# DESIGN AND IMPLEMENTATION OF AN ELECTRICITY ON-LINE BILLING PAYMENT SYSTEM

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**ABSTRACT:** *Electricity consumers are often faced with the problem of inaccuracy and delay in monthly billing due to the drawback in reading pattern and human errors. Thus, it is essential to have an efficient system for such purposes via electronic platform with consideration to proximity. The proposed system automates the conventional process of paying electricity bill by visiting the Electricity Board which is tiresome and time consuming. It is also designed to automate the electricity bill calculation and payment for user convenience. The system is developed with Microsoft Visual Studio using C# as the base programming language which can be used to develop websites, web applications and web services. The Microsoft Structured Query Language (SQL) server is also used for creating back-end database. The system would be having two logins: the administrative and user login. The administrator can view the user's account details and can add or update the customer's information of consuming units of energy of the current month in their account. The Admin has to feed the system with the electricity usage data into respective users account. The system then calculates the electricity bill for every user and updates the information into their account every month. Users can then view their electricity bill and pay before the month end.*

*Keywords: Billing system, bill payment, C#, e-payment, internet billing, IOT, PBS, SQL*

## I. INTRODUCTION

The Electricity Online Bill Payment web application is provided to all the users who want to pay their electricity bill. This web application can reduce the pressure of the user to stand in queues for bill payment and charges. This limitation has led to the development of a small model that enables the user to perform all the payment of bills and charges sitting at the comfort of his/her own desk. The importance of an Electricity Online Bill System cannot be over emphasized because its calculation reflects the exact power consumption for prospective consumers, and in monitoring the billing details of electricity consumers [1]. It provides an environment to maintain the consumer details starting from receiving bill, making bill payments and so on [2]. Consumers can lodge complaint and make their bill payments just by logging into the system.

 system to capture data related to the consumer's profile in order to assign an identification code with transactions relating to power billing. It constitutes various modules, among which the administrator and consumer module are integral. The consumer is granted access only through the username and password created from the first visit to the online system, or while registering at the web portal. The administrator module is handled by an authorized Electricity Board employee, in order to grant request relating to validating every transaction online and to order or confirm payment via the electronic system.

The Microsoft Visual Studio and Microsoft Structured Query Language (SQL) server will be used as front end and back end databases respectively for developing the project. Microsoft.

Visual Studio is primarily a visual design environment which will be used for creating the graphical user interface. The Microsoft SQL server is a structured query language based client/server relational database. It can be used to efficiently create and manipulate database systems. Figure 1 shows a simple block diagram of the proposed online billing system:
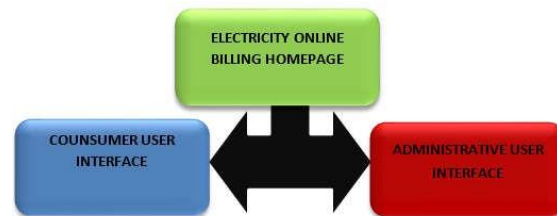


*Figure 1: Block diagram showing the Proposed Online Electricity Billing System.*

Various empirical and theoretical studies have been undertaken at the national and international level to analyze various online bill payment systems. The studies mainly focus on online bill payment systems such as: an online power billing system, an e-payment system, a mobile based billing system and so on. These services have not only improved the satisfaction level of customers, but it has also helped in reduction of processing time and transaction time. The survey of literature review covers some major works that have been carried out on online electricity billing. These include but are not limited to:

In [3] this paper presented the design and implementation of a web-based application with online capability called Power Billing System (PBS). PBS is a solution system developed with Microsoft Visual Web Development and Microsoft Access with Structured Query Language (SQL) for back-end database. In [4] the paper, proposed an online payment scheme which uses the traditional e-payment infrastructure but which reveals no payment information to the seller. In [5] this paper presented the design of an advanced centralized billing system using Internet of Things (IOT). In [6] this paper, the author first identified some vulnerability in the mobile billing system. The proposed system can achieve authentication, non-repudiation, and fairness,

which are desirable requirements for an undeniable mobile billing system. The billing system design based on internet environment was proposed by [7]. Concerning the performance of four network scenarios for billing purposes was presented and discussed by [8] and the result shows that the environments that use differentiated services are both convenient for customers and service providers. The authors of [9] also trying to improve the e-payment system with a smart card. In this paper, the third party can link a payment to a corresponding withdrawal to prevent money laundering and blackmailing.

## II. Proposed Method

This section gives the detailed design and operation of the proposed system. It also explains in details the operation and functions of each module in the proposed system.

## III. Proposed System

Considering the anomalies into the existing system, a computerized system is built using Asp.Nnet with C# as a base language. The system enhances and upgrades the old existing system by increasing its efficiency and effectiveness. The software improves the working methods by replacing the existing manual system with the computer-based system. The proposed system automates each and every activity of the manual system and increases its throughput. Thus the response time of the system is less and works very fast. The system uses a quick response with very accurate information regarding the user's electricity bill information. The proposed system has a very user friendly interface, thus the user will feel very easy to work on it. The software provides accuracy along with a pleasant interface. The transactions reports of the system can be retried as and when required. Thus there is no delay in the availability of any information, as whatever will be needed, can be captured quickly and easily.

The Microsoft Visual Studio will be used as a front end and The Microsoft Structured Query Language (SQL) as back end for developing the project. Visual studio is primarily a visual design environment. This design environment will be used to create text boxes, buttons and adding support codes in the respective modules (the administrator and user modules). The Microsoft SQL server is a powerful database application with which the user can efficiently create and manipulate database systems.

## IV. System Modules and their Description

The system comprises of two major modules, which are further divided into sub- modules. They are as follows:

i.   Administrative Login: In the administrative login, the administrator has the authority of the system. The administrator can add, delete notifications and update the system. The administrator performs the following functions on the system:

- Consumers Registration: The Admin will register the consumer by entering the consumer's basic registration details such as: Name, Contact Address, Residential Address, Consumer type, Password and Email Address.

- View Registered Users: The Administrator can also view all the registered users in the system, make necessary updates and update the bill status of the consumers.

ii.  Consumer Login: Consumers can login into the system and perform the following tasks:

- View Bill: Consumers can view their balance electricity bill amount of each month.

- Consumption Calculation: Consumers can calculate the total amount of units they consume in a month using a consumption calculator.

- Bill Calculation: Consumers can calculate the total number total amount that he/she will pay based on the units consumed, using a bill calculator.

V.   Database Design and Tables

Many physical database design decisions are implicit or eliminated when the database management technology is chosen to use with the information system that is being designed. Since many organizations have a standard for operating systems, database management system, and data access languages, only choices that are not implicit are dealt with in the given technologies. The primary goal of a database design is data processing efficiency.

There are four different tables used for storing different records in the system. They include: Consumer Table, Administrator Table, Bill Charge Table, and Bill Calculation Table. Tables 1 to 4 show the consumer table, bill charge table, administrator table and bill calculation table respectively.

Table 1: Consumer Table

| Field Name | Data type | size | Constraint |
|---|---|---|---|
| User_id | Int | Nil | Primary key |
| Consumer_id | int | Nil | Nil |
| first name | Varchar | 50 | Nil |
| Last name | Varchar | 50 | Nil |
| Username | Varchar | 50 | Nil |
| Password | Varchar | 50 | Nil |
| Email address | Varchar | 50 | Nil |
| Contact address | Varchar | 50 | Nil |
| City_id | Int | - | Nil |

Table 2: Bill Charge Table

| Field Name | Data type | Size | Constraint |
|---|---|---|---|
| Bill_id | Integer | Nil | Primary key |
| Bill number | Integer | Nil | Nil |
| Fix charge | Integer | Nil | Nil |
| Maintenance charge | Integer | Nil | Nil |
| Total charge | Integer | Nil | Nil |
| Total unit | Integer | Nil | Nil |

Table 3: Administrator Table

| Field name | Data type | Size | Constraint |
|---|---|---|---|
| Customer id | Integer | Nil | **Primary key** |
| City | Variable character | 50 | Nil |
| State_id | Integer | Nil | Nil |

Table 4: Bill Calculation Table

| Field name | Data type | Size | Constraint |
|---|---|---|---|
| Bill number | Integer | Nil | Nil |
| Bill date | Variable character | Nil | Nil |
| Amount | Integer | Nil | Nil |
| City | Variable character | Nil | Nil |

These are the tables which are used in the development for storing different records. Every table has a primary key for storing a unique record.

Consumers are classified based on their mode of consumption and by tariff classification. Electricity tariff is defined as the rate at which energy is selling to the consumers (Othman, *et al* 2015). Usually electricity tariff are fixed by Government. In Nigeria Electricity consumers are divided into five categories namely: Residential, Commercial, Industrial, Street Lighting and Special Tariff respectively.
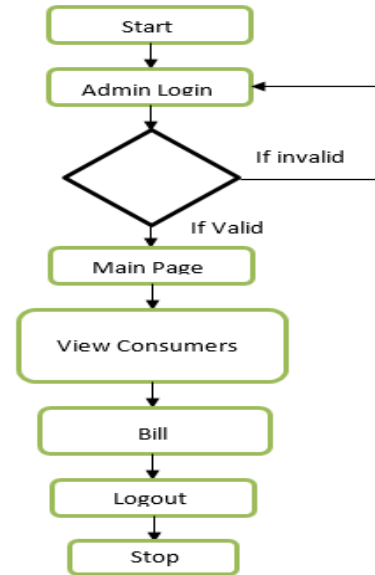
## VI. Formal Model of Proposed System

The formal model of the proposed system is represented in flowchart diagrams. All these models will give the conceptual view of and provide the graphical analysis of the user's requirements. As a major modeling tool, entity relationship diagrams helps in the organizing of the functional elements of the system into entries and also define the relationships between the entities. This process will enable the analyst to understand the database structure so that data can be stored and retrieved in the most efficient manner. The flowchart shows the flow of data from external entities into the system. It also shows how data moves from one process to another as well as its logical storage. Figures 2 and 3 shows the flowchart activity of the administrator and consumer respectively.



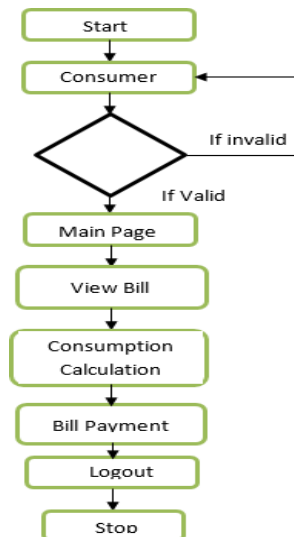Figure 2: Activity Flow-Chart of the Administrator



Figure 3: Activity Flow-Chart of the Consumer

## VII. System Architecture

The system architecture gives the overview of the organizational system that shows the system boundaries, external entities that interact with the system, and the major information that flows between the entities and the system. Figure 4 shows the system architecture of the system
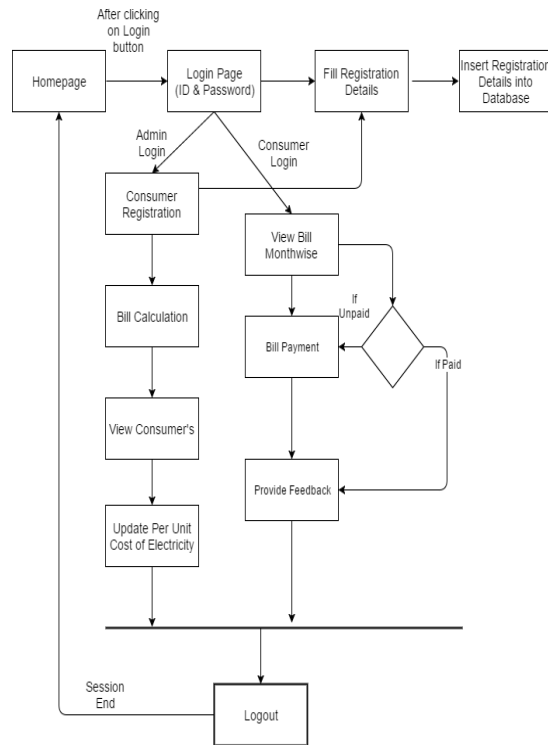


Figure 4: System Architecture of the System

## VIII. System Implementation and Operation

The implementation was done using Microsoft Visual Studio and SQL server for backend application. The system captures information related to energy demand, payments, and so on, from various level of organization with the aim of capturing it from as close to the source as possible.

The system consists of two login pages namely: the administrator page and the consumer page. The system operation is described as follows:

- After connecting online, the application starts by displaying the homepage. There after the username and password are requested for the specified status (the consumer or administrator). If it is a new user, the user will have to register by filling all the required registration details.

- If the password and username details are valid, the consumer then gets access to the main page. On the main page, the consumer can:

a. View his/her bill status

b. Use the consumption calculator to calculate the total amount of units he/she will want to consume. Figure 5 shows the consumption calculator page.



Figure 5 Consumption Calculator Page

The user starts by selecting the appliance he/she uses on daily basics. The wattage of each of the appliance is provided. If a particular appliance is not listed, the user can select the 'others' option and insert the wattage of that particular appliance. The calculator now calculates the total amount of wattage of all the appliances based on the selections made by the user. The user now selects the total number of the appliances that he/she has and the total time per day he/she uses the appliances. The consumption calculator now uses this information to calculate the total units consumed in kWh. The consumption calculator uses eqn. (1) to calculate the total unit consumed in kilo Watt hour (kWh) per month:

$$\frac{kWh}{m} = \frac{ABC}{1000} \times 30$$

Where:

Kwh/m is the total kWh per month

A is the total wattage of the appliances;

B is the number of appliances;

C is the number of hours used daily

From Figure 5 the total units consumed using eqn. (1), is calculated as follows:

For the Television:

Total kWh consumed = [(150 × 1 ×2) ÷ 1000] × 30

Total kWh consumed = 9 kWh per month.

For the Ceiling fan:

Total kWh consumed = [(75 × 1 × 4) ÷ 1000] × 30

Total kWh consumed = 9kWh per month

For the Cloth dryer:

Total kWh consumed = [(1000 × 2 × 4) ÷ 1000] × 30

Total kWh consumed = 240 kWh

For Desktop computer

Total kWh consumed = [(100 × 2× 1) ÷ 1000] × 30

Total kWh consumed = 6 kWh

The total kWh consumed for the month = 9kWh + 9 kWh + 240 kWh + 6 kWh

Total kWh consumed for the month = 264 kWh per month

c. Use the bill calculator to calculate the total amount he/she will pay based on the units consumed as shown Figure 5. The total billing charge can be computed by using (eqn. 2).

$$\gamma = \varphi\omega$$

Where:

$\gamma$ is the total bill charge in Naira

$\varphi$ is the tariff (unit cost), and $\omega$ is the total units consumed (kWh/m)

From Figure 5, the total tariff is ₦10.00 therefore the total bill in Naira for 264 kWh per month using eqn. 2 is given as:

Total bill in Naira = ₦10.00 × 264 kWh

Total bill in Naira = ₦2640

d. After the total bill is calculated, the consumer then clicks on the 'Pay Now' button. This will direct the user to the bill information page, where other charges such as the maintenance fee charge, fixed charge, and Value Added Tax (VAT) charge are added to the unit charge give the grand total bill the consumer will pay. Figure 6 shows the bill information page.



Figure 6: Bill Information Page

The grand total bill is calculated using eqn. 3

$$\beta = \alpha x \delta x \mu x \rho x \tau$$

Where:

$\beta$ is the grand total bill in Naira,

$\alpha$ is the maintenance fee

$\delta$ is the fixed charge,

$\mu$ is the unit charge (kWh)

$\rho$ is the VAT charge, and $\tau$ is the miscellaneous

From Figure 6, the grand total bill calculated using eqn. (3) is given as:

Grand total bill in Naira = 50 + 10 + 2640 + 300 + 0

Grand total bill in Naira = ₦3000

e. After the grand total bill is calculated, the consumer then clicks the 'pay now' button. The consumer is then directed to the Internet Payment Gateway page where he/she makes payment for the electricity bill. Figure 7 shows the Internet Payment Gateway page

Figure 7: Internet Payment Gateway Page



f. After the payment has been successfully made, the consumer then gets a 12 digit token code which will be sent to the notification bar in the profile page of the consumer. Which the consumer will enter into the power meter. The consumer can then successfully logout out of the system.

## IX. Conclusion

Usability testing was part of the post implementation review and performance evaluation for the Electricity Online Bill Payment System, in order to ensure that the intended users of the newly developed system can carry out the intended task effectively using real data so as to ascertain the acceptance of the system and operational efficiency. It caters for consumers' bills and also enables the administrator to generate monthly reports. It is possible for the administrator to know the consumers have made payment in respect of their bills for the current month, thereby improving the billing accuracy, reduce the consumption and workload on the Electricity Board employees or designated staff., increase the velocity of electricity distribution, connection, tariff scheduling and eliminates variation in bills based on market demand. The conceptual framework allows necessary adjustments and enhancement maintenance to integrate future demands according to the technological or environmental changes with time. It manages the consumers' data and validates their input with immediate notification centralized in Electricity Board offices across the nation.

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