when they want to sleep or also leave any needs. So that it causes waste of electricity use. In order to cover the expenditure of electricity consumption, the fees usually includes in to the fees of the homestay rental. Furthermore, rental prices will be expensive, so that make the homestay business is less competitive. Therefore, the electricity consumption cost should separating from total rental fees. The rent fees become cheaper and the homestay business become more competitive. Consumers are required to manage and pay how much they want to consume the electricity [12-16]. If consumers want to minimize their electricity usage they can manage the number and time of the appliances on [14-19].

For this purpose, in this work the homestay is equipped with the coin kilowatt hour (ckWh) meter device. To turn on the power source, a number of coins must be inserted into the ckWh meter. The total number of coins entered will be proportional to the length of time the electricity resources on [20-22]. This means that for a number of coins that have been entered, if the amount of load is reduced the electricity resources on will be longer and vice versa will be shorter. The type of coins that can be used is 1 ringgit, 50 cents, 20 cents and 10 cents. The payment rate for electricity bills is RM 0,281/kWh following the electricity rates used by Tenaga Nasional Berhad (TNB) [23, 24]. Then this level of payment will follow changes during the time set by TNB. The total amount of money available and also the use of electric power per hour will be shown to consumers using liquid-crystal display (LCD) [21].

This paper consisted of three sections. Section one explains about introduction about the problem that will overcome. The second section explains how the problem is solved in detail. The second section explains the methodology used to solve the problem in detail. Starting from designing the equipment to be made, explaining the functions and testing the performance of each components and finally fabricate equipment. The last section elaborates the equipment test results and analysis to determine whether it meets the objectives.

2.   RESEARCH METHOD

Methodology is defined as systematic step by step to solve the problem in order to achieve the objectives. The steps include the design, implementation and test.

2.1. System design

System design in the form of block diagrams will show each sub-block that represents its function in the system as a whole. Figure 1 shows the block diagram of coin kilo Watt meter developed.
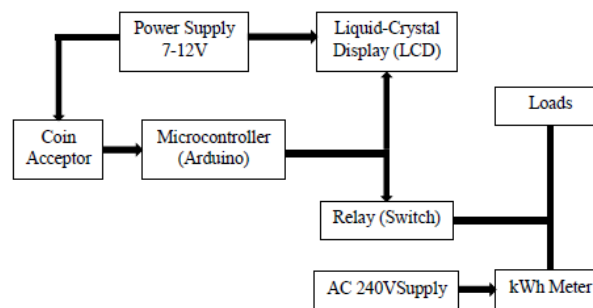

Figure 1. Block of the coin kilo Watt hour (ckWh) meter

The main component of ckWh meter is an Arduino Uno microcontroller as a brain of this device [25]. It has a function to control all the sub-components such as coin acceptor, liquid-crystal display (LCD),

kilowatt hour meter (kWh Meter) and relay. All control commands are compiled in programming code. The flowchart how the system work is shown by Figure 2 below.
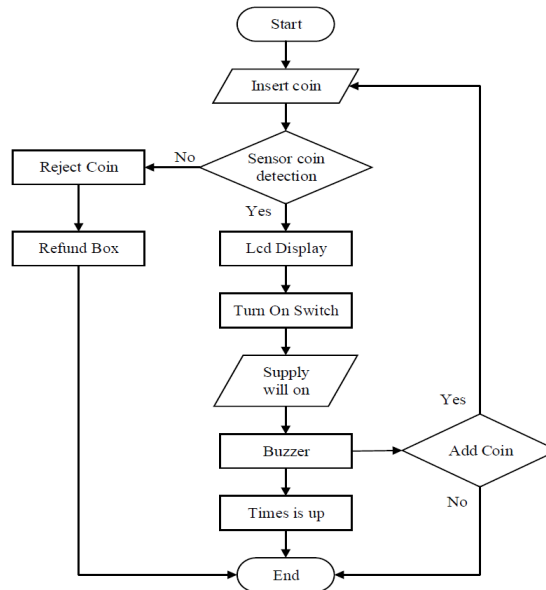
Figure 2. System operation flow chart

2.2. Coin aceptor

The coin acceptor device is a module which detects and counts the number of coin and then sends the signal to the Arduino board [20, 21]. The accepted coins consist four types, they are 1 ringgit 50 cent, 20 cent and 10 cent. The coin acceptor has a function for inserting coins. The total amount of coins that have been entered will be processed by Arduino to determine the amount in the form of money and show it on the LCD display. Then the Arduino will send signal to the relay to close the contactor in order to on the electricity source.

2.3. Coin aceptor component

The microcontroller used in this work is Arduino Uno. Where this type of microcontroller board is based on the ATmega328P. It has 14 digital input or output pin ports which 6 can be used as PWM outputs, a USB connection, a power jack, an ICSP header and a reset button. In order to get it started, it is essential to simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery [25].

Arduino will receive the signal from the coin acceptor as described earlier. The signal will be processed, the first is to determine the amount of the total coins that have been insert in form of money and display it on the LCD display. Second is to send the command to the relay to close the contactor and display on the LCD that the power source has been on and ready to use. Furthermore, if the consumer connects an equipment with an electric power source, Arduino will calculate the total power of the equipment and determine how long it will be available to allow the contactor to connect and display on the LCD screen. At that time, if consumers reduce or increase the number of equipment or loads connected, at the same time Arduino will recalculate the length of time the contactor can on and shows it in the LCD screen.

2.4. Liquid-crystal display (LCD)

Type of LCD use is 16×2 LCD display. Its name is based on it has 16 Columns and 2 Rows. This type is fulfill the requirement of the device developed. Figure 3 shows the physical form of LCD.
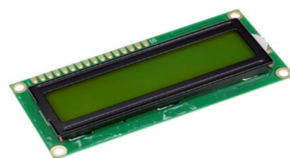
Figure 3. Liquid-crystal display (LCD)

2.5. Relay

The function of the relay is to open or close the circuit connection between ckWh meter and the loads. When the Arduino detects any amount of coin (money), it sends the signal to relay to close the contactor. After the time on of contactor based on the Arduino calculation has been reached, then Arduino sends signal to relay to open the contactor.

2.6. Kilowatt hour meter (kWh Meter)

Kilowatt hour meter is the one important component in this device [23,24]. It has functions to determine the energy usage and display it. The type of the kWh meter is a pulse type, it means the power used in hour is counted through pulse. The total power per hour for one pulse (u) is determined using Equation. (1) to (4) below:

$$p = (p\_r \times W \times t) \div (1000 \times 3600) \tag{1}$$
$$t\_p = p \times t \tag{2}$$
$$PF = W \div t\_p \tag{3}$$
$$u = (PF \times t\_p) \div 1000 \tag{4}$$

Where: p is pulse, p_r is pulse rate, W is power, t is time, t_p is total pulse, and PF is prorate factor. The specification of the kilo Watt hour meter used in this study is elaborated in Table 1.

Table 1. Specification of kilo watt hour meter

Nominal voltage (Un)	120/230 AC
Operational voltage	84 – 156V AC/161 – 300V AC
Basic current (Ib)	5A/10A/20A
Maximum rated current (Imax)	60A/63A/100A
Operational current range	0.04A – 60A/0.08A – 100A
Over current withstand	1800A/3000A for 0.01s
Operational frequency range	50/60Hz ± 10%
Internal power consumption	≤ 2W/10VA
Test output flash rate (RED LED)	500 impulses per kWh
Backlit LCD display	7+1 digits
Data save	20 years
Maximum cable capacity	25mm2

2.7. Coin Kilowatt Hour Meter

The combination of several components that have been described previously formed a prototype of a coin kilowatt hour (ckWh) meter. Based on the circuit connection the prototype of ckWh meter is fabricated. Where the top view and front view of the prototype of ckWh meter are shown by Figure 4. To run this equipment it is necessary to have a program in the form of a list of commands which covers how each component's work, coordination of each component and the working sequential of each component. This list of commands will be embedded in the Arduino boards that function as the brain of ckWh meters.

| (a) | (b) |

Figure 4. Prototype coin kWh meter, (a) top view, (b) front view

3. RESULTS AND DISCUSSION

In this section, it is explained the results of research and at the same time is given the comprehensive discussion. Results can be presented in figures, graphs, tables and others that make the reader understand easily [2, 7]. The discussion can be made in several sub-chapters.

3.1. Power consumption estimation and total billing

Firstly, to estimate the total amount of loads in homestay. The loads can be electrical appliances and components such as fluorescent lamp, ceiling fan, ventilating fan, air-conditional, water heater and some socket outlet. Furthermore, the total load will be calculated to determine the maximum demand. From this data, it can be calculated the total hourly energy consumption with equation. (5):

$$E_T = P_{max} \text{ x D x H} \tag{5}$$

Were: E_T is total energy per hour, P_{max} is maximum demand, D is number of day and H is hour.

One of the homestays in Parit Raja area, Batu Pahat Johor Malaysia has been taken as a sample in this study. The unit of electrical appliances and components is assume based on normal semi-detached house 3 rooms. The estimation of total energy consumption is 486 kWh for 5 days. The electrical bill is calculate automatically based on tariff from TNB standard [19, 24, 25] and obtained total bill for 5 days is RM 125.60. The total bill have been calculated at maximum energy consumption. The bill can reduce if the users reduce electricity consumption. The summary of energy demand for minimum, average and maximum based on 5 different type of houses that have supply from the utilities company are shown in Table 2.

Table 2. Summarises of energy demand

No	Type of houses	Minimum (kW)	Average (kW)	Maximum (kW)
1	Low cost flats, single storey terrace	1.5	2.0	3.0
2	Double storey terrace or apartment	3.0	4.0	5.0
3	Single storey, semi-detached	3.0	5.0	7.0
4	Single storey bungalow & three-room condominium	5.0	7.0	10.0
5	Double storey bungalow & luxury condominium	8.0	12.0	15.0

3.2. Coin acceptor precision performance test

Coin acceptor have their own number of precision form number 1 to 25 to detect the types of coin when insert into the slit [22]. The smaller the number, the more accurate the precision but the suggestion in manual is number 8. Only 4 testing which is the selected number precision are number 1, number 8, number 16 and number 25 with 6 difference coins for 20 times. Figure 5 represents the coin acceptor test result. The results have taken from the serial monitor in Arduino software. To run the serial monitor, the Arduino board should connected with the computer using Universal Serial Bus (USB) and compiled into the Arduino board.
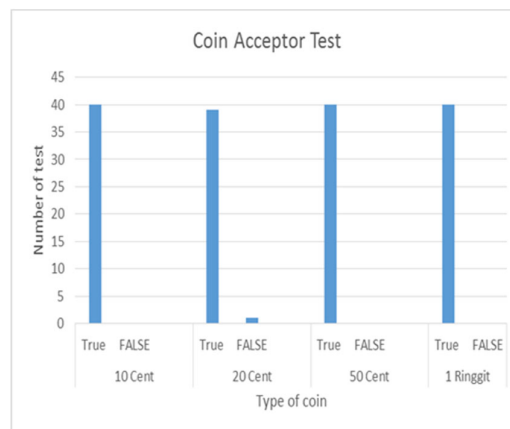

Figure 5. Coin acceptor test

The table above shows that only 1 time the false occurred by the coin acceptor in determining the type of coin entered. Trials for each type of coin are carried out 40 times. The false is happen for 20 cents coin type (2.5%). While for other types of coins, 100% coin acceptors can detect correctly. The error may occur due to the existence of two different sizes for 20 cents coins. Where the new 20 cents coin has a smaller size compared to the old 20 cents coin.

3.3. Unit and balance
The unit is a unit to state the amount of energy available according to the amount of money (Ringgit Malaysia) that has been entered into the coin acceptor. While balance indicates the amount of money currently available. The data shown by Figure 6 is the data changing, including the remaining money for each one pulse increases.
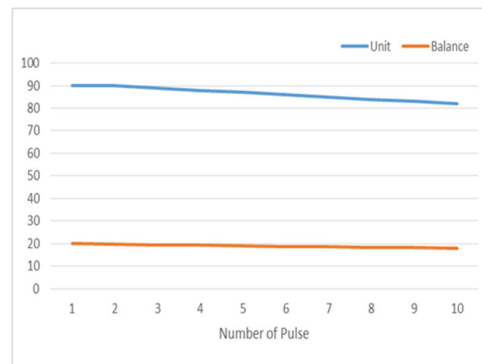

Figure 6. Unit and balance for each one pulse increases

Above data is acquired for 18 minutes testing time with 55 watt load, 500 pulse rate of kWh meter and 20 cents initial balances.

3.4. Comparison between test result and calculation result
Calculation below shows the values of unit and balance in 18 minutes according to the data that have been taken.

$$pulse = (pulse\ rate\ x\ watt\ x\ time) \div (1000 x 3600)$$
$$= (500 x 55 x 60) \div (1000 x 3600)$$
$$= 0.5\ per\ min$$

Based on pulse per min previous calculation result, it means for 18 minutes time load supply the total pulse is 9 as below:

$$total\ pulse\ in\ 18\ min = pulse \times time\ taken\ (t)$$
$$= 0.5 \times 18min$$
$$= 9\ pulses\ (led\ blinking)$$

Then, the number of unit is

$$unit = (PF \times total\ pulse) \div 1000$$
$$= (2 \times 9) \div 1000 = 0.018$$

Tariff should be paid for 18 minutes use of 55 watt load is

$$bill\ (cents) = unit \times unit\ rate(tariff)$$
$$= 0.0018 \times 2.18\ cen$$
$$= 0.392\ cents$$

Total bill in Ringgit = RM 0.39

For hardware experimental test, result for unit and bill are 0.0188 and 0.388 cents ringgit as shown by Table 3.

Table 3. Comparison experimental test and calculation result

Type of Comparison	Experimental	Calculation
Total Pulses (Led blinking)	9	9
Unit	0.0183	0.018
Total bill	RM 0.0388	RM 0.39

Based on the data in the table above, there appears to be a slight difference between the data from the experiment and the results of the calculation. The difference is 1.7% greater than the unit obtained from the experiment than the calculation, then the total bill from the calculation of 0.5% is greater than the total bill obtained from the experiment. This small difference may occur due to the decimal rounding done in the calculation.

4.   CONCLUSION

Based on the experimental test of the device develop, it able to work well. The coin kWh meter can accept 10 cents, 20 cents, 50 cents and 1 Ringgit coins. From the 40 trials for each type of coin, only one false (2.5%) occurs in the 20 cent coin type. This means that coin acceptors have good performance. The unit obtained from the experiment is 1.7% greater than from the calculation, then the total bill from the calculation is 0.5% greater than the total bill obtained from the experiment. These two differences are smallest and can accept.

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