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Web-Based Electricity Billing System with SMS Notification

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Abstract
In the Philippines, electrification services are often provided by local electric cooperatives. The Iloilo III Electric Cooperative, Inc. (ILECO III) is the services provider to 13 municipalities in northern Iloilo. Due to its wider service areas, the ILECO III is becoming crowded with the increasing number of consumers. There are perceived issues in the preparation of billing statements. These perceived issues included the delay in the preparation of statements of accounts. There are instances that the consumer is not aware of the schedule of payment because they were not able to receive their electric billing statement on time. To improve the delivery of electric bills, we developed the "Web-Based Electricity Billing System with the SMS Notification". It is an automated billing system which can be accessed by consumers through the internet which can provide effective and efficient reminders to consumers of their monthly electric consumption. As such, they will be promptly updated of their accounts, schedule of fees as well as other important and relevant information. The Waterfall model was employed in the development of the system prototype. Findings showed that the level of usability of the developed system in terms of appropriateness recognizability, learnability, operability, user interface aesthetics and accessibility as perceived by household evaluators was "Very Good". Similarly, the performance of the developed system as to time behavior and resource utilization as perceived by the expert evaluators also yield to "Very Good" responses.
Keywords: *electricity billing system, SMS, waterfall model*

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I. INTRODUCTION

Electrical power has become essential to human survival and progress. Apart from efforts to meet growing demand, automation in the energy distribution is also necessary to enhance people's living standard. Traditional energy bills distribution by a human operator is inefficient to meet the future residential development needs [1]. As such, electric billing is extremely important for they know their electric consumption for every month.

The Iloilo III Electric Cooperative, Inc. (ILECO III) is a non-stock/non-profit electric distribution utility with its main office at Barangay Preciosa, Sara, Iloilo, Philippines. It serves thirteen (13) municipalities in the northern part of Iloilo Province namely Anilao, Banate, Barotac Viejo, San Rafael, Ajuy, Sara, Lemery, San Dionisio, Concepcion, Batad, Estancia, Balasan and Carles [2]. As ILECO III grows as the number of consumers, there are perceived issues in the preparation of billing statements. These perceived issues may include the delay in the preparation of statements of accounts. There are instances where the consumer is not aware of the schedule of payment because there were not able to receive their electric billing statement due caused by delayed distribution of bills.

Technology-enabled billing systems are becoming common process of utilities providers. Web-based water billing systems were developed by [3][4] to efficiently managed water billing and collection processes. Web-based gas billing systems are also becoming popular [5][6].

For many electric power distribution utilities, the next major step is to improve the manner by which the issuance of billing statements is made. For instance, [7] developed a mobile based system to collect, process and notify consumers about electricity consumption. They were able to successfully implemented an electricity meter reading prototype Peripheral Interface Controllers, GSM and Android which reduces the cost of labour involved, increases the accuracy of meter reading and saves a large amount of time. In [8], they created an online web application they called SOEBIMS which was implemented using client-server approach. It is deemed to reduce human errors and save time to key in the data from keyboard. SOEBIMS helps to retrieve the real time meter value via GSM and send it to customer's mobile phone through GSM. The prototype will be able to introduce the billing system to the customers, get the power consumption data from smart meter, keep

the data in centralized database and generate the report. It will help the user to access the data and report easily through online.

In [9], they proposed for an automatic power meter reading and billing system to generate the bill to automate the payment process. Their proposed work measures the energy consumption in each house and generates the bill automatically with Arduino and Wi-Fi. The goal of their work is to automate the billing process by checking the electricity unit's consumption in a house and hence subsequently reduces the manual labor. The calculations are carried out automatically and the bill is updated on the Internet by the help of Wi-Fi. The bill amount can be checked by the owner anywhere and at any time by visiting the website or the online portal.

In Nigeria, [10] design and developed an optimized web–based energy billing system. The proposed system uses a smart meter to measure accurately the electric power consumed by customers in a user-friendly manner. The meter measures and transmits consumed unit of a customer at the end of the month through a dedicated network. The system allows postpaid customers to clear their bills using recharge cards produced by the system administrator, while prepaid customers recharge their accounts before they have access to power and their consumption charges is deducted in real time. Customers can have access to their consumption history.

To improve the delivery of electric bills, we proposed to develop an information system, to be known as Web-Based Electric Billing System with the SMS Notification. The develop system will be used to view the electric bills of every consumer thru the use of the Internet to avoid the delayed distribution cause by manual process. Moreover, it shall provide SMS notifications as an alternative distribution of information to consumers. We would like also to determine the level of usability in terms of appropriateness recognizability, learnability, operability, user interface aesthetics and accessibility as perceived by household evaluators and evaluate its performance in terms of time behavior and resource utilization as perceived by expert evaluators.

II. METHODOLOGY

2.1 Research Design

In this study, the developmental-descriptive research design was employed. Developmental research is a systematic study of designing, developing and evaluating instructional programs, processes and products that must meet the criteria of internal consistency and effectiveness [11]. The developmental research was applied using its systematic and logical approaches to the development of a web-based information system. On the other hand, descriptive research is a type of research that explore and explain an individual, group or a situation [12]. In line with the study, the survey method was used in order to describe the perception of the respondents based on specific factors as defined in the objective of the study.

2.2 Software Development and Life Cycle

The systems development life cycle (SDLC) is a conceptual model used in project management that describes the stages involved in an information system development project, from an initial feasibility study through maintenance of the completed application [13]. The researchers used the waterfall model as the SDLC for this study. The waterfall model is a software development process. In a Waterfall model, each phase must be completed before the next phase can begin and there is no overlapping in the phases [14]. Once a phase of development is completed, the development proceeds to the next phase and there is turning back. Figure 2 shows the Waterfall model as the development life cycle model used in this study.

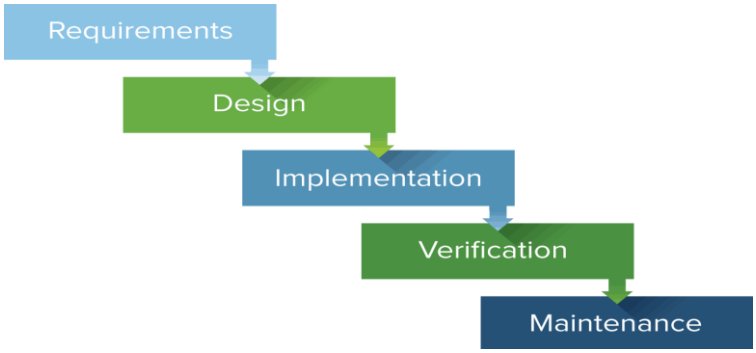

Figure 1: The Waterfall Model as the SDLC approach used in the study.

2.3 Coding and Implementation Phase

In this stage, the system specifications were converted into a working and reliable solution. This was the actual system development. There were two tasks in this phase. These were the preparation of the development software and construction of the system prototype.

2.3.1 Preparation of the Development Software

The first task under this phase was the preparation of the necessary application development software used and the needed equipment and materials deemed necessary in the actual construction of the system prototype. It included the identification of the programming language used as well as the database management system that was able to address the database requirements. Since the construction of the developed system was implemented in a client-server environment, we made use of our personal laptop computer as the server during the development. Since web development approaches were used, appropriate scripting languages such as HTML, CSS and PHP were selected.

The XAMPP application package was downloaded and installed on the server computer. The XAMP, which is comprised of Apache as the web server, MySQL for database management and PHP as the server-side scripting language, is Microsoft Windows operating system web development environment. Installing this application package allowed the researchers to develop and test the system prototype on the local machine. For the SMS component, the module was developed using the Microsoft Visual Basic 2010. We also used the Globe Tattoo USB stick. The device is GSM-ready which handled SMS-related activities.

2.3.2 Construction of the System Prototype

Once the necessary preparation was done, the next task was the actual construction and development of the system prototype. The design of the system prototype was based on the standard web development technique for efficient user interface design. Font colors, styles and sizes, as well as background colors and images and even whitespaces, were properly configured while taking into considerations of the user's profiles.

2.3.3 Testing and Evaluation

The development of the system prototype would not be completed without testing the functionalities of the various modules to meet user requirement. We requested two groups of evaluators to test the software product. The first group was comprised of 50 conveniently selected respondents representing the household consumers while the second group was comprised of seven (7) expert evaluators in the field of software engineering. The purpose of their evaluation was to determine whether the proposed system met the user requirements. Their feedbacks were made as basis for further refinement of the product.

A researcher-made survey questionnaire was developed based on the ISO/EIC 25010 quality model specifically on two characteristics namely usability which was evaluated by first group of respondents while the performance characteristic was evaluated by the experts group. The instrument measures the user's perception of the proposed system using a 5-point Likert scale where 1 as strongly Disagree, 2 as Disagree, 3 Undecided, 4 as agree and 5 as Strongly Agree was used the developed system prototype.

The Mean was used to interpret the results where 1.00 to 1.80 was described as "Poor", 1.81 to 2.60 as "Average", 2.61 to 3.40 as "Acceptable", 3.31 to 4.20 as "Good", 4.21 to 4.99 as "Very Good" and 5.00 as "Excellent".

III. RESULTS AND DISCUSSION

Level of Usability of the Proposed System in terms of Appropriateness Recognizability, Learnability, Operability, User Interface Aesthetics and Accessibility as Perceived by Household Evaluators

Usability refers to the degree to which a product or system can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use [15]. Perception of the household evaluators indicated that the Web-based Electric Billing System with SMS Notification, the usability characteristic is described as Very Good (M=4.66). In terms of appropriateness recognizability (M=4.63), learnability (M=4.60), operability (M=4.67), user interface aesthetics (M=4.71) and accessibility (M=4.68) were all described as very good.

The proposed system was found to be user-friendly, easy to navigate as well as accessible anytime and anywhere since it was made available in the Internet. The household evaluators echoed that the operations of the system were very straight-forward and can be managed even by novice users. Table 1 shows the result of the mean for the respondents' feedback on the usability of developed system in terms of appropriateness, correctness, and completeness.

Table 1: Level of Usability of the Proposed System in terms of Appropriateness Recognizability, Learnability, Operability, User Interface Aesthetics and Accessibility as Perceived by Household Evaluators

Implementation Indicators	Mean	Verbal Interpretation
Level of Usability	4.66	Very Good
Appropriateness Recognizability	4.63	Very Good
Learnability	4.60	Very Good
Operability	4.67	Very Good
User Interface Aesthetics	4.71	Very Good
Accessibility	4.68	Very Good

Note: 1.00-80 (Poor); 1.81-2.60 (Average); 2.61-3.40 (Acceptable); 3.41-4.20 (Good); 4.21-4.99 (Very Good); and 5.00 (Excellent)

Level of Performance of the Develop System in terms of Time Behavior and Resource Utilization as Perceived by Expert Evaluators

The level of performance is relative to the amount of resources used under stated conditions. This characteristic is composed of time behavior, resource utilization and capacity [15]. As perceived by the expert evaluators, the mean performance was described as very good (M=4.64). Specifically, in terms of time behavior the proposed system is described as very good (M=4.60).

The evaluators were argued that the system is able to respond to processing in a timely manner resulting to quick results. For the resource utilization, the proposed system is described as very good (M=4.67). The evaluators unanimously agreed that the server computer, which is a laptop, is equipped with low-end computing components in today's standards, is able to perform efficiently since the proposed system only requires minimal resources. The table below shows the result.

Table 2: Level of Performance of the Develop System in terms of Time Behavior and Resource Utilization as Perceived by Expert Evaluators

Implementation Indicators	Mean	Verbal Interpretation
Level of Performance	4.64	Very Good
a. Time Behavior	4.60	Very Good
b. Resource Utilization	4.67	Very Good

Note: 1.00-80 (Poor); 1.81-2.60 (Average); 2.61-3.40 (Acceptable); 3.41-4.20 (Good); 4.21-4.99 (Very Good); and 5.00 (Excellent)

IV. CONCLUSION

Results of the evaluation of the household evaluators clearly suggest that the proposed system yielded a very good level of usability. When implemented, it will considerably improve the distribution of billing statements since the household consumers can simply use the internet to gain access to their accounts. The operations of the proposed system was described by the evaluators as very simple to operate due to its simple interface design.

The performance of the proposed system was also described as very good. The findings suggested that the respondents believed the response time and its reliability were impressive. The system was able to provide real-time information with SMS notification. It also provided the correct results with utmost precision and was able to facilitate accomplishment of specific tasks they wanted. The evaluators unanimously agreed that the proposed system is remarkably functional, operational and reliable.

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