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NotiPower: A Mobile-Based Power Advisory for Bukidnon Second Electric Cooperative, Inc. Consumers

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***Abstract*— *Oftentimes, a power outage is prevalent in areas where the power supply is insufficient or may be triggered by damages to electric transmission lines, faults at the power station or overloading of electricity mains. Electric utilities are faced with greater pressure to improve not only their restoration efforts but also how to quickly notify its final consumer about the restoration process. In the absence of information, customers tend to conclude that this utility is insensible and primarily interested in profits rather than customer satisfaction. This prompted the researchers to develop a NotiPower Mobile Application to help the electric consumers be updated about the scheduled and unscheduled power failures of areas covered by Bukidnon Second Electric Cooperative, Inc. (BUSECO). In the development process, a Modified Waterfall Model was used. The researchers used a WordPress platform, PHP and Android as the programming languages, and firebase as the database. The finished system was put through the various testing environment to ensure harmonious execution before it was deployed. The system evaluation involved 200 respondents from the City of Malaybalay, Province of Bukidnon. ISO 9126 type of questionnaire was also used by the researchers to assess the acceptability of the system in terms of functionality, usability, reliability, efficiency, and portability. The result of the evaluation yielded an average mean of 4.49 which means that majority of the respondents strongly agreed that the system was very acceptable*.

***Keywords*— *Android Application, Electric Cooperative, Notification System, Power Advisory, Power Failure*.

I. INTRODUCTION

A notification is a message that automatically pops up on mobile phones informing users about something. According to El-Gazzar, Badawy & Kholief (2010), events are the most important pieces of information that must be delivered as soon as it is available. It is important that a person must have the ability to be well-informed with the recent trends of technology in order to be notified of the significant events that need to be addressed immediately (Aribe et.al, 2019). Berglin and Lagerstedt (2013) also said that once the distribution of information is delayed, it will be meaningless. The rapidly advancing technology makes mobile devices an ideal vehicle for an urgent transmission of information (Leclerc, 2010). Over the years, BUSECO, as a distribution facility of electricity in some parts of the Province of Bukidnon, has been disseminating power advisory to its consumers particularly on the scheduled and unscheduled power interruption. This notification is conducted through its Facebook Page with 6, 184 followers and 5, 997 likers as of October 29, 2018. Figure 1 shows how BUSECO informs its valued Member-Consumer-Owners (MCO) on the power interruption, including the time and cause of tripping, affected areas and the necessary troubleshooting and line patrol for power restoration.

Figure 1. Official Facebook Page of BUSECO

Additionally, its website, http://buseco.coop/, as shown in Figure 2, is also used as an alternative tool to connect with its clients in conjunction with the maintenance activities conducted by their line maintenance and operation crews.

Figure 2. Official Website of BUSECO

In line with its cooperative vision for a "reliable, viable and efficient electric distribution utility operated and managed

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by competent honest, responsive human resources towards satisfied consumers", an effective notification system is an important tool. With the rising growth of mobile owners, information can be instantly and conveniently delivered. The researchers came up with a power outage alarm tool called NotiPower, a mobile app power notification system which was developed to notify users via Short Message Service (SMS) or through their Android devices. This app has the capability to send messages using the standard mobile telephone network.

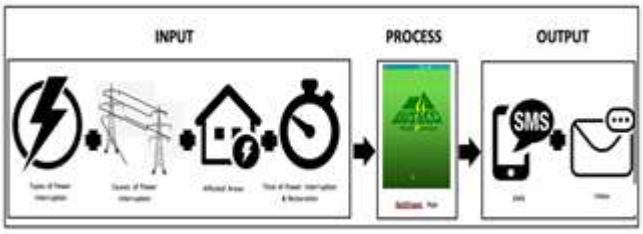

Figure 3. Conceptual Framework of NotiPower Mobile Application.

Figure 3 illustrates the conceptual framework that the researchers used in this study using Input-Process-Output (IPO) Model. Types of power interruption and its causes, affected areas, time of power interruption and power restoration serves as an input to the design and development of the BUSECO NotiPower application. The application will then process inputted information and convert into a power outage notification system. The output is the real-time and up-to-date SMS or messages sent through the application inbox.

Several studies have been conducted on power outage notification system using GSM-based technology. Sarsamba, Yanamshetty, & Sangulagi (2013), used a mobile embedded system to monitor and record load fluctuations with respect to current and voltage in electric power lines. Ganiyu, Arulogun, Adetunji & Okediran (2013), also developed a GSM based household power management system that could be used to remotely control at most ten household appliances when the user is away from home. Same study was also conducted by Awodele, Ologure, Izang, & Adams (2011) who developed an interface which is a phone based home/office remote controller equipped with power to turn it on or off and receive status of electronic appliances which are remotely situated. Another study focused on the detection of power failure and took reflex action to solve the problem with help of modem communication using GSM was conducted (Boopathi, Jagadeeshraja, Manivannan, & Dhanasu, 2015). Another study conducted by Wahab, et al, (2010) which uses the electronic pigeon hole is able to send notification message via short SMS to the designated user if any new letter is placed in it. Additionally, in the study of Palamar (2010), he have presented the design and implementation of a SMS based control systems for monitoring. The system has three modules which includes a sensing unit for monitoring complex applications, a microcontroller-based processing unit and a communication module that uses GPRS modem or cell phone via serial port RS-232. Likewise in the study of Vimalraj & Gausalya (2013), the authors identified that distribution transformers have a long service life if they are operated under good and rated conditions. These studies have found positive effects associated with the use of a GSM-based SMS notification systems. However, in the study of Salau, et al (2017), the life of these developed systems are significantly reduced if they are overloaded, resulting in unexpected failures and loss of supply to customers thus affecting the system dependability.

Furthermore, in the proposed system conducted by Salau, et al (2017), they developed an SMS notification system thru ezzzyNotifier mobile app using a Global System for Mobile Communication (GSM) which incorporates a shift timetable arrangement for the effective operation of a Network Operation Center (NOC). This system may provide a flexible and accurate control of load parameters and also provided an effective means for rectification of faults if any abnormality occurs in the power lines through SMS notification. Likewise, a proposed system (Dhimar, Patel, Shaikh, Musani, & Patel, 2017) can send commands in the form of SMS messages to read remote electrical power parameters. The system can send automatically the real time information, based on time settings, the electrical power parameters in the form of SMS alerts whenever the Circuit Breaker trips. However, both studies did not contain a client-side mobile application where consumer can interact with the system. The NotiPower, on the other hand, allows transmission of large number of messages to target audience using multiple communication methods such as SMS and Incoming Messages sent directly to the application inbox.

The present study will help electric consumers of BUSECO experience the full benefits of mobile phones by the development of a mobile application with important key features. Likewise, the study is anchored on Unified Theory of Acceptance and Use of Technology or UTAUT (Ghazizadeh, 2012) which combined the traditional mobile technology acceptance, like Technology Acceptance Model (TAM), Theory of Reasoned Action (TRA) and Theory of Planned Behaviour (TPB) and introduces new model of user acceptance in a unified view. In the UTAUT model, four core determinants of usage and intention (social influence, effort expectancy, performance expectancy, and facilitating conditions) and four moderating variables (voluntariness of use, age, experience, and gender) acting as the key relationships were considered. The aim of formulating this theory is to provide a deeper understanding of individual and organizational acceptance of IT and mobile services and applications to researchers and managers. Figure 4 shows the connection of the core determinants as well as the moderating.

Today, mobile phones are an essential part and pervasive companion to most people across the globe (Pielot, Church, & Oliveira, 2014). Gummaraju (2010) also said, "mobile phones have become the most widely used wireless devices and as a result, cellular systems have experienced exponential growth over the last decade and there are currently about two billion users worldwide". The NotiPower application is the notification app for mobile phones which provides quick notification and smart response to its clients. In times of power failures or restoration, it is necessary for Information and Communication Technology (ICT) personnel of BUSECO

to effectively carry out their operations and provide the best network service.

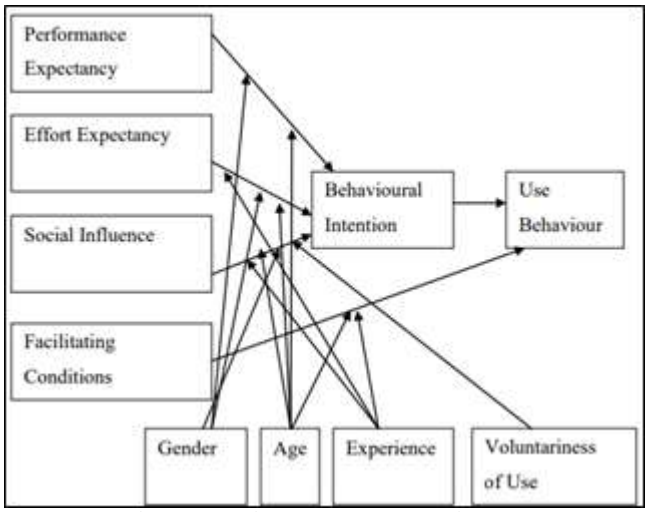

Figure 4. Unified Theory of Acceptance and Use of Technology Model (UTAUT)

II. Materials and Methods

In order to achieve the objectives of this study, the proponents are using the developmental research design implemented by using firebase, one signal, word press, and Android platform.

Prior to the development, the proponents conducted interview and survey to the electric consumers of BUSECO to gather the data needed to develop the prototype and functional requirements of the application based on the user's preferences.

In creating the BUSECO NotiPower, Android, an open source mobile operating sytem, and a widely used cross-platform was selected to be used in the development. This platform is easy enough for beginners since a lot of coding tutorials are can be found on the internet. The researchers also used the firebase as the data storage of the system and one signal for the platform of sending a notification to mobile devices.

When the developed prototype has been done, the application was put through various testing environments to make the product remove its bugs and errors to ensure harmonious execution. Two hundred respondents from Malaybalay City, Bukidnon were asked to try-out using and evaluate the app. Results were then validated and interpreted.

Research Design

This study used the developmental research design. This research design is the systematic study of designing, developing, and evaluating instructional programs, processes, and products that must meet criteria of internal consistency and effectiveness. Since the researchers' main aim of conducting this study is to develop a system to address the problem encountered by the target clients, the developmental research has contributed as a huge aid for the success of the system development. Through this research design, the researchers have able to create various system designs, diagrams, and architectures, and these were used for the development of the system. Whenever the system needs further enhancement after evaluation, developmental research is an ideal choice for the researchers to assess possible changes and improvements of the system based on the user's needs, demands, and preferences.

Research Locale

This study was conducted in the City of Malaybalay, Province of Bukidnon where the BUSECO branch office is located. It started its operations in 1979 covering 10 cities and municipalities of Bukidnon, to wit: Malaybalay City, Malitbog, Manolo Fortich, Impasug-ong, Sumilao, Lantapan, Cabanglasan, Libona, Baungon, and Talakag. Recent data from Bukidnon Second Electric Cooperative, Inc. indicates a total of 16,157 households with power connections. Of these 14,107 or 87.31% are having residential connections, while 1,454 or 9.00% are having commercial establishments.

Sampling Method

Random sampling was used by the researchers to conduct user assessment about the acceptability of BUSECO NotiPower Mobile Application. There were 200 respondents being considered in the conduct of the survey. This is the most widely used method for choosing a sample among the population for a wide range of purposes and removes bias from the selection procedure. Using this sampling method, the researchers were able to gather statistically significant and reliable data.

Process Model

The proponents' process model used in this study is the Modified Waterfall Model of System Development Life Cycle as shown in Figure 5. This model was chosen by the proponents since it was used widely in software engineering and ensures success in the project. This approach is very simple to understand and easy to use. The diagram illustrates that any phase of a system development process should be completed before the next phase can begin.

Requirement gathering and analysis - modified waterfall process model begins with data gathering. The researchers conducted an interview with various electric consumers to identify what problems they have that might be solved through technology.

System Design - when the requirements are known and analyzed, the design of the system is created. This phase concentrated on how the software will be built. The researchers made some sketch or a step by step process diagram, architectures, algorithms, and flowcharts about the system.

Implementation - constructing or coding based on the design of the system created by the researchers were implemented. Android studio was used for the client mobile application and PHP for the administrator and server.

Testing - the researchers put the finished product through various testing environments to make the product to remove its bugs and errors to ensure harmonious execution.

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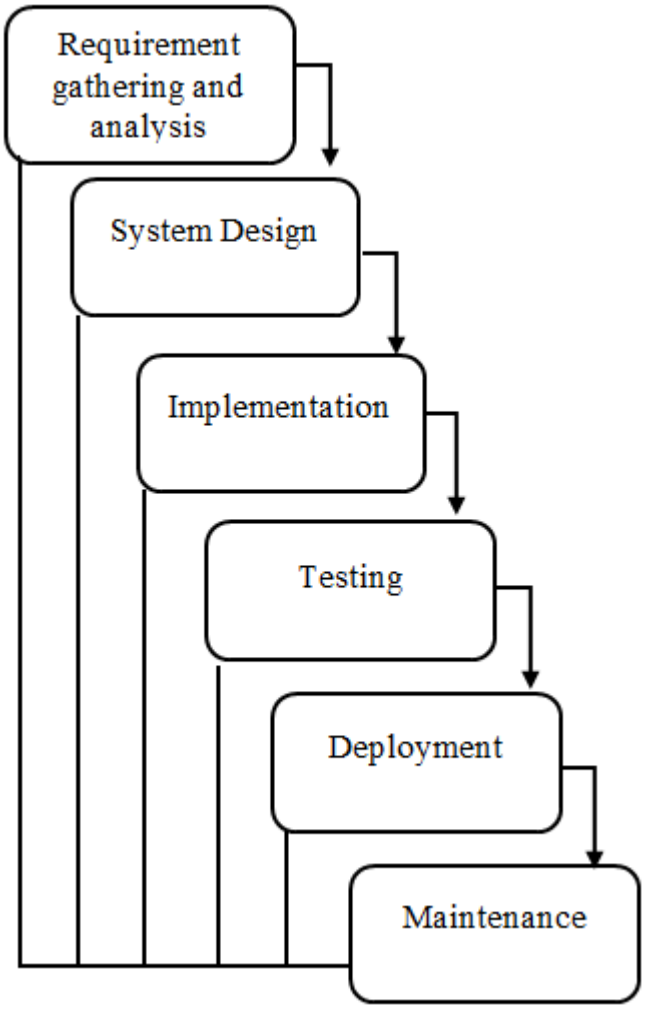

Figure 5. Modified Waterfall Model

Deployment - functional and non-functional testing was already done, the product was deployed and installed by the researchers to the Bukidnon Second Electric Company as administrator of the system and also the notification mobile application was released, accepted, and used by the target customer.

Maintenance - After the deploying the product, the proponents are in charge of maintenance of the system, fix any minor bugs or issues that will come up during operation. Also, the proponents will enhance and upgrade the system based on the user's preferences.

III. Results and Discussion

As a result, the researchers was able to develop a NotiPower Mobile Application for the electric consumers of BUSECO. Results were gathered by the researchers through thorough testing and evaluation made with the intended stakeholders as part of the Modified Waterfall Model.

Application Assessment

The tables present the frequency of end-user acceptability of the mobile application based on ISO 9126 standard characteristics of the software quality in terms of its functionality, usability, reliability, efficiency, and portability, the user acceptability of the application may vary from each area as shown in Figure 6.

Figure 6. ISO 9126 Model

In this study, the researchers are primarily tasked to determine feedback from the electric consumer of Malaybalay City Bukidnon. The data gathered will serve as the foundation for the realization of this study.

Table 1. *Statistical Significance*

Tests of Between-Subjects Effects					
Measure: MEASURE_1					
Transformed Variable: Average					
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Intercept	33670.334	1	33670.334	19290.761	.000
Error	26.181	15	1.745		

As shown in Table 1, in order to measure the statistical significance of BUSECO NotiPower Mobile Application assessment, the researchers used ANOVA, a statistical tool to measure the statistical significance of a study that contains hundreds of respondents. The test yielded a result of .000 which means that the data gathered from the respondents are statistically significant.

Table 2 presents the data gathered from end users about the acceptability of the application based on its functionality. The means of each item were not too far from each other which denote that the items were favorable to the majority of the respondents. From the data gathered, it can be interpreted that the items were consistent from among the rests. The table also revealed that all of the items were having the quantitative description of strongly agree. The overall result of evaluation from table 4.10 yielded an average mean of 4.52 which means that the application is very highly acceptable in terms of its functionality.

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Table 2. *Level of Functionality*

FUNCTIONALITY	5	4	3	2	1	Mean	Qualitative Description
The application provides alert notification when a power interruption occurs.	133	50	16	1	0	4.575	Strongly Agree
The application gives alternatives to users on what to do when an emergency situation occurs.	111	76	13	1	0	4.49	Strongly Agree
Contact and about us functionalities provide sufficient information about the company.	109	70	20	0	1	4.43	Strongly Agree
Overall, the application is helpful and useful	134	51	15	0	0	4.595	Strongly Agree
Total Average						4.5225	Strongly Agree

Table 3. *Level of Usability*

USABILITY						Mean	Qualitative Description
It is easy to perform its functions.	139	55	5	1	0	4.66	Strongly Agree
It is easy to learn how to use the application.	132	59	9	0	0	4.615	Strongly Agree
Commands button are clear.	121	66	13	0	0	4.54	Strongly Agree
It is easy to operate and control	130	58	12	0	0	4.59	Strongly Agree
Total Average						4.60125	Strongly Agree

Table 3 presents the other quality characteristics of the application which is usability. From the data gathered, it can be interpreted that the items were consistent from among the rests. All items in the table were having a qualitative description of strongly agree. It yielded an average mean of 4.60 which means that the end users strongly agree that the application is very highly acceptable in terms usability. The overall interpretation of the table means that BUSECO NotiPower is a user-friendly mobile application.

Table 4. *Level of Efficiency*

EFFICIENCY						Mean	Qualitative Description
The software's response time is appropriate	101	87	9	3	0	4.43	Strongly Agree
The software's execution time is appropriate	87	97	15	1	0	4.35	Strongly Agree
Total Average						4.39	Strongly Agree

In table 4, the majority of the respondents have given the application a good response in terms of efficiency. The result revealed that all items in this table were having a qualitative description of strongly agree and yielded an average mean of 4.39 which means that the application is very highly acceptable. The overall result also shows that the software successfully executes its function appropriately and efficiently.

Table 5. *Level of Reliability*

RELIABILITY						Mean	Qualitative Description
The application provides precise and real-time notification.	128	58	14	0	0	4.57	Strongly Agree
Use of application is relevant to the purpose and user needs.	125	62	13	0	0	4.56	Strongly Agree
Information is error-free, factual and reliable	110	70	18	2	0	4.44	Strongly Agree
Total Average						4.52	Strongly Agree

Table 5 presents that all items in this table were having a qualitative description of strongly agree and yielded an average mean of 4.44 which means that the application is very highly acceptable. The overall result in this table justifies that the application is really reliable.

Table 6. *Level of Portability*

PORTABILITY						Mean	Qualitative Description
It is easy to install in other environments	114	71	13	2	0	4.485	Strongly Agree
It is easy to adapt to other environments	102	85	9	4	0	4.425	Strongly Agree
It is easy to replace another program	110	70	18	2	0	4.445	Strongly Agree
Total Average						4.451667	Strongly Agree

Table 6 presents the data gathered from end users about the acceptability of the application based on portability. All items in this table were having a qualitative description of strongly agree and yielded an average mean of 4.49 which means that the application is very highly acceptable. The overall interpretation of table 4.8 means that the installation of this application is not difficult and easy to install and adapt to other environments.

Table 7. *Over-all Perceptions of Respondents*

Summary	Mean	Qualitative Description	Qualifying Statement
Functionality	4.52	Strongly Agree	Very highly acceptable
Usability	4.60	Strongly Agree	Very highly acceptable
Efficiency	4.39	Strongly Agree	Very highly acceptable
Reliability	4.52	Strongly Agree	Very highly acceptable
Portability	4.45	Strongly Agree	Very highly acceptable
Total Average	4.49	Strongly Agree	Very highly acceptable

Table 7 presents the summary of the user acceptability assessment of BUSECO NotiPower application. In the table, all items come out to have the highest mean and yielded an

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average mean of 4.49 which was qualitatively described as very highly acceptable. The overall result in this table also proves that the proponents of this study have successfully achieved their objectives that is to develop a precise and a real-time mobile notification application that would meet the users' preferences.

Respondents Feedback

These are the comments and suggestions provided by the respondents in accordance with the BUSECO NotiPower mobile application.

Table 8. *Summary of Respondent's Feedback*

Suggestions
Cebuano Dialect: "dapat naa pud mi access nga pwedi name magbayad sa online aron dali rah og dili napud kayo me mahasol" *English Translation: "We should have access to online payment to avoid hassle in queueing and paying personally."*
"It should also cover the whole provinces of Bukidnon"
Cebuano Dialect: "dapat kay makasend ug message/feedback sa admin" *English Translation: There must be a mechanism to send messages or feedback to the administrator.*
Comments
Cebuano Dialect: "tsada para sa amo nga mga consumanti sa kurente" *English Translation: It is helpful for us as electric consumer.*
"It is commendable program!"
Cebuano Dialect: "tsada ang program kay makabalo ug makaandam kung naa man galling brownout" *English Translation: The program is useful in terms of informing and preparing consumers during power interruption.*
"It is really nice because it can make aware if later on will be going to have a brown out"
"more convenience to use"

Table 8 above illustrates the feedback from the respondents which give the researchers an additional idea to further enhance the application in order to completely meet user needs and preferences. Most of the suggestions pointed out the need for a better notification system for the application. As of now, the application only notifies the user of important events of BUSECO. The researchers must update the application in a way that the end user can also send a message back to the administrator. The comments from the respondents have given the application a really good feedback indicating the acceptability and the usefulness to them once the application will be deployed officially.

Prototype Interface

Figure 7 shows the BUSECO Power NotiPower Application welcome page where users have to need to wait for a few seconds until the app loading execution has done. The welcome page will appear after the users tap the BUSECO Power NotiPower application icon.

Figure 8 shows the Main menu of the notification application for the clients. It has three menu sections that include: inbox, profiles, and about us section.

In the Main Menu Page that depicts the Figure 9, one of the features of the BUSECO NotiPower is "Inbox" where you can see all the lists of information received in your device.

Figure 7. User Welcome Page

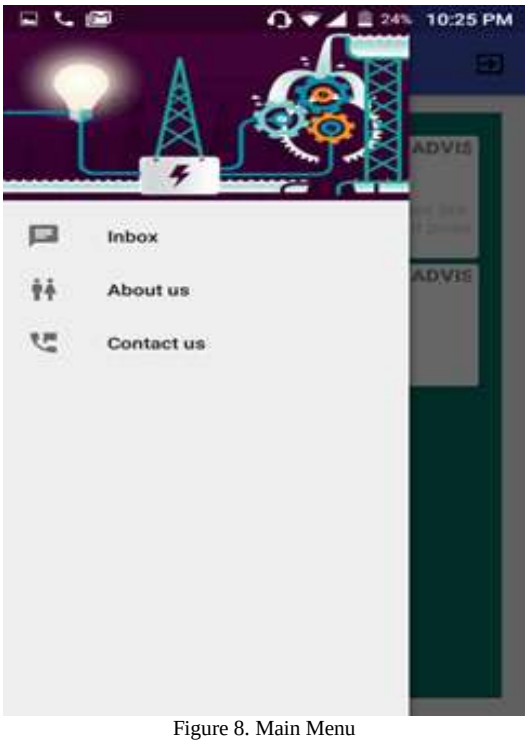

Figure 8. Main Menu

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Figure 9. Inbox Page

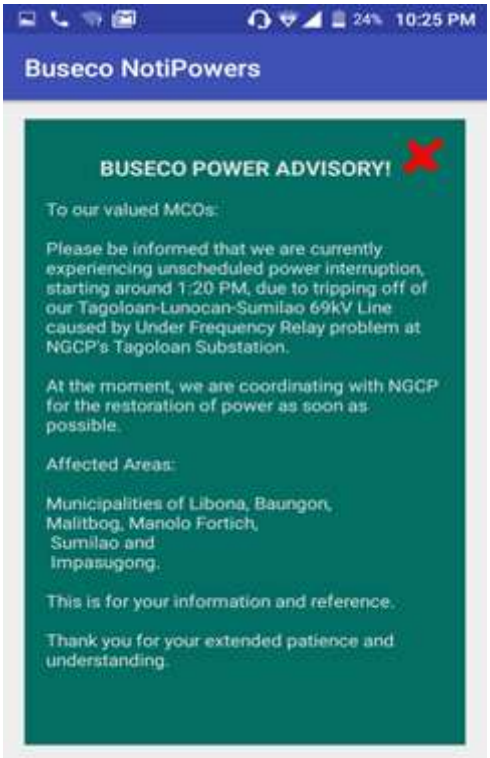

Figure 10. View Message Page

If the user clicks the view button feature it will show the Figure 10 where he can read important advisory sent from the BUSECO administration.

Figure 11 shows the BUSECO Power NotiPower Application Login Page for the administrator where it has the option to log-in. The login page will automatically appear after the user taps the sign in button.

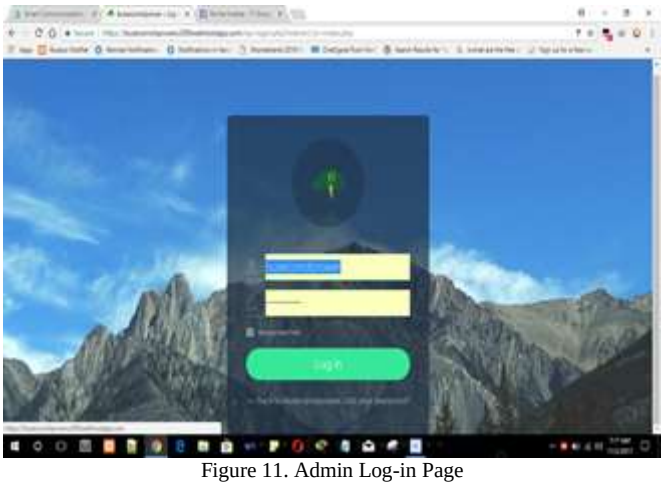

Figure 11. Admin Log-in Page

Figure 12 shows the home page for admin of the BUSECO NotiPower System. This will automatically appear after the user has successfully login in the system. This page has five major menus namely; home, about, advisory, contact, and log out.

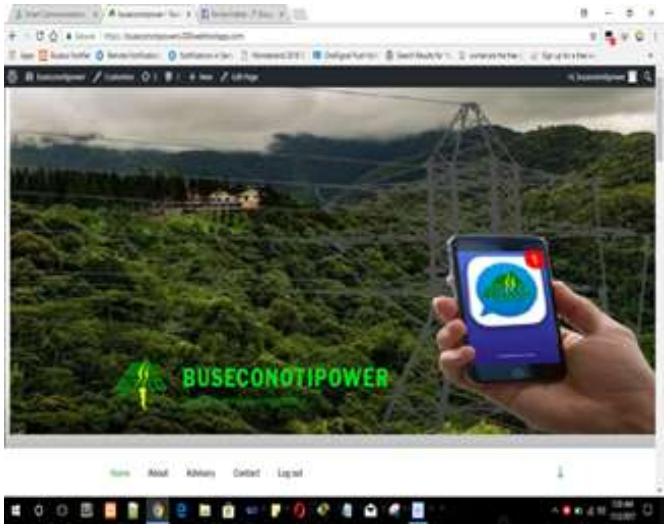

Figure 12. Admin Home Page

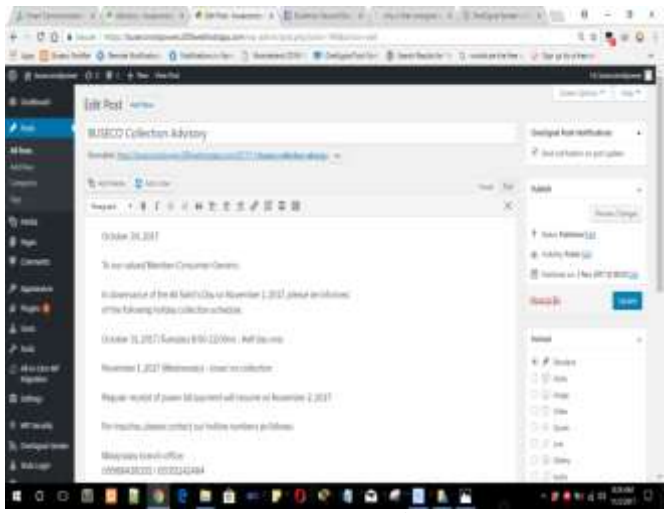

Figure 13. Admin Send Notification Page

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Figure 13 above illustrates the send notification page for admin. In this page, the administrator is given the privilege to send information about important events of the company.

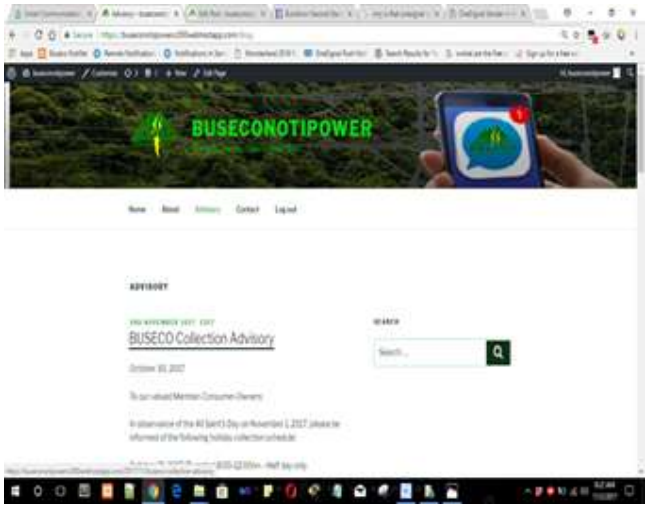

Figure 14 Advisory Admin Page

Tapping the advisory button will display Figure 14 wherein the admin can preview advisory about events of the BUSECO Company.

IV. Conclusion

The development phase of the proposed system was managed carefully in order to come up with the desired output. The comments from the respondents have given the application a really good feedback which means that the system has really met its objectives. Based on the process of developing the system, the conclusions of the study are as follows:

1. The design and development of the BUSECO NotiPower system was developed and has complied with the expected functional requirements;
2. BUSECO NotiPower system can now be installed and used with android platform of mobile phones; and
3. The result from the system evaluation showed that the respondents strongly agree with the ISO 9126 standard of the system's acceptability in terms of functionality, usability, reliability, efficiency, and portability with an average mean of 4.49.

Recommendations

Based on the foregoing findings of the study, the following are recommended for future enhancement of the developed BUSECO NotiPower: A Power Advisory System:

1. The users should be able to send a message/feedback to the administrator pertaining to the updates of any events as an additional feature of the system.
2. The system must able to send location-based notifications.
3. IOS version of mobile application must be developed.

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