

Electric Power Substitute Meter Management via Mobile Application

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Abstract - EPSMvMA is composed of Digital Sub-Meter connected to different components namely the GSM module, Bluetooth module, Power Analyzer Module, LCD Module, Relay Module and Main Microcontroller module. The connection via Mobile is made possible by the modules mentioned. The software that the proponents will be dealing with in the study is C++ language, which will be used in programming the Main Microcontroller module and Visual Basic Language for the Android Phones. The Bluetooth module can access the Android Phones and connect to the digital sub-meter in a limited distance. The users will be at ease since a code embedded to the microcontroller will make the utility sub-meter produce the desired value of electricity (KWH) and wherein the computed Sub-meter reading can be viewed through the LCD. This project is accommodating to those person that is always on the go and prudent.

Keywords – Sub-meter (Substitute Meter), Microcontroller, Android Phone, GSM module and Mobile app Controlled Power Sub-meter, Digital Sub-Meter

I. INTRODUCTION

With global energy consumption on the rise, people everywhere are looking to abate their energy usage through conservation and efficient design to obtain both economic and environmental welfares. A key to meeting this challenge is to understand when and how energy is consumed in a facility. Moreover, people can't afford to have their own houses thus most of them were residing in apartments and more likely deals with their monthly electric bill or electricity charges. This leads to the development of Prepaid Retail Electricity Service (PRES) which is one of the innovations being introduced so that consumers can have more power to control their electricity bills.

Devidas (2010) believed that the present system of energy metering as well as billing in Bangladesh which uses electromechanical and somewhere digital energy meter is error prone and it consumes more time and labor. The conventional electromechanical meters are being replaced by

new electronic meters to improve accuracy in meter reading. Still, the Indian power sector faces a serious problem of revenue collection for the actual electric energy supplied owing to energy thefts and network losses. One of the prime reasons is the traditional billing system which is inaccurate many times, slow, costly, and lack in flexibility as well as reliability. The Previous electrical meters were electromechanical devices with poor accuracy and lack of configurability. Theft detection was also a big problem. Moreover in tenant – landlord relationship, landlords still encounter problem such as even though every units have Substitute meters, some tenants didn't pay their bills on time and even leave without paying their electric consumption. This study will help the landlords to solve this problem.

A Prepaid Energy Meter enables power utilities to collect electricity bills from the consumers prior to its consumption. The Electric Power Substitute Meter Management via Mobile Application is a microcontroller based project that innovates the

way of customary Power Substitute Meter Management. The project uses the concept of the Prepaid Energy Meter, but it is managed by the administrator or particularly the landlord. It is the combination of citizens requirements as mentioned earlier, a new innovation in the field of Electricity Management, the new technology using Android phones, a hassle free activity for the user or host and for the consumers and at the same time a manageable means of compensation according to the consumers budget. The landlord will just have to load the amount requested by the tenant to his/her Android phone. It is reloadable and can also be monitored through the use of Android phones or any other mobile phones.

Related work

From the article of Pinoy-Business.com, the ERC believes that the prepaid scheme would benefit the consumers who frequently travel and leave their residences and offices for a time. Budget-conscious residential consumers can now control their electricity consumption better. Consumers may opt to buy electric energy credit in reasonably small increments. This will allow users to better control their budget. Prepaid electricity has a particular appeal for landlords and tenants. Lessors/landlords can now be free of unpaid electricity bills left by errant tenants. For the lessees/tenants, they can move in and use the leased unit without the need to for an electricity connection.²

As of txtbuff news article from Caroline Sinel, Manila Electric Company (Meralco) with the support of Energy Regulatory Commission (ERC) will use SMS, instead of an in-home display (IHD), for consumer's monitoring of electricity under the prepaid retail electricity service (PRES). Wherein it will permit the consumers to monitor the use of electricity by doing SMS commands such as balance inquiry, get meter status, and receive low balance warning messages on their cell phones. And also through SMS the registration, loading of prepaid electricity credits, receive advice of disconnection/reconnection, and remote disconnection/reconnection can also be done.³

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II. OBJECTIVE OF THE STUDY

The objectives of this study is to generate a user – friendly electric power Substitute meter wherein the Landlord can input value, control and monitor the utility Substitute meter. This also helps the tenant to contain his energy expenditures on a pre-planned schedule. The researchers aimed to connect GSM module to the Substitute meter in order to monitor the electric consumption, to develop Android based Mobile Application that will monitor and control the usage of electricity and lastly to design a circuit using microcontroller that will serve as the main control to the Mobile App and the Substitute meter.

III. MATERIALS AND METHODS

The project is composed of a GSM module, Main Module, Power Analyzer Module, Relay module and an LCD Display. The GSM module sends status to a specific mobile phone, and it is also interfaced to the Main Module to receive an input from the Landlord's mobile phone. The Main Module is interconnected with all other modules. The electricity will first go into the Relay Module which serves as a switching device of the project then pass through the Power Analyzer Module which is responsible for reading the power consumption. The data being measured by the Power Analyzer will send to the Microcontroller for computation process. After the electricity is being measured and computed, the data will be now presented in the LCD module which displays

the output or the reading of the consumed power as well as the remaining load.

The input will be consists of software requirement and hardware requirement. In the software input, the proponents will be using two languages such as Android Software using Java Programming and Arduino Development Environment. The Android Development Software using Java Programming is a programming tool responsible for the entire operation of the Android Mobile Application. It is used to control the power of the Substitute meter. On the other hand, Arduino Development Environment is a programming tool used to program the Arduino microcontroller or the Main Microcontroller module as well as the GSM module. The proponents have applied the GSM module, Main module, Power Analyzer, Relay Module and LCD Display as the hardware Inputs.

Preliminaries

This study aims to create an Android Application with a user-friendly Graphical User Interface (GUI) that will able to control and manage electric power consumption of every tenants through the use of the following modules; Power Analyzer module, Relay module, LCD Display, GSM module and the main microcontroller module.

Project Design

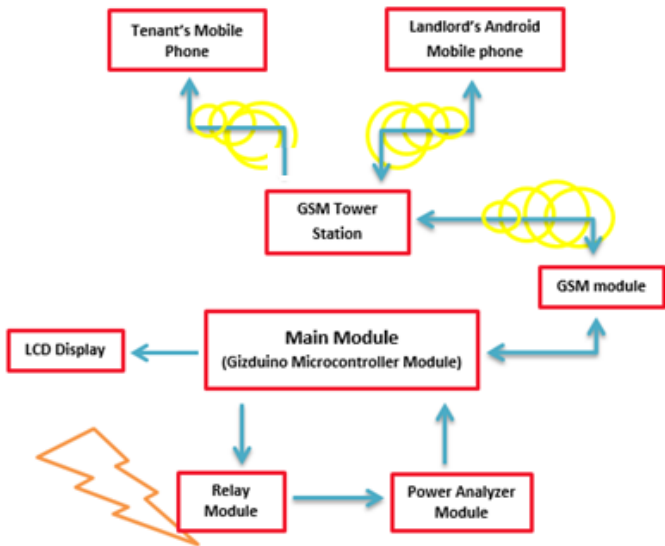


Figure 1 Methodological Framework

**Flow Chart GSM Process
 Landlord/Administrator's Mobile App**

The figure below shows how the Landlord's mobile app able to calculate the energy cost of a particular appliance, to load a certain amount in the meter and to view the messages sent and received to and from the GSM module.

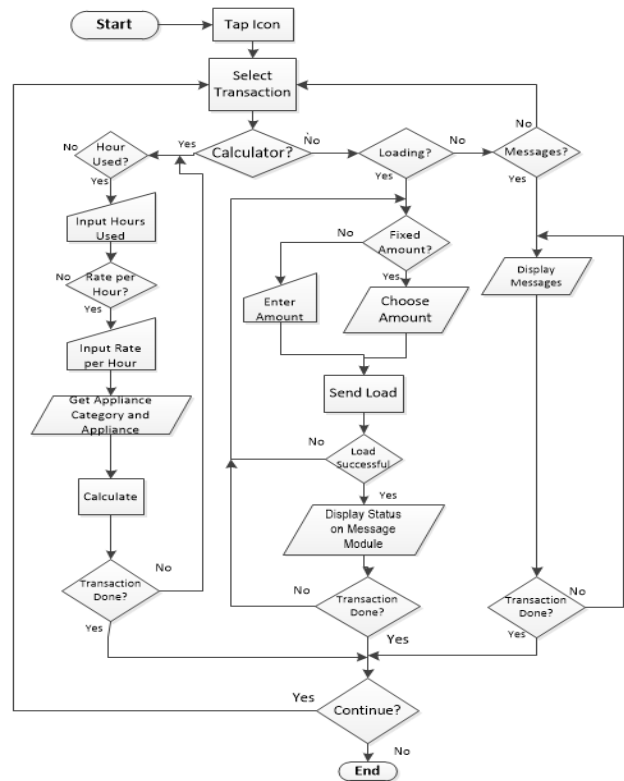


Figure 2 Flowchart of Landlord's Mobile App

Testing and Evaluation Procedure

The followings are the procedures and criteria considered in testing and evaluating the project. The reliability and precision of the GSM module to send confirmation and status to the mobile phone of the Tenant, and the correctness of data received by the Main Module from the Landlord mobile phone through the GSM module are carefully observed. The proponents will test if the load is exactly loaded to the electric substitute meter upon sending the commands through the GSM module and also the confirmation message once the Substitute meter reaches the critical level.

The following measures also aimed to conclude the functionality, aesthetics, workability, durability, economy, safety, salability, content,

reliability, availability and maintainability of the Electric Power Substitute meter Management via Mobile Application.

To test the Functionality, the ease of the operation, provision for comfort and convenience and user-friendliness must be considered. In terms of Aesthetics, things to think through are the color appeal of packaging, the attractiveness of design and the appropriateness of size. For Availability, availability of materials, availability of technical expertise and availability of tools and machine are noted. To determine its Durability, the quality of material, quality of workmanship and quality of design are assessed. For Economy, the economy in terms of materials needed, economy in terms of time/labor spent and the economy in terms of machine/s required must be considered. In terms of Safety, there should be an absence of toxic/hazardous material, absence of sharp edges as well as provision for protection device. For Salability, the presence of market demand, the accessibility to finished product and the competitiveness to price must be taken into consideration. In terms of content, it is important to evaluate the accuracy of content, updatedness of content as well as the presentation of the content. For Reliability, the conformance to desired result, absence of failures, and accuracy in performance must be considered. For Availability, it should perform according to specification, has provisions for security requirements and has completeness of the design. In terms of Maintainability, the ease of maintenance, provision for diagnostic tools and procedure and provision for enhancements and modifications must be evaluated.

Survey Description

The proponents made two types of surveys for Rental Business owners or also known as Landlords as well as tenants. The first survey is for preliminary preparation of acquiring information about the Pre-Paid Electricity. The purpose of the first survey questionnaire is to gain perceptions and expectations around consumer awareness and acceptance of Pre-Paid Electricity services and products. Survey questions explored actual or perceived benefits, concerns and expectations tied

to Pre-Paid Electricity. From the survey questionnaire given to them, the proponents will be able to summarize the Landlord's and tenant's perspective about the development Electric Power Substitute Meter Management via Mobile Application. Moreover during development, the proponents realized that the survey is not just for tenant and landlord but it can also be applied to every individual or household. On the other hand, the second survey questionnaire is given to the different respondents mentioned earlier at the end of the project development for testing and evaluation of the Project Output.

The type of questionnaire used in the preliminary survey is a Multiple Choice questionnaire. The questions are based on every individual and tenant's perception about the Pre-Paid Electricity as well as the Landlord's basic information, background about the business, problems encountered in the rental business, their solutions about these problems, and some information about the collection of bills on the rental business. On the other hand, the second survey questionnaire uses a Rating Scale Questions. With rating scale questions, the survey taker selects a single rating for every question.

The gathered information from the different respondents specifically the landlords, tenants and ordinary individuals around Caloocan, Malabon and Valenzuela area will be used to compile and conclude the results if the objective of project proposed may be suitable based from the proponent's response.

IV. RESULTS AND DISCUSSION

The testing and evaluation procedures of the Electric Power Substitute Meter via Mobile Application are used to satisfy the objectives of the study. This section summarizes all the results and findings of the testing procedure and surveys conducted by the proponents.

To test the GSM module in terms of its reliability and consistency, the proponents conducted several trials for every test to be evaluated. For test I, the GSM module is tested if the amount to be loaded by the landlord to the meter is equal to the amount of load the meter

received. In ten trials, it shows that the two data or amount of load are exactly the same hence, the proponents achieved their 100% satisfaction in GSM's reliability in terms of loading. The same thing for Test II, which test the reliability of GSM module to send notification to mobile phones as well as Test III, which test the GSM's reliability in terms of Adding Load to the current load.

The surveys for landlord showed that 100% of the landlords in the survey conducted are having a problem of the late payments and late charges of their tenants. They were also aware about the recent increase in electrical charges, while 70% of them have their plans to solve the issue since they were also having an agony from paying the unpaid electricity bills of the tenants if the tenants did not pay their bills. Because of that, 100% of them wanted to increase their control over the electricity billing and payment. Moreover the perception and awareness of the tenants are being tested in terms of managing electricity consumption. It has been found out that 40% of them came from the families of medium low socio-economic class which makes them conscious about the recent increased of electricity bills. When asked if they agree to use a Prepaid Electricity as an alternative solution to the problem about the electricity hike, the proponents found out that 60% of them wanted to have one while 40% of them didn't want to, because for them it is a waste of time and it's a hassle procedure.

During the development of the project, the proponents realized that the kind of survey they've conducted can also be applied to the individuals who have their own house and meter. The surveys for household show that 100% of them are aware of the price hike of electricity that is why 90% of them are agree to reduce their electric consumption and 100% of them concurred to use an alternative way to monitor and control their power consumption. The results showed that 80% of them wanted to have a prepaid electricity by monitoring and managing their electric consumption so that they could able to reduce their energy utilization and therefore, they could save money.

Lastly for the assessments of the three respondents in terms of the different categories of the project, it has been summed up by the proponents that the project was very good in terms of its functionality, aesthetics was rated as good, availability was rated as very good, workability was evaluated as very good, economy was assessed as very good, safety of the project was appraised as good, salability was rated as very good, content was evaluated as very good, reliability was graded as good, workability was marked as very good and last but not the least, the maintainability of the project was evaluated as very good.

V. CONCLUSION

As a conclusion based on several testing and from proposing the research project, formulation, planning, designing, testing and based on overall observation for the whole project, the proponents had successfully combined the initial modules of the project namely the power analyzer to measure the real-time consumption of electricity and the Main microcontroller module using C++ language in the Arduino Development environment to program the computation per kilowatt hour reading, and to deduct the reading of power analyzer to each load that will be entered into the program. It was effectively tested that once the Main microcontroller module reaches the limit it will generate a command to the GSM module to notify and send an alert message to the Tenant's mobile phone. The GSM module is programmed to send notification only to the Tenant's mobile number, and to receive a load from the Landlord's Android Phone as well as to switch the electricity flow which has been efficiently responding to the project's objective. The proponents were able to connect the different modules into the mobile application, as indicated in the previous chapters. They were also able to control and monitor the usage of electricity through the Android Mobile Application, such as the monitoring is by supervising and frequently checking the LCD module and the term control is to watch over the notification sent by the project. The whole project was controlled and managed by the Main

Microcontroller, to send data and information to the Substitute meter and to the Mobile Application.

Of course there are many factors to consider for the whole project to be perfect, due to the presence of several interconnected modules. And by testing the project, it has been noted that inconsistency of power is not dependable. Nevertheless, the project importance is possible but requires right equipment, correct analysis, countless patience, hard work, and prayers to accomplish the projects goal. In the end, the proponents conclude that they've only achieved 80% of the project's objectives compared to what they've really expected to accomplish which is to 100% perfectly attained the target goals of the design project.

As a recommendation to the project, the future work should have the following:

- Memory of the remaining load issue in case of power failure
- Can turn on or off the meter through the Android Development Application Software
- Make the rate per hour changeable, modifiable, editable since it changes every month
- Can send notification messages both to tenant and landlord if loading is successful, and if load is near its critical level and if there is zero load or balance.

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