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LOAD SURVEY OF DOMESTICINSTALLATION TOWARDS OPTIMIZATION OF POWER CONSUMPTION

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ABSTRACT

The demand for electrical energy has increased exponentially over the last decades. The purpose of this paper is to demonstrate how the domestic power consumption measurement and its appliances were used to improve energy efficiency as consumer's needs to be more aware of their energy consumption; to help the consumer in saving energy and money. This will increase the understanding for accurate and economizing methods of energy consumption. It will also enable the user to understand their meter readings regularly without any confusion. The study followed empirical observation to achieve its objectives by using energy meter that continuously monitors and records the energy consumption. The theory on optimum use of electrical energy and the advantages of effective utilization of amount of monthly bill can be achieved by observation from related work. This study was conducted through survey on public's view regarding electricity bill calculation, consumption cost and the ways to reduce the burden of electricity bills. Thus, the study was conducted at Taman Parit Raja and it involved only 10 respondents for in-house sampling. The result from this interview was analyzed and it revealed that mode of payment of electricity bills varies according to income, standard of living, climate, types of residence and the usage in each household. However, the final result indicates that there

have been so many ways and approaches to minimize electrical consumption in order to reduce cost.

Keywords: Electricity consumption, billing andcost reduction

1.0 Introduction

Electricity consumption in domestic buildings is determined by some factors, these include the number of households, population, income, temperature and growth in number of appliances; and the use of these appliances by the occupants of the building(Firth, Lomas, Wright, & Wall, 2008). The types of housing can also have an impact on energy consumption. Flats have the lowest heat loss while bungalows and detached houses have higher heat-loss levels as there is a larger surface to volume ratio. The amount of energy required by two people living in two households is greater than the amount of energy required by two people living in the same household. Again, in houses with similar built forms there can be a wide range of different appliances in use and these appliances will have a range of different power consumptions. Occupants influence the electricity use of a dwelling both by their purchase of electrical appliances and through the use of these appliances. The variation in the type of electrical appliances present and the occupant's semi random use of these makes domestic electricity consumption difficult to predict with accuracy, particularly at short time steps such as an hour or less(Firth et al., 2008).

Furthermore, it has been recognized that a sound understanding of domestic electricity consumption is required for the design and implementation of energy efficiency measures and on-site electricity generation as a device that measures the amount of electrical energy consumed in each residence, business premises or in any electrically powered device. This type of electrical meters are typically calibrated in billing units, the most common one being the kilowatt hour (KWh); they are broadly classified into electromechanical meters and electronic smart meter(Roberts 2013).

In addition to that the smart meter is one of the core components in Advanced Metering Infrastructure (AMI) that is responsible for providing effective control and monitor of electrical energy consumptions(Swan & Ugursal, 2009). The multifunction tasks that a smart meter carries out such as facilitating two-way communication between utility providers and consumers,

managing metering data, delivering anomalies reports, analyzing fault and power quality, simply show that there is huge amount of data exchange in smart metering networks. Its functionalities allow it to be used for simple domestic electric power measurement applications that are used by the utility providers for billing of energy consumed(Sun et al., 2016).

In view of the above, the ways to which bills are being calculated be it prepaid meter or normal energy meter are largely depending on by the different types of tariffs. Again, in billing system, monthly consumption of all equipment is considered for calculation of bills. So, for the consumer to know exactly the amount of total electrical energy used in a month is illustrated below:

If 15watts bulb runs for 1000 hours, it consumes energy of

$15 \times 1000 = 15{,}000\text{Wh}$ or 15kWh.

If the cost of 1 unit is considered RM6/kWh then the bill for this application will be

$15 \times 6 = \text{RM}90$.

While calculating the energy cost of an appliance or electronic device is easy. Most devices have a label that lists how many watts it uses, either on the device or in the owner's manual(Brickfield, Mahling, Noyes, & Weaver, 2011). You will need to find this number to figure out how much the appliance is costing you. You will also need to estimate how many hours a day you use an appliance. Furthermore, if you can't find the wattage label, there are other options to determine how much power your device uses. For example, you can purchase a wattage measuring device, such as the Kill A Watt®. Simply plug your appliance or electronic device into the Kill A Watt® to determine how much power it uses. Again, you can contact the manufacturer, with your model number, to find out how many watts a device consumes.

While estimating the watts a device consumed; when you get your electricity bill each month, you may not think a whole lot about what goes into it. But, every appliance or electronic device adds a little something to your bill. By figuring out what the biggest energy hogs are in your home, you can adjust your usage by unplugging or simply using the device less. Every change you make should help shape down your energy expenses(Raj, Sudhakaran, & Raj, 2009).

2.0 Literature on domestic power consumption

In a related literature Fischer (2008) talked about domestic electricity use and calculation, Brickfield also discussed about the automatic energy calculation. They all highlighted on general issues that are relevant to the debate on the future of energy in the residential sector and how it is

understood and controlled. These previous authors' presents a high-resolution model of domestic electricity use that is based upon a combination of daily activities, profiles and how people spend their time performing certain activities with electricity.

In a similar investigation,(Rojchaya & Konghirun, 2009) have explained about smart meter based consumption monitoring and warning system that explained how consumers willtake care of his/her electrical energy consumption. And how consumer will protect themselves from extra charges incurred due to minor changes in slab categories, even though these changes are small, but they affect the consumer's bill severely.

Additionally, Sugiura, Miwa, and Uno (2013) in their findings analyzed household energy consumption of lighting and account for a large percentage of household energy consumption. Consequently, it is estimated that the energy consumption of domestic electric appliances will decrease by some amount from the older level, mainly due to the energy savings expected for domestic appliances. According to Raj et al. (2009) many consumers could simply unplug their appliances and go on holidays, assuming that their electricity meter would just stop. In his paper, standby power consumption of various domestic appliances was determined using an energy cost meter; thus the experimental results shows that the standby power of various house hold electrical appliances is consuming more electricity during standby mode(Raj et al., 2009).

Furthermore, Ashiquzzaman, Afroze, and Abdullah (2012)discussed about design and implementation of wireless digital energy meter using microcontroller. They present a micro-controller based wireless digital energy meter to facilitate energy consumption measurement. This paper has thus provided simple, accurate and useful information to the consumer so that one knows about real time consumption of appliances.

One of the aims of the present development is to implement a power management system to help the consumer in saving energy and money (Santinato, Arione, & Braghini, 2017). Another purpose of the present development is to make the user aware of potential energy cost savings in selecting different delayed switch-on times for each appliance. A further item of the present discovery is to provide a system which comprises user interface through which the user may also input a predetermined energy cost saving target referred to a certain fixed time (week, month), the system being able to select the proper times for switching-on the appliances in order to get the energy-savings target(Santinato et al., 2017).

2.1 Common Wattages for household appliances

Household electrical appliance categories the electricity consumption of a household is determined by the electric power consumed by each appliance and the amount of time each appliance is in use(Setlhaolo, Xia, & Zhang, 2014). The wattage on appliances or electronics varies by device. Typically, older model appliances use more energy, but newer models tend to be more efficient. However, in Table 2.1is the list of common wattage of household appliances for everyday devices. Though your particular device may vary, it should give you a rough estimate of the energy expenses related to the device(Setlhaolo et al., 2014).

Coffeemaker	900-1200watts
Microwave	750-1100 watts
Toaster	800-1400 watts
Dishwasher	1200-2400 watts
Washer	350-500 watts
Dryer	1800-5000 watts
Iron	100-1800 watts
Ceiling fan	65-175 watts
Space heater (40gal)	4500-5500 watts
Hair dryer	1200-1875 watts
Laptop	50 watts
Computer monitor	150 watts
Computer tower	120 watts
Television 19"-36"	65-133 watts
Television 53"-61"	170 watts
Air conditions	1Hp – 2Hp

Table 2.1:List of common wattage on household appliances

2.2 Type of tariff that are more appropriate

Daily energy demand isn't flat; peaks of energy are generated during the day which creates variable demand and increases a utility company's charge to consumers. To avoid dangerous blackouts utility companies are searching for ways to smooth energy demand by offering advantages to customers who are able to control their power consumption(Santinato et al., 2017).

Consequently, it would be advantageous to design a new generation of appliances that are able to manage power consumption with different tariffs on the base of signed power supply contract(Santinato et al., 2017).A tariff is the way you get charged for your energy. Choosing the

right tariff for you can help reduce what you pay for your energy below are two types of tariff that determined the charges: Electricity and gas tariffs

Also, to help you work out the best for you in terms of electricity tariff as regard to what the different tariffs are and how they work. However, there are three types of electricity tariffs, namely: single rate, time of use (including flexible pricing), and Controlled load as further explained below.

a. Single rate tariffs

With single rate tariff offers there are no peak or off-peak periods. This means that you pay the same rate whatever time of day you use energy.

However, the rate is usually lower than the peak rates of a time of use or flexible pricing tariff. This means a single rate offer could be a good choice if: You are at home a lot in the evening Monday to Friday and sometime the consumer may need to use his appliances more often from Monday to Friday, may be by using washing machine or dishwasher etc. Also, a single rate tariffs are sometimes called: flat rate, standard rate, anytime rate, or peak rate. Similarly, single rate tariffs are available to everyone. You don't need a smart meter to get a single rate tariff offer.

b. Time of use tariffs

The time of use tariff means that electricity costs different prices at different times of the day. Peak electricity costs the most; peak rates usually apply in the evening on Monday to Friday. But some people prepare off-peak electricity is cheapest. Off-peak rates usually apply overnight on Saturday and Sunday. While shoulder electricity costs a bit less than peak, because shoulder rates usually apply in between peak and off-peak periods.

Again, a time of use tariff offer could be a good choice if: You are out a lot in the evenings Monday to Friday, you are at home during the day or on weekends and you use your appliances on the weekend, like your washing machine or dishwasher.

In a note shell, some retailers have even more time periods than peak, shoulder and off-peak for example, a flexible pricing tariff. Flexible pricing tariffs are not available in all areas yet. You will only be able to search for flexible pricing tariff offers on Energy Made Easy if they are available in your area. Retailers will also tell you how to start and end times of the different periods for their time of use offers in the Energy Price Fact Sheet or the retailer's written summary of the offer. To get a time of use tariff offer, you need a meter that measures your

electricity usage at different times of the day. For example, a smart meter or time of use meter(Kavousian et al., 2013).

c. Controlled load tariffs

For some appliances you can be charged a controlled load tariff when slab are under floor heating, or electric hot water systems. This means that the retailer charges a rate just for that appliance and the energy it uses. Often that appliance has its own meter. It is usually only for appliances that run overnight or in off-peak times. So controlled load rates are usually lower and are sometimes called: dedicated circuit consumption, or off-peak.

2.7 Summary

From the above literature survey, conclude that, the first literature survey suggests the saving of energy consumption. From second literature survey, it gives the idea about the energy consumption of daily activities. In third literature survey, it suggests consumer shall be aware for energy consumption and awareness of extra charges. Last paper is very useful for this project work, it suggests the idea about real time consumption with cost using microcontroller.

3.0 Methodological direction

3.1 *How power consumption is calculated*

This calculation of energy consumption is developed to provide the real time consumption detail of every load and about consumer's bill. Calculate electricity consumption - 4 Easy Steps

STEP 01 watts per day

To calculate energy consumption costs, simply multiply the unit's wattage by the number of hours you use it to find the number of watt-hours consumed each day. For example, let's say you use a 125-watt television for three hours per day. By multiplying the wattage by the number of hours used per day, we find that you are using 375 watt-hours per day.

125 watts X 3 hours = 375 watt-hours per day

STEPS 02 convert to kilowatts

But electricity is measure in kilowatt hours on your electricity bill. Since we know that 1 kilowatt is equal to 1,000 watts, calculating how many kWh a device uses is as easy as dividing by 1,000.

375 watt-hours per day / 1000 = 0.375 kWh per day

STEP 03 usages over a month period

Now to find out how much that's going to cost you on your electric bill, you'll have to take the equation a bit further. First, you'll need to figure out how many kWh the TV uses per month:

375 watt-hours per day X 30 day = 11.25 kWh per month

STEP 04 figuring out the cost

Next, pull out your last electric bill and see how much you pay per kWh. For this example, let's say you pay 10 cents per kilowatt hour. To find how much the TV is costing you in a month, multiply your electricity rate by the kWh per month that you calculated above.

11.25 kWh per month X $0.10 per kW = $1.13 per month

Another example

Here's another costlier example: Your refrigerator runs 24 hours a day. Most refrigerators consume 300-780 watts of electricity. Let's assume you bought a model that uses only 300 watts.

300 watts X 24 hours = 7,200 watt-hours per day

7,200 watt-hours per day / 1000 = 7.2 kWh per day

7.2 kWh per day X 30 days = 216 kWh per month

216 kWh per month x $0.10 per kWh = $21.60 per month

4.0 Finding

The process of obtaining data on electricity tariffs was conducted by interviewing 10 respondents from Taman Parit raja. Because of the interview session, we got some information about:

4.1 Wiring Type

a. Single phase

The type of load available at user home using single phase wiring is 45 lamps, 1 air conditioning (2h/p), 6 ceiling fans and 4 portable fans. The amounts to be paid by consumers on average are RM300- RM350.

b. Three phases

The type of load available at user home using three phase wiring is 50 lamps, 4 air conditioning (2h/p) and 7 ceiling fans. The amounts to be paid by consumers on average are RM180 - RM250.From these two types of electrical wiring systems, three phase wiring has low charging rates compared to single phase wiring. The use of load in three-phase wiring is more than single phase wiring(Yan, Tan, Lee, Chaudhuri, & Hui, 2015). This shows that the three-phase wiring is better than single phase wiring which can reduce the electricity bill.

4.2 Method of reducing electricity bills

a. Savings

Consumers should save on electricity usage to reduce electricity bills. Users should be minimizing the use of electrical appliances. For example, switch off the lights before going to bed and the other part of house when they are in the living room.

b. Reduce the power value

Each electrical equipment; has a different wattage value(Setlhaolo et al., 2014). When the value of this electrical equipment has a high watt value then the value of electricity consumption will be increase. For example, a fluorescent lamp has a value of 40 watts while LED light has a value of 20 watts. This LED light has a low wattage value compared to fluorescent lamps. In addition, this LED light is brighter, good and effective. So by reducing the use of low electrical equipment watts can reduce electricity consumption(Setlhaolo et al., 2014).

c. Use the timer

Use of timer in electrical appliances such as air conditioning; when using the timer, we can control the duration of use of electrical equipment. For example, when using individual air conditioning before sleep can set a timer for two or three hours of use. Then automatically the air conditioner will switch off after time.

d. Home design

One of the weaknesses of home in Malaysia is its inappropriate design(Romli et al., 2017). Most homes have designs that cause poor lighting. There is not much number of windows and doors available. For example, normally in every part of the room is a wall that causes the light can't enter the space of the room. According to Romli et al. (2017) to make the design of a house with good lighting, individuals can use a transparent sliding door or rooftop to ease light entering the

house. In addition, users can install solar roof bracket mounting system. This system uses renewable energy that can save electricity users.

e. Awareness and knowledge

Every individual needs to have awareness and knowledge about the need for electricity consumption. Usually, the individual responsible for paying the bill only has an awareness of the need to reduce the electricity usage. Supposedly every individual in the home should play a role in reducing this electricity consumption. Otherwise it will not happen. For example, when the number of individuals in the house increases and all have no awareness of the use of electricity this will cause them to use electrical equipment at will which is will increase the amount of bill payable.

f. The use inverter

The use of the inverter is one of the most helpful methods to reduce electricity consumption. This inverter will work to use the same current when using this electrical equipment. It only uses once high energy to get started. Typically, electric appliances that do not use the inverter will use a cut off when it reaches a maximum value and will repeatedly use high energy to start the equipment again. Examples of equipment that use inverters are washing machines, air-conditioners and refrigerators. Usually this equipment has a star symbol that shows the level of electricity savings.

5.0 Analysis and discussion

5.1 *Factors affecting high use electricity*

a. The frequency of the use of electrical equipment

The use of electrical equipment that has value and the beginning of a great power often will lead to increased electricity consumption. For example, women in Malaysia often use automatic dry iron in their daily lives. Whenever they want to wear a scarf they will use this iron. The use of this equipment requires a high-power start-up. So, to save on the use of electricity this should set its use like using this iron once for a week wears.

b. Number of people in household

The number of individuals in a house also affects the use of this electricity. When many residents in a house will increase electricity consumption; for example, the respondents will only pay their

electricity bill of RM180 for the regular month but on school holidays the total electricity bill will be RM250 as their children return home and increase the number of users.

c. Individual awareness

Every individual must have awareness of electricity consumption. If these individuals are unaware they will use this electrical equipment at will, though they do not need it. For example, individuals who do not have the awareness will let the lights open when they sleep and turning on the lights in another room while not using the room.

d. Home design

Home design is also a source of high electricity consumption. For example, a house that has several windows and doors that less will cause poor lighting. This causes the use of lamps even during the day.

3.4 The benefits of reducing electricity consumption

When we reduce this electricity consumption we can reduce electricity bill payments. It would be beneficial if it can save you money and used elsewhere. For example, when the value of the payment can be reduced from RM250 to RM180, we can reduce by RM70. It is a great value and very useful. If we save energy and use it we can save money.

4.5 It is up to individuals to decide on electricity consumption

Usually responsible individuals who pay attention to reducing energy consumption are parents and people who pay bills. Individuals who do not pay their bills are usually not involved and aware of this problem because not using their money. Parents will usually give awareness and knowledge about this and usually it is only temporary. Individuals involved in these savings are individuals who find it difficult to pay electricity bills.

6.0 Conclusions and limitation

This study adopts the use of domestic power consumption measurement and its appliances. The result from findings carried out on the load survey of domestic installation for electric power consumption measurements in Parit Raja domestic buildings has shown that there is a great variation in the electricity consumption based on standard of living, climate, types of residence population of household and it is also depending on the usage of appliances in each household.

The contributing factors to these variations were shown to be increases in consumption from continuous, standby and active appliances.

This work is limited to only domestic power consumption measurement and its appliances to demonstrate the role of monitoring in understanding the trends in electricity consumption in household.

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