SMART ONLINE ELECTRICAL BILLING MANAGEMENT SYSTEM (SOEBIMS) USING GSM

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SMART ONLINE ELECTRICAL BILLING MANAGEMENT SYSTEM (SOEBIMS) USING GSM

WONG YING YIN

A report submitted in partial fulfillment
of the requirements for the award of the degree of
Bachelor of Computer Science (Computer System & Networking)

Faculty of Computer Systems & Software Engineering
University Malaysia Pahang

JUNE, 2012

DECLARATION

I declare that this thesis entitled "Smart Online Electrical Billing Management System (SOEBIMS) using GSM" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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SUPERVISOR'S DECLARATION

"I hereby declare that I have read this thesis and in my opinion
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the degree of Bachelor of Computer Science (Computer System & Networking)"

Signature : .....

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Date : June 13th, 2012

DEDICATION

To my beloved mum and dad

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ABSTRACT

Nowadays the billing system integrated with smart meter is used by staffs, residents and those who use electricity to retrieve the price rate and meter value of power consumption. There are several billing system integrated with smart meter invented in Italy, Sweden, UK, USA and so on. However, the current metering system in Malaysia is not capable to measure variable time price and it is gradually replaced by digital or smart meters. The purpose of this study is to develop a prototype of Smart Online Electrical Billing Management System (SOEBIMS) using GSM. SOEBIMS is an online web application as it can 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 staffs allow modifying the variable package price in specific duration. The administrator can analyze the customer's power consumption data and generate the report from the data online. The prototype is developed using waterfall model as the prototype can be implement and develop by followed the sequential phases. 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.

ABSTRAK

Pada masa kini, sistem bil bersepadu meter pintar digunakan oleh kakitangan, penduduk dan orang-orang yang menggunakan elektrik untuk mengambil kadar harga dan nilai meter penggunaan kuasa. Terdapat beberapa bil sistem yang disepadukan dengan meter pintar yang dicipta di Itali, Sweden, United Kingdom, Amerika Syarikat dan sebagainya. Walau bagaimanapun, sistem pemeteran semasa di Malaysia tidak mampu untuk mengukur harga masa berubah dan ia beransur-ansur digantikan dengan meter digital atau pintar. Tujuan kajian ini adalah untuk membangunkan satu prototaip *Smart Online Electrical Billing Management System* (SOEBIMS) *using GSM*. SOEBIMS adalah aplikasi web kerana ia boleh mengurangkan kesilapan manusia dan menjimatkan masa untuk memasukkan data dari papan kekunci. SOEBIMS membantu untuk mendapatkan meter masa nilai sebenar melalui GSM dan hantar ke telefon bimbit pelanggan melalui GSM. Kakitangan membenarkan mengubahsuai pakej harga berubah-ubah dalam tempoh tertentu. Pentadbir boleh menganalisis data penggunaan kuasa pelanggan dan menjana laporan daripada talian data. Prototaip yang dibangunkan dengan menggunakan model air terjun sebagai prototaip boleh melaksanakan dan membangunkan oleh diikuti fasa berurutan. Prototaip akan dapat memperkenalkan sistem bil kepada pelanggan, mendapatkan data penggunaan kuasa dari meter pintar, menyimpan data dalam pangkalan data berpusat dan menjana laporan. Ia akan membantu pengguna untuk mengakses data dan melaporkan dengan mudah secara online.

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LIST OF ABBREVIATIONS

3G - 3rd Generation

AC – Alternating Current

AMI - Advanced Metering Infrastructure

AMR – Automatic Meter Reading

ASI – Associated System Incorporation

CDMA – Code Division Multiple Access

CD-ROM - Compact Disc-Read Only Memory

CEO – Chief Executive Officer

CIS - Computer Information Systems

CRM - Customer Relationship Management

DFD – Data Flow Diagram

ENEL - **E**nte **N**azionale per l'energia **El**ettrica

ERD - Entity Relationship Diagram

EU - European Union

GB – GigaByte

GPRS - General Packet Radio Service

GSM – Global System for Mobile Communications

IC – Identity Card

kWh – kiloWatt hour

LAN – Local Area Network

LED – Light Emitting Diode

MAN – Metropolitan Area Network

MB – MegaByte

Mhz – Megahertz

PLC - Programmable Logic Controller

RAM - Random Access Memory

SABS - South African Bureau of Standards

SDLC – Software Development Life Cycle

SDM – Systems Development Method

SIM – Subscriber Indentity Module

SMS - Short Message Service

SQL - Structured Query Language

SSGC - Sichuan South Gas Compressor Company

ST - Singapore Technologies

TNB – Tenaga Nasional Berhad

TV – Television

US – United States

USA - United States of America

USB - Universal Serial Bus

WAN – Wide Area Network

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CHAPTER 1

INTRODUCTION

The overview of this research will be briefly discussed through this chapter. It contains five parts; which are introduction, problem statement, objectives, scopes, and thesis organization.

1.1 Introduction

Since 19th century the monitoring of electricity is performed using electromechanical meters or electrical meters. Even though these meter are a master art of engineering designed a hundred of years ago measuring in kilowatt hour (kWh) but still they are not capable to measure new rates structures i.e. variable time pricing and are unable to provide awareness to users about their power consumption pattern. In traditional monitoring, human labour i.e. a lineman plays a significant role in the collecting and managing field data. However, due to the size increase of consumption areas, this conventional practice is considered time consuming and labour intensive. Around hundreds plus of the linemen and other supporting staff are required for this manual data collection process (Anderson, 1998). This process always has chances of human error. The current metering system in Malaysia is not capable to measure variable time price and it is gradually replaced by digital or smart meters.

Power management system provides high quality alternating current (AC) power to

control the flow of power (Dudas, 2002). It allows monitoring and delivering electrical power in more efficiently and accurately (Freescale Semiconductor, Inc., 2011).Examples of electrical appliances are computers, mobile phone, printers etc. When the electrical appliances are inactive, the power will manage the system and able to turn off to a low-power state automatically (Domingo & Landmann, 2010).

The trend change for smart metering also affected the Asian region. Sichuan South Gas Compressor Company (SSGC) who is responsible for more than 80% of power networks in China announced huge investment in term of smart grid. Smart meters will be an integral part of these change programs. Advanced Metering Infrastructure (AMI) which utilizes two-way communications to enable real-time monitoring and control of energy use in residential, commercial, and industrial buildings will be an important tool for utilities to accomplish their smart grid objectives. According to a new forecast from Pike research group, China will represent more than three-quarters of the installed base of smart meters in Asia Pacific, and the government has declared plans to continue a large-scale meter deployment through at least 2020 (Ovel, 2011).

Singapore is also competing in this technology, the authorities signed a deal to shift to advance metering. ST Engineering's electronics arm, ST Electronics, on 13th Sep, 2010 announced that its subsidiary, Telematics Wireless Ltd has been awarded a contract worth US$21.5m (about S$29m) by Arad Technologies Ltd (Arad) to supply Automatic Meter Reading (AMR) radio transceivers for Arad's DIALOG 3G AMR solutions. The supply cooperation agreement between Arad and Telematics Wireless takes effect immediately and extends to 2015 (Business News, 2010).

Tenaga Nasional Berhad (TNB) is the largest electricity utility company in Malaysia that providing excellent services to the customers. There are approximated RM71.4 billion worth in assets and approximately 28,000 staffs serve seven millions of customers. In order to raise the economic growth and develop the social in the country, TNB continues to lead the effort (TNB, 2011). It shows that Malaysia being a rapidly growing developing country towards adaptation of technologies. To adopt and change with changing technologies is a healthy approach to keep ourselves up dated. But if a careful analysis is not taken into consideration this change may result into drawbacks rather than making some solid contribution and achievement. Malaysia in 2007 signed a deal with International metering supplier company for installation of a number of smart meters that was expected to be a move towards technology in metering infra-structure (AMI, 2007 and NTDW, 2007).

Smart Online Electrical Billing Management System (SOEBIMS) using GSM is an online system that keeps track of customer's power consumption by using GSM. GSM is one of the digital communication technologies that allow sending and receiving voice and data services at anywhere and anytime (GSMA, 2011). By using GSM, the system can receive the customer's power consumption information hourly. Besides that, it saves the electricity, energy and battery automatically when the GSM is not activated. By using this system, TNB can save costs on hiring staffs and may reduce the use of paper to print the electrical bill. The system can read and retrieve the value of meter then send it to TNB database via GSM. The centralized database of the system allows the TNB staffs to manage the billing statement easily. The report generation of power consumption by hourly allows customers to be aware of the power usage and it can help the customers to reduce cost by planning the usage of the electrical appliances. The system uses the variable package price rate to do calculation, so it allows saving time for entering the meter value and help to reduce human error made as the system is done automatically and more accuracy. This system also allows the TNB staffs to monitor and modify the variable package price rate based on the peak hour without hiring programmers for modification of the system.

1.2 Problem Statement

Nowadays, the monitoring of electricity is still required the human to record the meter value from the house customers have to receive the electricity bill then able to make payment without knowing the accuracy of power used by the house owner. The value of meter may not be very accurate as the meter value is entered by human and sometimes human may make mistakes when entering the meter value. This leads to the serious problem when the workers have to go to the house again and re-enter the meter value in order to correct it. Furthermore, it is difficult to keep track the customer's value of meter and calculates the usage of power for large resident area. Besides, the customer cannot keep track of the usage of the power consumption hourly and cannot plan on the power consumption. It is also difficult to manage the price of customer's power used in meter without centralized server.

1.3 Objectives

This research consists of several objectives as stated below:

i. To develop an online system to manage electrical billing for the administrator and customer.
ii. To collect the power consumption information and integrate with centralized database system via GSM device.
iii. To calculate the electrical bill and generate a report on the power consumption information through online.

1.4 Scopes

The scopes of this project are:

i. System Platform and Architecture
   The system collects the power consumption information and send to the centralized server every hour through GSM.
ii. Data
   The system can generate the reports based on the power consumption information received from GSM for customer respectively.
iii. System Functionality
   The system allows the customers to access and view the value and the accumulate cost of power used through online with centralized database.
iv. System User
   The target users of this system are the customers and TNB person in charge.

1.5 Thesis Organization

There are four chapters in this thesis. Chapter 1 will introduces the system by showing the basic concept, problem statements, objectives, scopes, and thesis organization. Chapter 2 describes the manual and existing systems. Besides, it also depicts the technique, method, equipment, and technology that had been used in those existing systems and also those will be used in this research. Chapter 3 elaborates about the overall workflow in the development of the project, which includes the method, technique or approach that has been used while designing and implementing the project. Chapter 4 summarizes the project.

CHAPTER 2

LITERATURE REVIEW

The purpose of this chapter is to explain the research on Smart Online Electrical Billing Management System (SOEBIMS) using GSM. This chapter reviews the manual system, current or existing systems, technologies, techniques and methods used.

2.1 Manual System

In traditional monitoring, human labour which is a lineman plays a significant role in collecting and managing field data. Around hundreds plus of the linemen and other supporting staff are required for this manual data collection process (Anderson, 1998). The current metering system in Malaysia is not capable to measure variable time price and it is gradually replaced by digital or smart meters.

Figure 2.1: House energy meter (Wan, 2010)

2.2 Current System

Tenaga Nasional Berhad (TNB) is the largest electricity utility company in Malaysia RM71.4 billion worth in assets and also the largest power company in Southeast Asia (TNB, 2011). It serves over seven million customers throughout Peninsular Malaysia and also the eastern state of Sabah through Sabah Electricity Sdn Bhd (Yahoo Inc., 2011). TNB's core activities are in the generation, transmission and distribution of electricity. Other activities include repairing, testing and maintaining power plants, providing engineering, procurement and construction services for power plants related products, assembling and manufacturing high voltage switchgears, coal mining and trading. Operations are carried out in Malaysia, Mauritius, Pakistan, India and Indonesia (Wikimedia Foundation Inc., 2011).

The current system for this research is TNB online billing system which is known as e-services. Figure 2.2 shows the screenshot of the current TNB system.

Figure 2.2: Main page of TNB

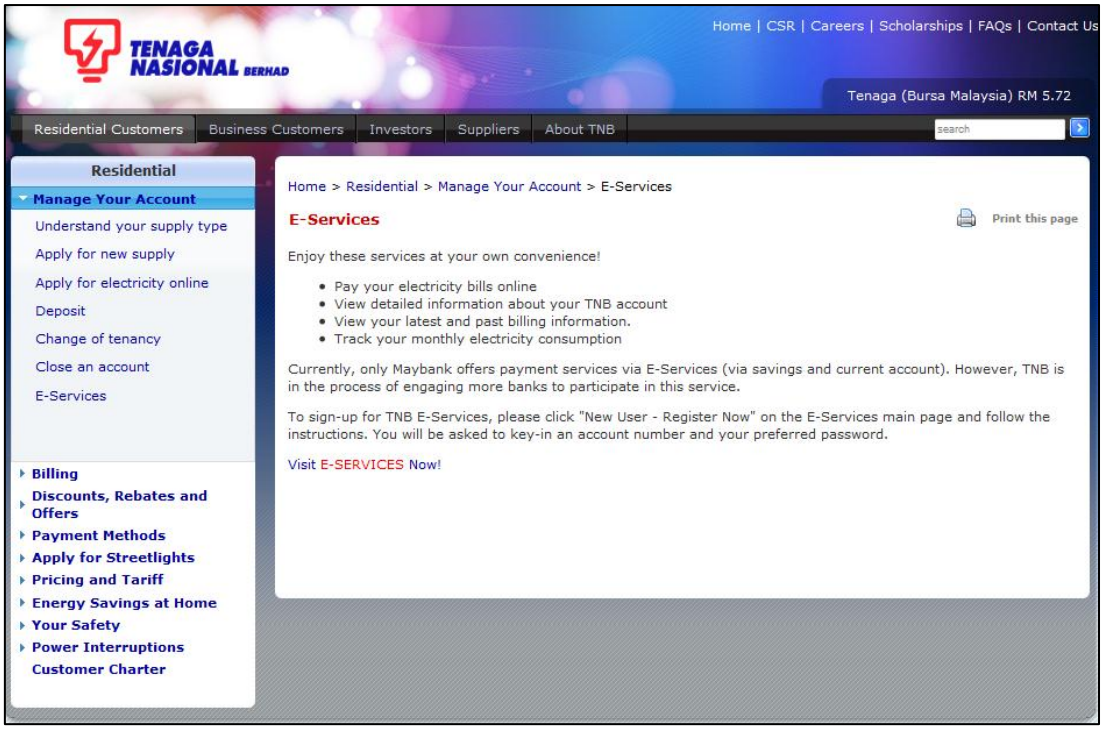


Figure 2.3: E-services page of TNB

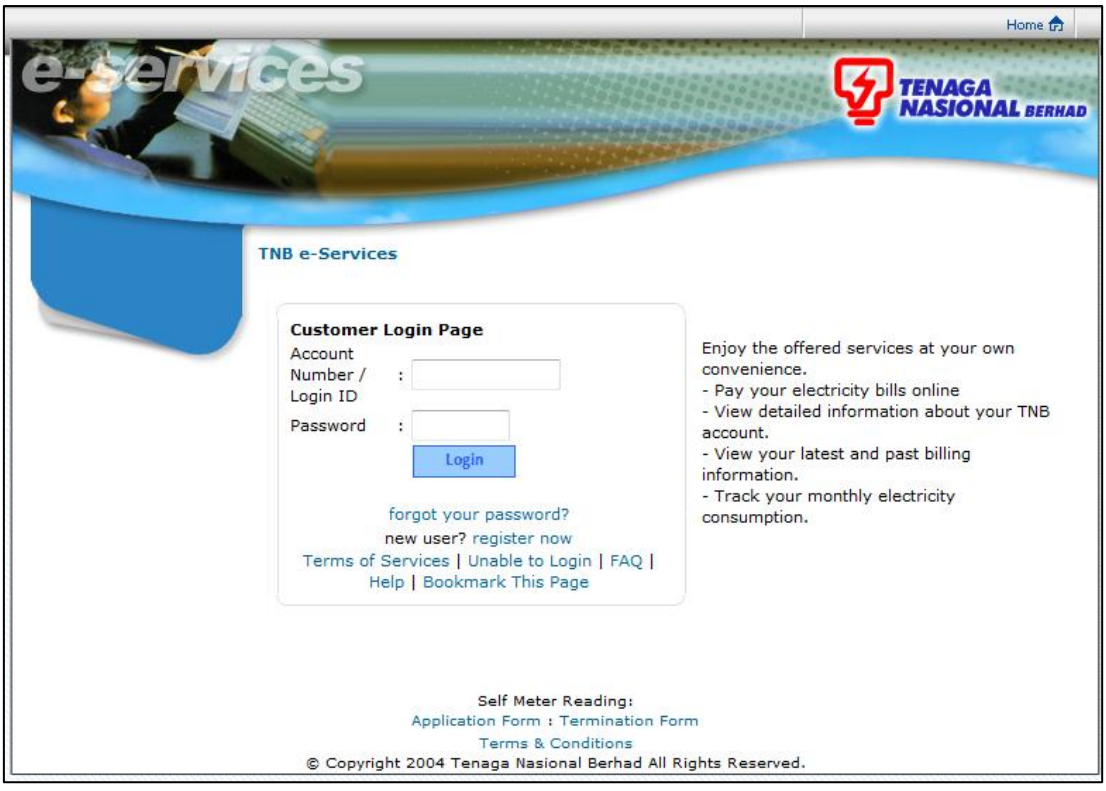


Figure 2.4: Login page of TNB e-services

2.3 Existing Systems

There are several current or existing systems in the market. Three of the systems are ASI EasiBill, Rural Billing, and BillMaster have been chosen for the comparison.

2.3.1 ASI EasiBill System

ASI offers one of the most effective, flexible and complete billing systems available to the utility industry, called EasiBill. This utility billing software provides the tools to improve the billing process while boosting efficiency and productivity to better serve to the customers. Those benefits include the unlimited number of services, multi dial and multiple meters per service locations, penalty or delinquent and cut-off processing, online credit processes and hand-held meter reading interface (Associated Systems Inc., 2010).

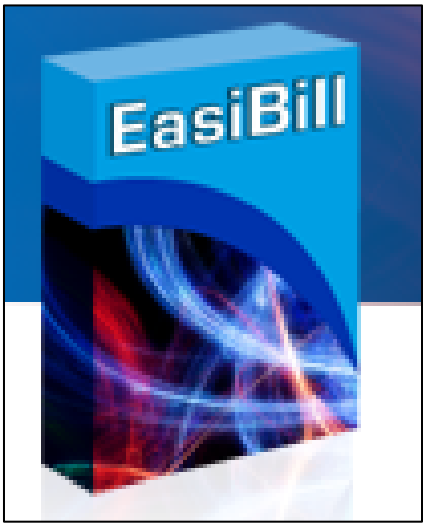


Figure 2.5: ASI EasiBill System

2.3.2 Rural Billing System

Redline Data Systems' Rural Billing utility billing package remains one of the most simple-to-use, expandable and affordable applications available today. Unlike billing systems that are too complex, too limited or too expensive for the smaller utility company such as 3,000 numbers of customers or less. Rural Billing is packed

with all the necessary features for running a small business including unlimited rate schedules, meter reading verification, individual user security settings and much more (Redline Data Systems, Inc, 2011).

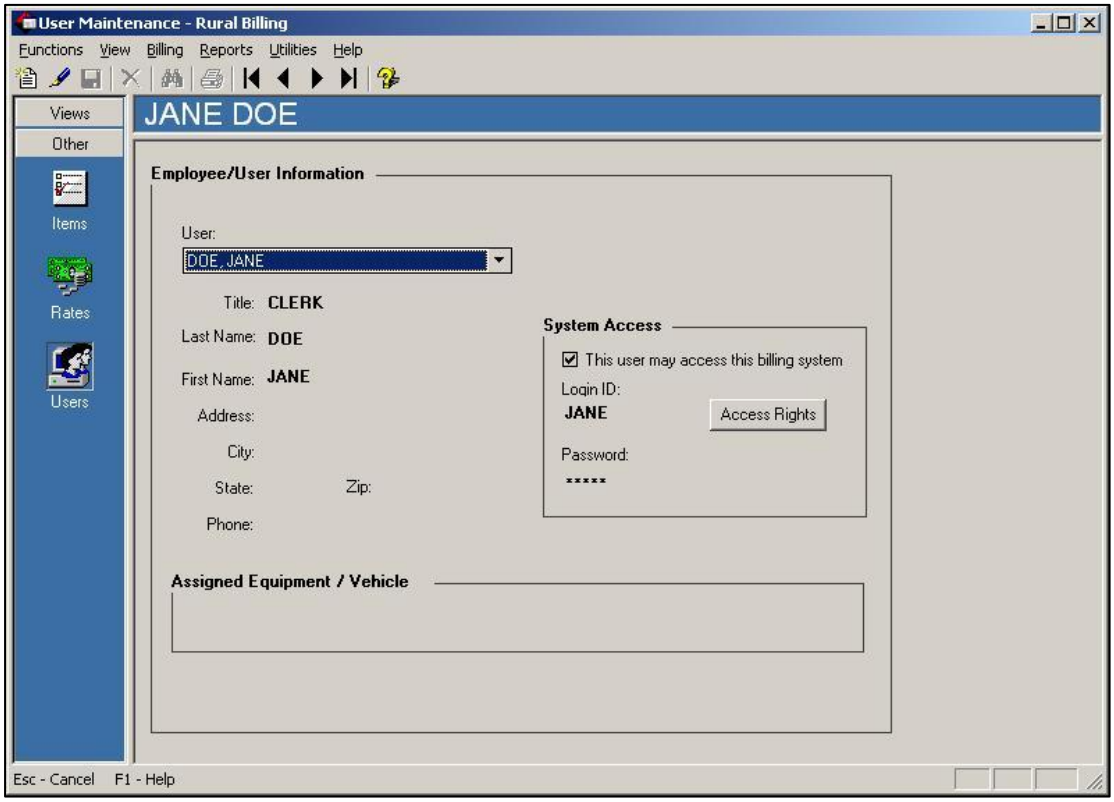


Figure 2.6: Rural Billing System

2.3.3 BillMaster System

BillMaster is a complete Computer Information System (CIS) for billing and management program which includes service orders, meter maintenance history and scheduling in addition to the Customer Relationship Management (CRM) and billing process. BillMaster features customizable account records, flexible reporting options, and unlimited rate schedules and charge calculations. Complex rate structures are supported. Every facet of the billing process may be adjusted to meet the specific needs (Data West Corporation, 2010).

Figure 2.7: BillMaster System

2.3.4 Comparison between the existing systems and SOEBIMS using GSM

The Table 2.1 shows the comparison between the existing systems and SOEBIMS using GSM.

Table 2.1: Comparison between the existing systems and SOEBIMS using GSM

Features	**ASI EasiBill System**	**Rural Billing System**	**BillMaster System**	**SOEBIMS using GSM**
Platform	• Other	• Windows	• Windows • Web Based	• Web Based
Location Served	• United States	• United States • Canada • United Kingdom • Europe • Australia	• United States • Canada • Latin America • Australia	• Malaysia
Advanta-ges	• Allow to view billing history • Have customer database • Have handheld meter reading • Flexibility	• Allow to view billing history • Have customer database • Have handheld meter reading • Have report generate • Easy to use	• Allow to view billing history • Have customer database • Have handheld meter reading • Allow to customize • Have report generate • Easier to use than Rural Billing System	• Allow to view billing and reading history • Have customer database • Have handheld meter reading • Allow to customize • Have report generate • Flexibility • Easier to use than BillMaster System • Able to retrieve value from GSM

				• Price reasonable
Disadvan-tages	• Expensive • Simple database • Do not have reporting • GSM not allow to access • Cannot be customized	• More expensive than EasiBill system • GSM not allow to access • Cannot be customized	• The most expensive compare to EasiBill System and Rural Billing System	

2.4 Technologies

The technology is the application of scientific knowledge for practical purposes, especially in industry. The technology used in this project is the smart meter and GSM technology.

2.4.1 Global System for Mobile Communication (GSM)

GSM is an acronym for Group Special Mobile, which has now been changed to Global System for Mobile Communication (Lovekar, 2011). GSM is the latest 'cellular' technology in several countries. Hence the popular name 'cell phones', the entire coverage area is divided into various hexagonal shaped cells. Every cell has a corresponding network tower, which serves the mobile phones in that cellular area. GSM is the most used cell phone technology in the world even though it is an older technology than CDMA (Carneiro, 2005).

2.4.2 Code Division Multiple Access (CDMA)

Code Division Multiple Access (CDMA) is a communication channel that employs spread-spectrum technology and a special code for every device in the coverage network. Besides, it can also refers to digital cellular telephony systems as both data and voice are separated from signals using codes and then transmitted using a wide frequency range (Diffen, 2011). So, CDMA is the preferred technology for the

3G generation, which are broadband access and the use of big multimedia messages as there are more space left for data transfer (Carneiro, 2005).

2.4.3 Comparison between GSM and CDMA

In this section, GSM and CDMA are compared in terms of feature, storage type, dominance and global market share. Table 2.2 shows the comparison between GSM and CDMA.

Table 2.2: Comparison between the GSM and CDMA (Diffen, 2011)

Technology	GSM	CDMA
Feature	GSM is a very straightforward standard	CDMA is somewhat complicated technology
Storage Type	SIM (subscriber identity module) Card	Internal Memory
Dominance	Dominant standard worldwide except the U.S.	Dominant standard in the U.S.
Global market share	82%	18%

2.4.4 Conventional Meter

The conventional meters had been installed up to 30 years ago. Testing them every 10 years, very few had been found that were not within the South African Bureau of Standards (SABS) guidelines. The conventional electricity meters that can measure the total amount of electricity used over a billing period (Wordpress Inc., 2010).

Figure 2.8: Conventional Meter (Toivonen, 2011)

2.4.5 Smart Meter

Smart meters look similar to conventional meters but the display is digital and there are no dials. The smart meters record how much and when electricity is used, typically hourly, and transmits this information automatically. The smart meter will record the total electricity consumption hour by hour and send that information to Hydro One through a wireless or another form of technology (Hydro One Inc., 2009).

As the communication network is installed in the community customers will receive bills produced with an automated meter reading. Automated meter reading will roll out across the province starting in 2009 through 2010. The smart meter will be notified the migrated to automated meter reading with a message on the first bill (Hydro One Inc., 2009).

Figure 2.9: Smart Meter (John, 2010)

2.4.6 Comparison between a conventional and smart meter

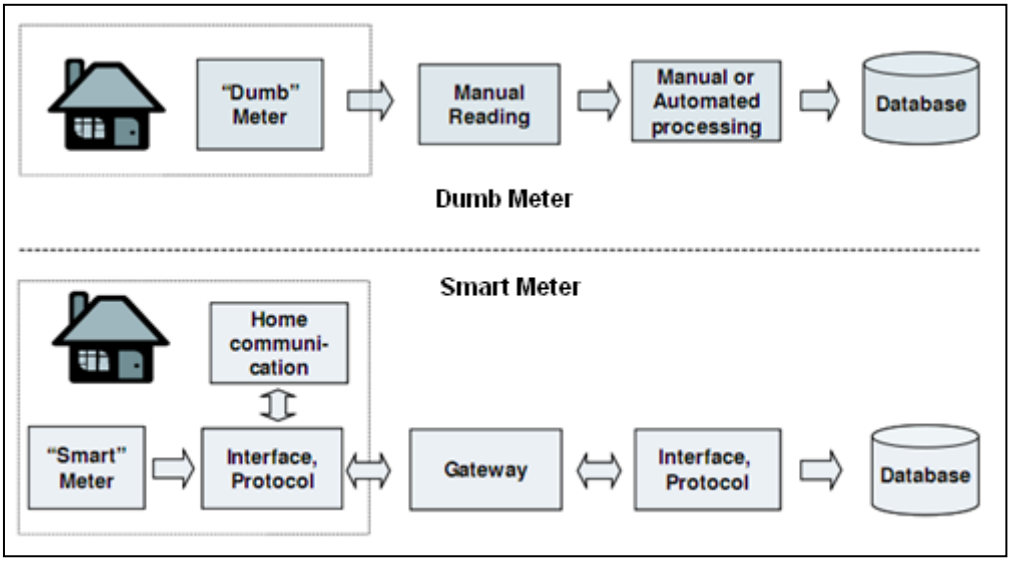


Figure 2.10: Difference between Conventional Meter and Smart Meter (Gerwen, Jaarsma, & Wilhite, 2006)

The basic difference between conventional meters and smart meters is that conventional meters provide one-way of communication whereas smart meters provide two-way communication. For instance, in order to carry out a meter reading

using a conventional meter, the meter reader needs to physically visit the customer premise and take reading. This reading will be sent to the utility company for billing. But in case of smart meters, this can be done automatically. The system operator will create a meter read request from the utility company office (Kamte, 2010).

The smart meter sends the meter reading as per the request to the utility company. This avoids manual intervention during meter reading and provides more accurate, real-time data to the company (Kamte, 2010).

2.4.7 Current Projects on Smart Metering

This section contains an overview of smart meter projects in Italy, Sweden, the Netherlands, United Kingdom, Victoria (Australia), Ontario (Canada), California (USA) and Northern Ireland.

2.4.7.1 Italy

The Italian utility ENEL introduced their "Telegestore project" with smart meters early in 2001 (Ofgem, 2006). Before deregulation of the energy market, ENEL made the in-company investment decision to introduce smart meters as first utility worldwide. Important reasons for ENEL were the expected savings or revenues in the areas purchasing and logistics, field operations, customer services and revenue protection (fraud). The regulator or government or other market parties had no or only marginal influence on requirements ENEL had to fulfill. Regarding the type of meter or the communication infrastructure ENEL was left totally free. ENEL has chosen for a smart electricity meter that communicates through PLC to the nearest substation. Next, centralized control rooms read the data through GSM. By the end of 2005, ENEL had 27 million smart meters installed, of which 24 million meters are being remotely managed and bimonthly read.

2.4.7.2 Sweden

In Sweden the first studies into smart metering were carried out in 2000 (Gerwen, 2005). Some companies had pilot projects then, but the government foresaw opportunities for energy savings and wanted to exploit the potential benefits. By obliging the grid companies to a monthly meter reading for all electricity users by 2009, the government stimulated the introduction of smart metering. This bill was passed in 2003 since the investments in smart metering have developed in a faster rate than required by law (Echelon, 2009).

2.4.7.3 Netherlands

In the Netherlands, the government is considering legislation to introduce smart metering after having conducted a detailed cost-benefit analysis for nation-wide introduction of AMR. The proposed legislation should become public by September 2006 as shown in Figure 2.6. Starting in 2008, all residential customers would get a smart meter. Proposed time frame for this introduction is 6 years. Minimum requirements for these meters are currently being established. In the meantime some pilot projects are being developed.

The Dutch grid operator has started with a pilot project in 2006. Some 50,000 smart meters would be installed with selected customers in 2006 to build experience with all operational aspects of smart meters. The smart meter registers both electricity and gas and communicates through PLC. Also a new energy supplier and certified metering company in The Netherlands (Oxxio, 2006), have started in 2006 to offer smart meters to its customers. Oxxio chose to pursue this initiative as they kept being confronted with administrative problems at their counter partners. Customers with a smart meter also have entry to a personal website with the actual energy use and energy costs. Oxxio's smart meter registers both electricity and gas and communicates through GSM/GPRS.

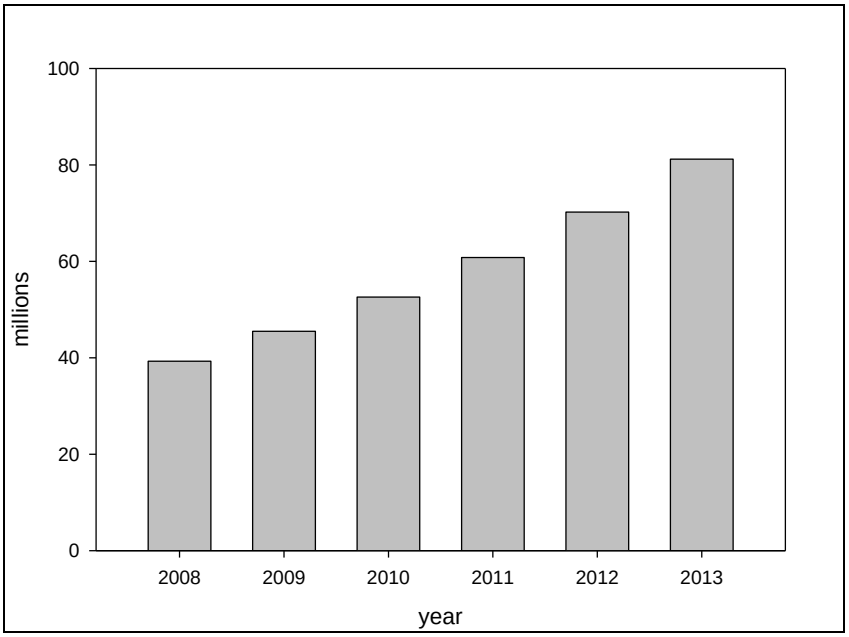


Figure 2.11: Market growth of smart metering in EU

2.4.7.4 Australia

In Victoria, increasing summer electricity demand peaks by air conditioning caused extra investments on low use plants (Ofgem, 2006). Introduction of smart meters to customers was seen as a mechanism to link wholesale and retail markets. The government changed legislation as instigated by the Essential Services Commission of Victoria. Installation was started in 2006 for dedicated categories and in 2013 about one million smart meters should be installed.

2.4.7.5 Canada

In Ontario, Canada, increasing electricity demand peaks were also the driver for smart metering (Ofgem, 2006). Energy conservation and demand side management have become important objectives within the energy policy. The Ontario Energy Board has proposed basic smart metering functions and some minimal technical standards. Each energy company is free to develop its own smart metering framework. Targets are installation of 800,000 meters by the end of 2007 and covering all 4.3 million Ontario customers by the end of 2010.

2.4.7.6 USA

The main driver for introducing AMR in California is to increase the reliability of electric supply in the state, through the reduction of consumer peak demand. California has a summer peak demand for power during approximately 50 to 100 hours per year. This peak is mainly due to the increasing use of air conditioners. The main energy agencies of California saw demand response as an important mechanism to decrease this peak. All three major California utilities developed their own plans to implement AMI systems to all residential customers. Deployment plans call for installing all advanced meters and communications infrastructure by 2012 or 2013, and represent some of the largest AMI deployments in the world. In response, a number of significant changes are occurring in AMI technology innovation and price reductions, as vendors seek to capture their share of this market.

2.4.7.7 Northern Ireland

The Northern Ireland Electricity used prepayment meters (Ofgem, 2006). Complaints and operational costs were increasing and necessitated installation of a new system. The introduction of the Liberty Credit Management keypad meter has started since 2000. By 2005, some 155 000 meters have been installed, covering 22% of customers. Since 2005 also trials have been undertaken in new customer services. These focus on pricing, offering different rates in specific periods, and indicate reduction of energy use by customers.

2.5 Techniques

The technique is a way of carrying out a particular task, especially the execution or performance of an artistic work or a scientific procedure.

2.5.1 Real Time Data Transmission

Today, it is possible to investigate used data communication systems into two categories, which are broadcast systems and data transmission systems. Broadcast systems basically are based on broadcasting the data by given frequency via the radio-modem, and taking these data via the radio modem on the other side and demodulating. It is possible to perform the broadcasting data via the general television frequency (Ocalan & Tunalioglu, 2010).

In other words, multiple users can use data broadcasted from one center. Therefore, this is available for the common systems such as differential correction data used by multiple users (Ocalan & Tunalioglu, 2010).

GSM and satellite telephones can be given as an example of data transmission systems. In these systems, the data is not broadcasted, only sent to a particular address. They are not preferred frequently due to expensive operating costs. Data transmission systems, then especially is formed by the wireless networks (Ocalan & Tunalioglu, 2010).

2.5.2 Modes of Data Communication

The transmission of binary data across a link can be accomplished in either parallel or serial mode. There is only one way to send parallel data, however there are two subclasses of serial transmission which are synchronous and asynchronous as shown in Figure 2.12.

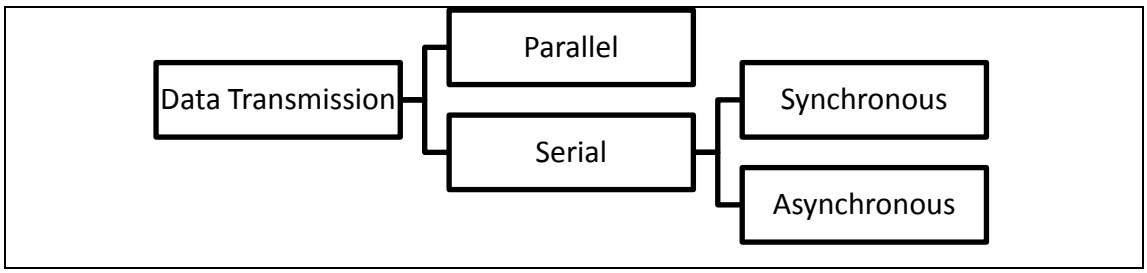
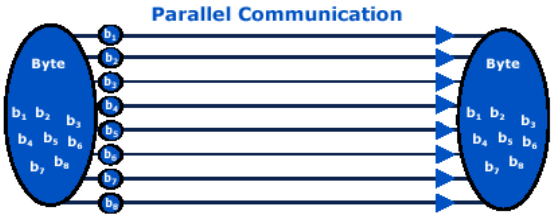


Figure 2.12: Data Transmission Modes

2.5.2.1 Parallel and Serial

Table 2.3 shows the differences between parallel and serial transmission.

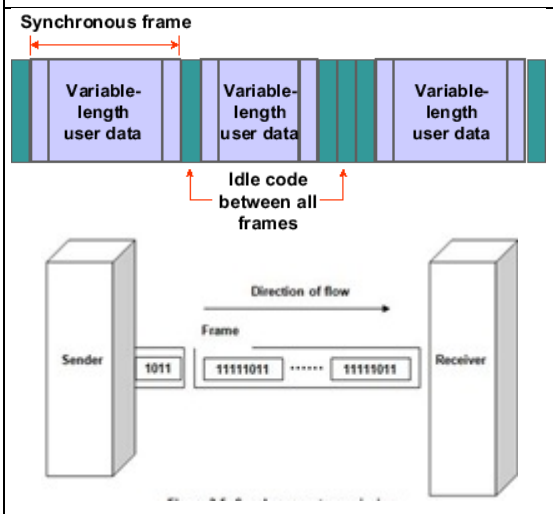
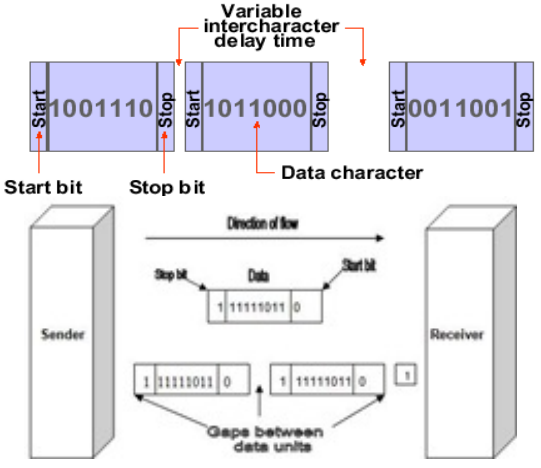
Table 2.3: Comparison between the parallel and serial transmission (Quatech Inc., 2011)

Parallel	Serial
	
Multiple bits are sent with each clock tick.	1 bit is sent with each clock tick.
All bits are grouped and transmitted from one device to another.	One bit follows another and transmitted from one device to another.

2.5.2.2 Synchronous and Asynchronous

Table 2.4 shows the differences between synchronous and asynchronous transmission.

Table 2.4: Comparison between the synchronous and asynchronous (Jeff, 2008)

Synchronous	Asynchronous
	

Frame-based transmission	Character-based transmission
Synchronous transmission usually combines much more data into the information payload carried in the bit stream of each serial frame.	Asynchronous transmission usually encapsulates individual characters in control bits called start and stop bits.
The transmitter and receiver are paced by the same clock.	The transmitter and receiver are paced without coordination about the timing of individual bits.
The receiver continuously receives even when no bits are transmitted for the information at the same rate the transmitter sends it.	There is no coordination between the two end points on the duration of transmitter leaves the signal at a certain level to represent a single digital bit.

2.5.3 Types of Communication System

There are 3 types of communication system as describe below.

2.5.3.1 Simplex

A simplex system is communication systems in which the message can be send in one direction only such as radio and TV broadcasting (LigatureSoft Inc., 2005).

2.5.3.2 Half duplex

Half-duplex data transmission means that data can be transmitted in one-way at a time. For example, walkie-talkie is a half-duplex device because only one party can transmit at a time. It has to push the “Talk” button to send the message. But as long as one of the people is holding the “Talk” key, the people cannot hear others people who is saying until the people release the button to receive voice from the

others (Wotel, 2004).

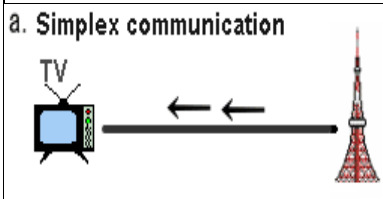
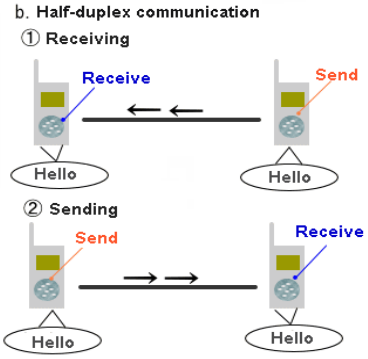
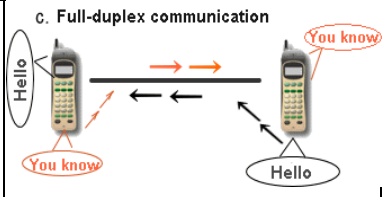
2.5.3.3 Full duplex

Full-duplex data transmission means that data can be transmitted in both directions on a signal carrier simultaneously. For example, on a local area network with a technology that has full-duplex transmission, one workstation can be sending data on the line while another workstation is receiving data (TechTarget, 2011).

2.5.3.4 Comparison between types of communication system

Table 2.5 shows the differences between simplex, half-duplex and full-duplex.

Table 2.5: Comparison between the types of communication system (Markun Inc., 2009)

Simplex	Half-duplex	Full-duplex
		
One-way communication and only one direction.	Two-ways communication, but it allows sending and receiving data only one direction at one time.	Two-ways communication and it allows sending and receiving data at the same time.

2.6 Network Types

There are 3 types of network discuss as follow, which are LAN, MAN, and WAN.

2.6.1 Local Area Network (LAN)

A local area network (LAN) is a computer network that supplies networking capability to a group of computers in close proximity and interconnects to each other in a limited area such as a home, school, computer laboratory, or office building (Donahue, 2006). A LAN is useful for sharing resources like files, printers, games or other applications. Most local area networks are built with relatively inexpensive hardware such as Ethernet cables, network adapters, and hubs. Wireless LAN and other more advanced LAN hardware options also exist (Mitchell, 2010).

2.6.2 Metropolitan Area Network (MAN)

A metropolitan area network (MAN) is a computer network that interconnects users with computer resources in a geographic area or region larger than that covered by even a large LAN but smaller than the area covered by a wide area network (WAN) which extends to a city or to a large university campus (McMurrich, 2000). A MAN usually incorporates a number of LANs to form a network by bridging them with a high-capacity backbone technology, such as fiber-optical links (Freewimaxinfo.com, 2011).

2.6.3 Wide Area Network (WAN)

Wide Area Network (WAN) is a computer network which collection of computers and network resources connected via a network over a large geographic area. Wide-Area Networks are commonly connected either through the Internet or special arrangements made with phone companies or other service providers. A WAN

is different from a MAN because of the distance between each of the networks. In a WAN, one network may be anywhere from several hundred miles away, to across the globe in a different country. Example, for home routers the port the router connects to the Internet connection is often labelled as a WAN, network or Internet port, and allows to home network to communicate with the Internet network (Groth, 2009).

2.6.4 Comparison between the types of network

Figure 2.13 and Table 2.6 show the differences between LAN, MAN, and WAN.

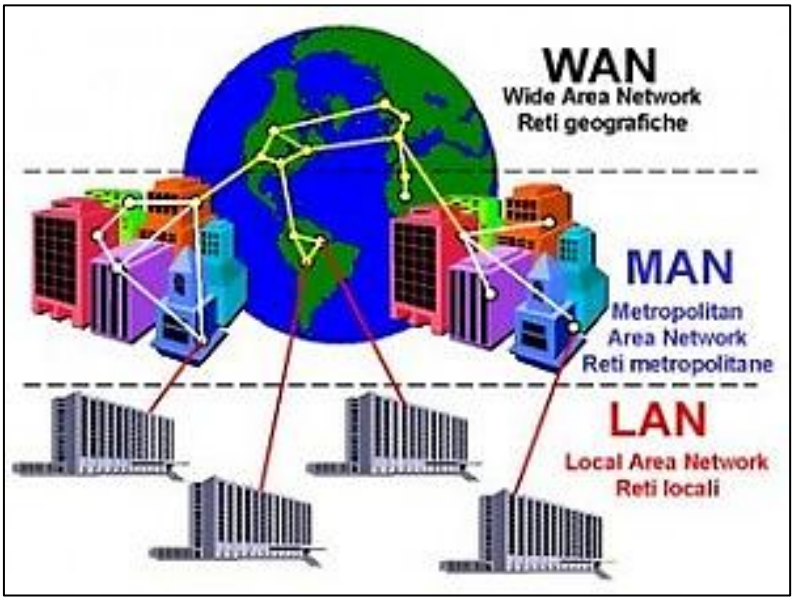


Figure 2.13: Types of Network (Awesome Inc., 2010)

Table 2.6: Comparison between the types of network

Types of Network	**LAN**	**MAN**	**WAN**
Network	Small	Medium	Large
Geographical area	Within an organization	Between the organizations	Worldwide
Accessibility	Private	Private	Public

2.7 Methodology

Methodology is one of the ways to solve the problem by structuring, planning, and controlling the process of developing an information system (CMS, 2008). Besides, it is also the system of methods and principles used to practices in a particular discipline, phases, tasks, techniques in the research study of the project (Smith, 2011). There are several methodologies often used in the software development nowadays.

2.7.1 The Waterfall Model

Waterfall model is a sequence of execution in which development systematically flowing steadily downwards fashion, like waterfall from one phase to other (Select Business Solutions Inc., 2011). The incremental waterfall model was one of the first variations to be derived from the waterfall model. The assumption behind the model is that the requirements can be segmented into an incremental series of the products, each of which is developed somewhat independently. Once a phase has been complete there is no turning back and it is on to the next phase (Flood, 2003).

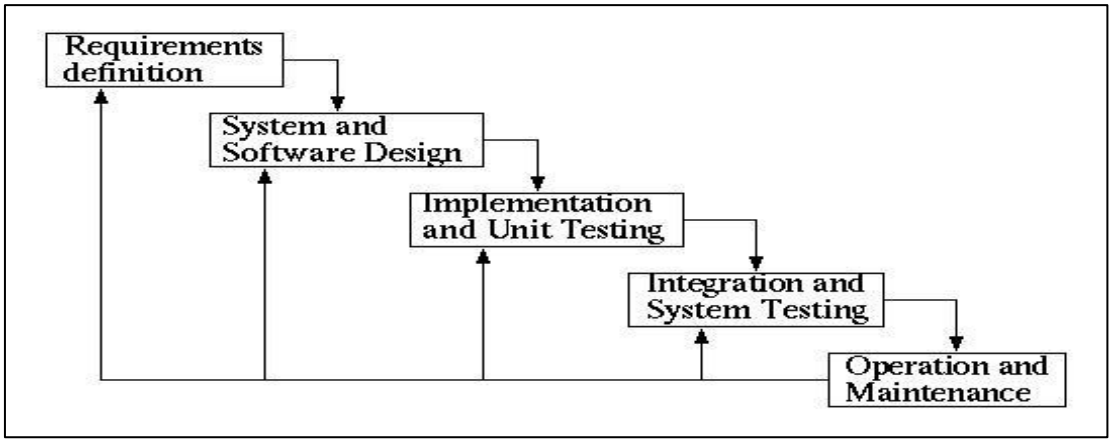


Figure 2.14: Waterfall Model (Sommerville, 2001)

2.7.2 Prototyping Model

The Prototyping Model is a systems development method (SDM) in which a working prototype is built, tested, and the developer attempts to use existing program fragments or applies tools that enable working programs to be generated quickly (Blogger, 2010). This model works best in scenarios where not all of the project requirements are known in detail ahead of time. It is an iterative, trial-and-error process that takes place between the developers and the users (Nehal, 2009). This model reflects an attempt to increase the flexibility of the development process by allowing the client to interact and experiment with a working representation of the product (Corporate Executive Board, 2009).

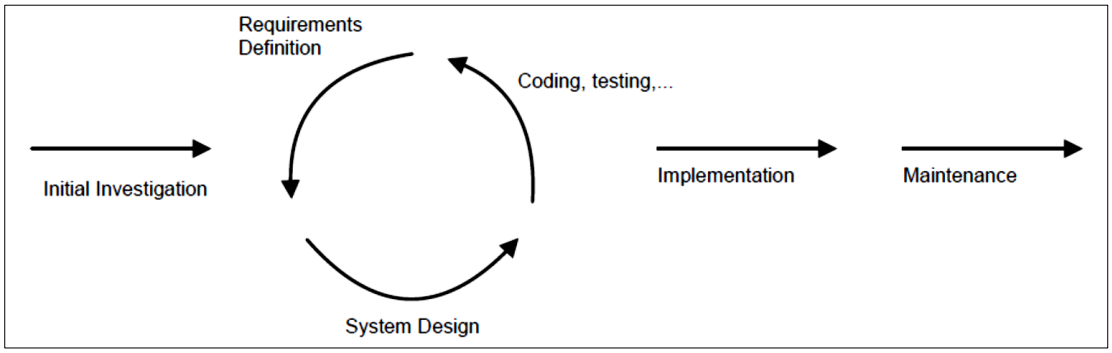


Figure 2.15: Prototyping Model (CMS, 2008)

2.7.3 Spiral Model

The spiral model, developed by Dr. Barry, is an enhancement of the waterfall/rapid prototype model, with risk analysis preceding each phase of the cascade. It can imagine the rapid prototyping model drawn in the form of a spiral, as shown in Figure 2.16. This model has been successfully used for the internal development of large systems and is especially useful when software reuse is a goal and when specific quality objectives can be incorporated. It does depend on being able to accurately assess risks during development. This depends on controlling all factors and eliminating or at least minimizing exogenous influences. Like the other extensions of and improvements to the waterfall model, it adds feedback to earlier stages. This model has seen service in the development of major

programming projects over a number of years, and is well documented in publications by Boehm and others (Deming & Ramamoorthy, 2006).

If the spiral was unrolled and laid out, it would resemble a series of waterfall models with an evaluation period between each. The spiral model is very risk aware and is very useful when starting out on a project that is totally unknown buy in which the pre-production period has to be kept shorter than it should be.

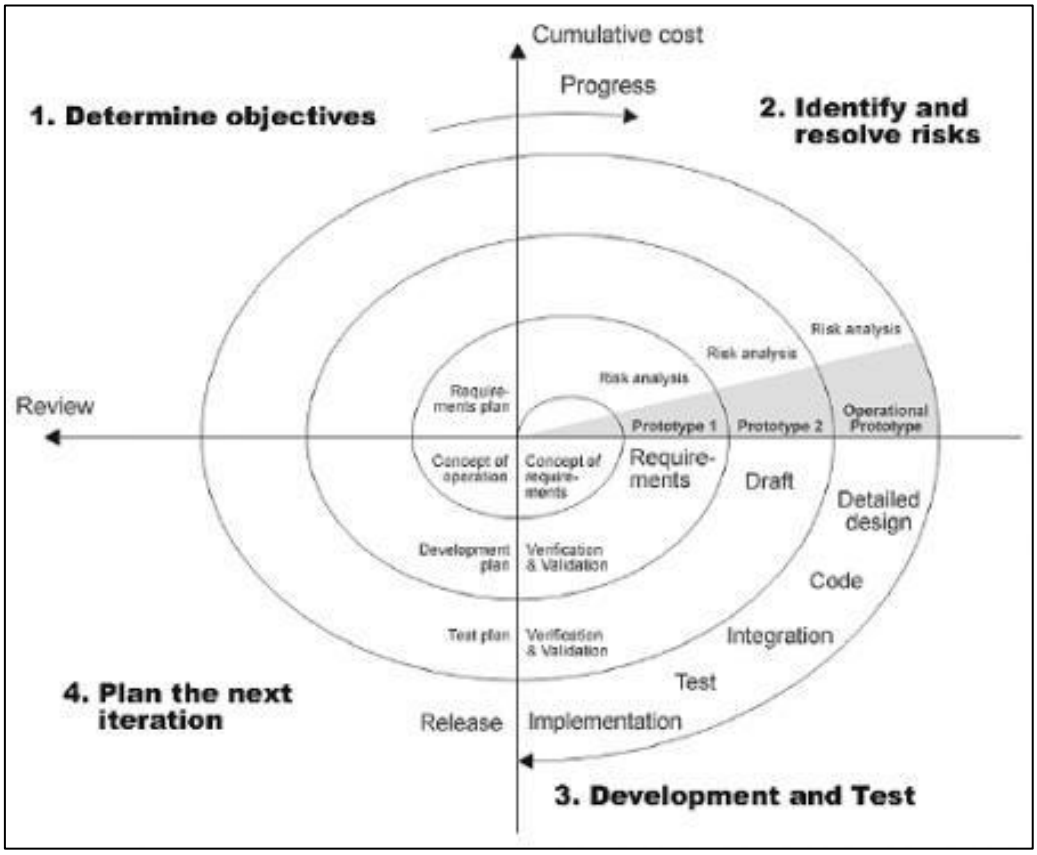


Figure 2.16: Spiral Model (DEB, 2008)

2.7.4 Comparison between methodologies

Table 2.7 shows the comparison between methodologies for system development.

Table 2.7: Comparison between the methodologies

Techniques	**Waterfall**	**Prototyping**	**Spiral**
Advantages	• Has distinct phases that need to be completed in a certain order • Detail documentation • Ensure quality, reliability, and maintainability of developed software. • Clear objectives and solution.	• Reduce time and costs • Improvement and increased user involvement	• Analyze the risks • Detail documentation
Disadvantages	• Slow development	• Insufficient analysis • Prototype too quickly cause inflexible design	• It needs training to operate • Hard to determine training algorithm
Suitable System	• Large, expensive and complicated projects • The goals are fixed	• Project objectives are unclear • Flexible design	• Large, expensive and complicated projects • The size and the constantly shifting goals of those large projects

2.8 Summary

Through this study of research, it will have a well understanding and concentrated on the billing systems, concept of real time data transmission and communication of network, and types of software development methodology deeply. Besides, it is able to help in deciding the enhancement or creation of the system by making the comparison of existing and current systems. Furthermore, it could help to make a better decision, improve performance, reduce operational costs and errors for the system.

CHAPTER 3

METHODOLOGY

This chapter briefly discusses about the methodology and the procedures of Smart Online Electrical Billing Management System (SOEBIMS) using GSM, the used of methods and techniques, hardware and software specifications of the system.

3.1 Introduction

This section explains on development stages of Smart Online Electrical Billing Management System (SOEBIMS) according to Software Development Life Cycle (SDLC) methodology. SDLC defines various distinct stages of software development, and the sequence in which the stages are organized. The stages include:-

(i) Requirements definition
(ii) System and software design
(iii) Implementation and unit testing
(iv) Integration and system testing
(v) Operation and maintenance

Waterfall Model as shown in Figure 3.1 is a software process model used to represent the different stages in software development in the SDLC.

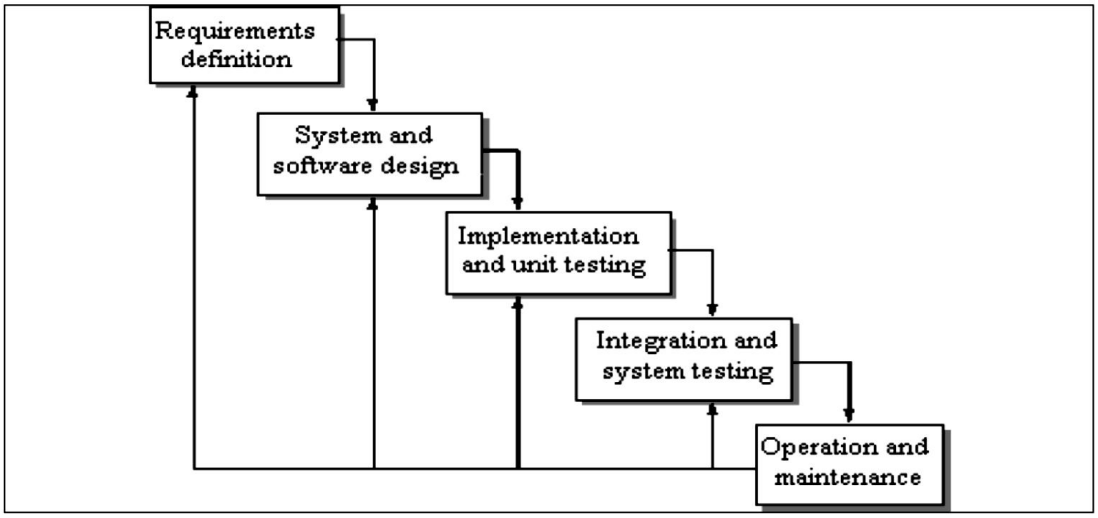


Figure 3.1: Stages of Waterfall Model (Sommerville, 2001)

Requirements Definition stage for SOEBIMS has been conducted to gather user requirements and to increase developer's comprehension on research area. Interviews, observation and sampling of existing documentation have been done.

System and Software Design stage for SOEBIMS has been carried out to model user requirements into detailed computer-based specification. At this stage, architectural design, database and interface design were developed.

Implementation and Unit Testing stage describes the development of modules of SOEBIMS. Each module was tested as a unit to ensure the system fulfils business and design requirements.

Integration and System Testing stage shows the integration of modules of SOEBIMS and testing of SOEBIMS as a whole system.

Operation and maintenance stage depicts SOEBIMS being in operation for the purpose of presentation of this thesis.

The details on each phases are explain in Section 3.3.

3.2 Justification of Chosen Methodology

Waterfall model has been chosen in this project because of the incremental waterfall model was one of the first variations to be derived and the assumption behind the model is that the requirements can be segmented into an incremental series of the products in SOEBIMS, each of which is developed somewhat

independently. In addition to the benefits of SOEBIMS that arise from being variation of the waterfall model as follow:-

(i) SOEBIMS is making the first delivery with less cost and time.

(ii) Less risk is incurred to develop the systems of SOEBIMS which represented by the increments.

(iii) The changes of user requirement in SOEBIMS may decrease because of the quicker time to first release.

(iv) Incremental funding is allowed as that is only one or two increments might be funded when the program of SOEBIMS starts.

Therefore, SOEBIMS is developed by using incremental waterfall model because it is easy to understand and users are able to get access to the product at the end of each cycle. The users provide feedback on the product for the planning stage of the next cycle and the development team responds, often by changing the product, plans, or process. This incremental cycle able to continue until the product is shipped.

3.3 Requirement Definition

Prior to requirements elicitation, a planning process for SOEBIMS has been conducted. System planning analyses problems with current system, defines project objectives, scopes and project direction. Analysis results of problem with current system, project objectives and scope of SOEBIMS is as documented in Chapter 1 at Section 1.2, Section 1.3 and Section 1.4.

Project direction states project schedules and milestones for SOEBIMS. The project direction of SOEBIMS is presented using Gantt Chart, as shown in Appendix A. There are five phases consists in the project schedule of SOEBIMS. Requirements definition phase defines the functional and non-functional requirements for SOEBIMS. Requirements definition for SOEBIMS has been conducted using three fact-finding techniques, which are interviews, sampling of existing documentation, forms and files, and observation of work environment.

An interview was conducted with Dato' Ir. Hj. Azman Mohd, Chief Executive Officer (CEO) of TNB. The Interview Transcript is referred to

Appendix B. Requirements had also been derived from sampling of organization chart of TNB. Observation of process of registering customer has also been done at counter information or website of TNB.

3.3.1 Overall Product Perspectives

The overall product requirement of SOEBIMS is SOEBIMS is an online application, implemented using client server architecture, which a database server function as a centralized database. There are three types of users, which are Admin, Staff and Customer from website of TNB. Development of SOEBIMS is divided into 3 modules, which are Admin Module, Staff Module and Customer Module.

3.3.2 Functional Requirements

Functional requirements define the expected services of the expected system, scope and required data structures (Maciaszek, 2005). The application of SOEBIMS allows to be used by two types of users; Staff and Customer.

Firstly, the Staff user is required to login to SOEBIMS. Staff uses SOEBIMS to search for customer information using customer's name or customer's id number. Staff can generate hourly, daily and monthly electrical billing information report. Staff can add customers when needed. Besides, Staff allows monitoring the peak hours of variable package price.

The Customer user is required register to SOEBIMS before he/she is able to login TNB billing system. Customer able to update and insert customer's personal account information through the website, verify customer identity by providing the user id and password in order to retrieve customer information, send SMS to the customer's mobile phone if requested, and storing customer information into the centralize database. Furthermore, customer allows viewing hourly, daily, monthly electrical billing information report.

3.3.3 Non-Functional Requirements

Non-functional requirements define constraints imposed on the development and implementation of the system in the approach of building quality into SOEBIMS. Software quality attributes such as performance, extensibility, and security must be exhibited from the system.

The program of SOEBIMS is stable and reliable. Error handling is implemented and the application should be able to handle all run time errors. If an error condition occurs, the system should output helpful error messages and, if recovery is not possible, it should exit gracefully.

SOEBIMS is maintainable and extensible, that is in the future which is more functionality and modules can be added to the application easily. The database in SOEBIMS is scalable that is it must have the capacity to hold large number of data in the future.

SOEBIMS is accessible only by authorized users with valid username and password. Only authorized staff is able to access the system for any update and maintenance.

3.3.4 Interface Requirements

There are 3 main interfaces of SOEBIMS, which are admin interface, staff interface and customer interface. The 3 main interfaces use the only 1 master login interface to do the validation and verification.

The SOEBIMS user interface is implemented in a way where it eliminates excessive keyboard data entry. Techniques of SOEBIMS to be implemented here are the use of drop-down menus, list boxes, option boxes and checkboxes. This requires user to select on valid values, rather than requiring user to input text.

All the user interfaces of SOEBIMS are standardized with the same size, colour, text font, text size and use of common icons.

3.3.5 Hardware Requirements

Hardware requirements are divided into developer hardware requirements and user hardware requirements.

Developer hardware requirements refer to the computer specification required for developer to develop SOEBIMS. Besides, user hardware requirements refer to the computer specification of the client-side and server-side of SOEBIMS. In addition, the client workstation should also be equipped with a mobile phone or GSM/GPRS modem, connected to the personal desktop computer or notebook through USB port, which also function as the central server, server-side or the central database server.

Those developer, user or client workstation comprises of a personal desktop computer or notebook, should meets the following specifications:

(i) At least Pentium 800 Mhz (or equivalent)
(ii) At least 192 MB RAM
(iii) A minimum of 2 GB of available disk space
(iv) Network Card
(v) USB port
(vi) CD-ROM drive
(vii) GSM

The specification given is a guideline in order for the application to run smoothly.

3.3.6 Software Requirements

Software requirements are divided into developer software requirements and user software requirements.

Developer software requirements are the decision on usage of software development tools used by developer to develop SOEBIMS. The tool usage is shown as Table 3.1.

Table 3.1: Developer Software Requirements

Purpose	Software
Operating System	Microsoft Windows 7 Home Premium 64 bit
Documentation	Microsoft Office Word 2010
Planning	Microsoft Office Project 2010
Interface Design and Programming	Microsoft Visual Studio 2008
Database Management	Microsoft SQL Server 2008
Slide Presentation	Microsoft Office PowerPoint 2010
Modelling and Designing	Microsoft Office Visio 2010

User software requirement refers to the software needed to access SOEBIMS and to run it smoothly. For client-side workstation, the software required is Microsoft Windows Vista Professional as operating system and Microsoft .NET framework version 3.5. For server-side, the software required is Microsoft Windows Vista Professional, Microsoft .NET framework version 3.5, and Microsoft SQL Server 2008 for database management.

3.4 System and Software Design

System and software design gives an overview design of SOEBIMS, its database design and interface design. SOEBIMS is modelled using structured approach based on two techniques, which are Data Flow Diagram (DFD) for process modelling and Entity Relationship Diagram (ERD) for data modelling.

The design of DFD consists of external entities, processes, data flows, and data stores. External entity is the source and destination which provide data and receive the information from the system (GetAhead Inc., 2011). An external entity can be a person, system, or organization that has pre-defined behaviour (Borysowich, 2007). The name of external entity must be a noun phrase. Process helps to manipulate data that received from data flows only, which cannot create data itself (Gangolly, 2000). The name of process must consist of verb phrase. It can be

combinations of verb and nouns phrase or verb and objects phrase such as validate account number (Hendon, 1998). Data flow is the transformation of data which shows the data flow into or out of the process (Oderog, 2011). The name of data flow must consist of a noun phrase (Gangolly, 2000), which can combine nouns and adjectives phrase such as valid account number (Hendon, 1998). Data store is a place to store information within the system (GetAhead Inc., 2011). The name of data store must be a noun phrase (Gangolly, 2000). In DFD, it has to ensure that the input and output of the data flow of parent DFD have to retain on the child DFD, it must be balanced. The context diagram shows the process 0 as black box, it can be zoom in to the next level to see it in more details of the process (Shelly, Cashman, & Rosenblatt, 2010).

An Entity Relationship Diagram (ERD) is a data modelling technique that shows the relationship between tables within the database. It shows the operation of the data works in database (Corporate Executive Board Inc., 2011).

3.4.1 System Design

SOEBIMS is divided into 4 modules, which are Admin Module, Staff Module, Customer Module and Meter Module. Process modelling for SOEBIMS represented using DFD, shows the hierarchical of SOEBIMS has divided business processes linked by data flows. Figure 3.2 shows the Context Data Flow Diagram (DFD), where it includes the system boundaries, entities that interact with SOEBIMS and information flow between the entities and SOEBIMS. There are 4 entities as shown in the context DFD, which are Admin, Staff, Customer and Meter. Customer refers to end user or resident. Admin refers to the staffs which has the highest post. Staff refers to the general staffs. Meter refers to resident's meter. These 4 entities depict the users of SOEBIMS and show data flows between the users and SOEBIMS.

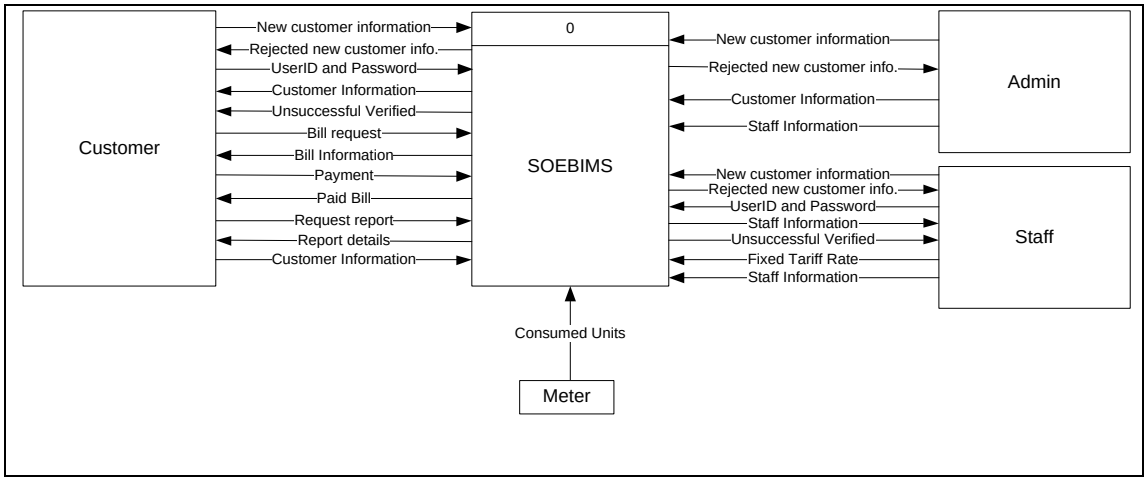
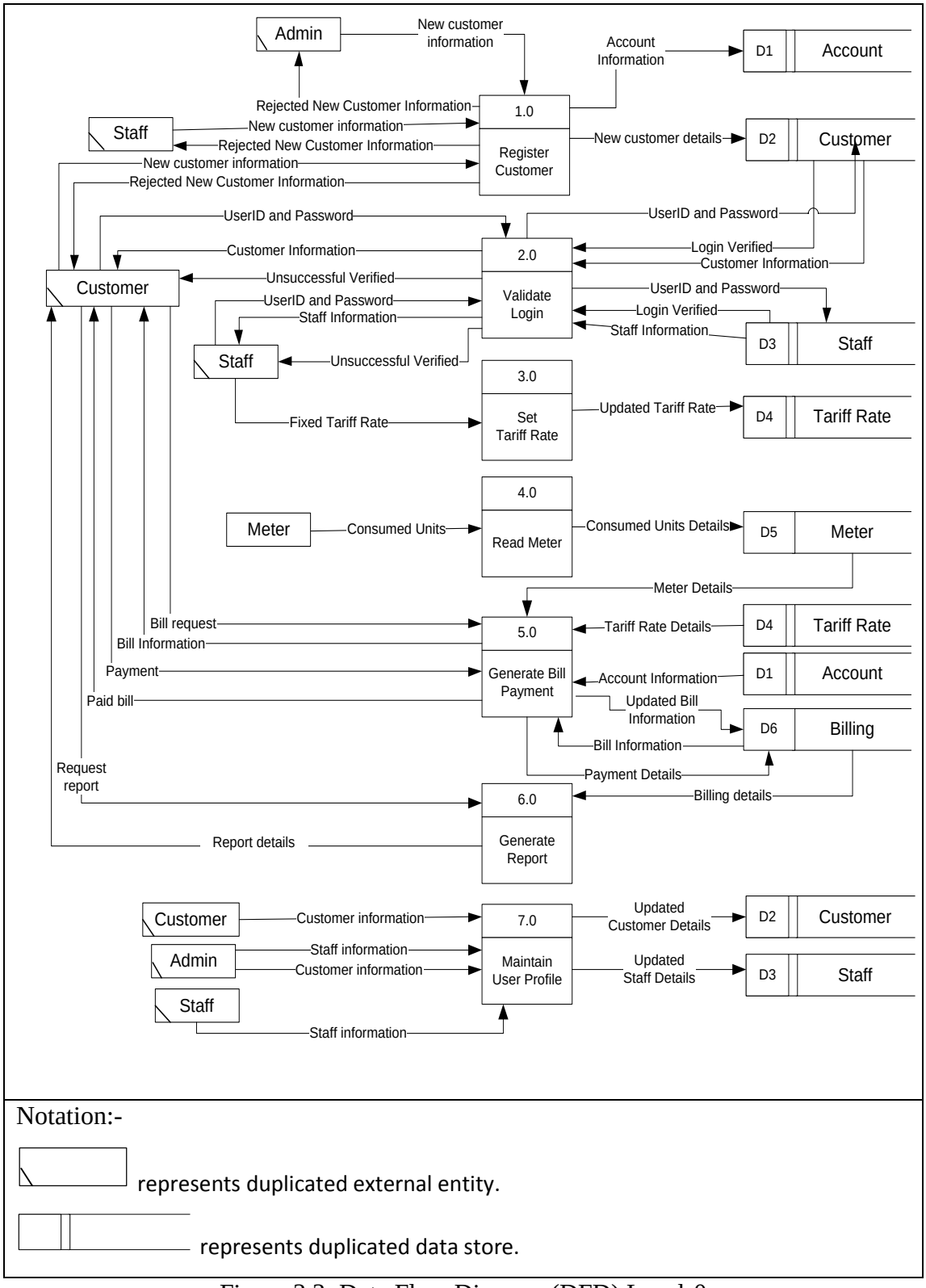


Figure 3.2: SOEBIMS Context Data Flow Diagram (DFD)

Main processes, data flows and data stores of SOEBIMS is modelled using DFD Level-0 and is shown in Figure 3.3. SOEBIMS consists of 7 main processes and includes 6 data stores. Description for each main process as explained in Table 3.2.



Notation:-

represents duplicated external entity.

represents duplicated data store.

Figure 3.3: Data Flow Diagram (DFD) Level-0

Detailed representation of each main process for SOEBIMS is referred to Data Flow Diagram (DFD) Level-1 at Appendix C.

Table 3.2: Main Process Descriptions

	Process	Descriptions
1.0	Register Customer	Customer register new customer by supplying customer information to SOEBIMS. Besides, admin and staff can help to register customer as well if they wish to receive information through mobile phone. Customer information is recorded into table Customer.
2.0	Validate Login	User login to SOEBIMS by supplying userID and password. SOEBIMS compares the validity of inserted userID and password with login credentials stored in table Customer.
3.0	Set Tariff Rate	The tariff rate is set and updated by the staff and stores it into the database for calculating bill purpose.
4.0	Read Meter	The meter value consumption of each customer stores into database in hourly.
5.0	Generate Bill Payment	The bill statement provides to the customers where they requested and it allows them to make payment.
6.0	Generate Report	It generates the report based on hourly, daily, monthly or yearly, which allows customer to select and it retrieves from database.
7.0	Maintain User Profile	Admin has the authority to help in modifying the staff's information and customer's information. Besides, it has the authority to delete staff if they had resigned. However, staff and customer can modify their information respectively.

Overall Process Flow for User Module

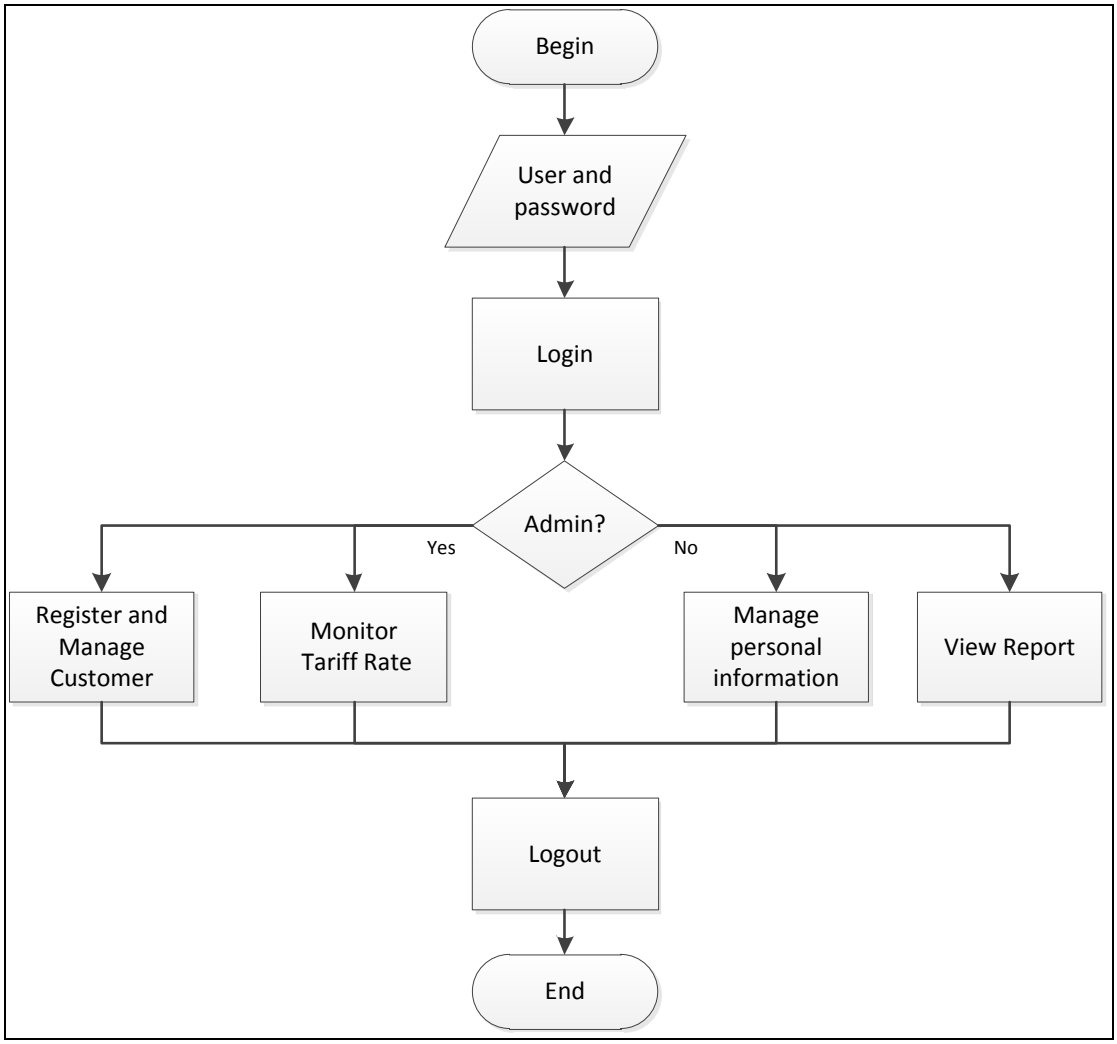


Figure 3.4: Process Flow for User Module

Figure 3.4 shows the overall process flow for user module. There are 2 types of user, which are staffs and customer. The customer has to be registered by staffs before the customer able to login. Staffs can manage and register the customer information and monitor the tariff rate. However, customer can manage their personal information and view the report. The system ends when the users logout the system.

Overall Process Flow for GSM

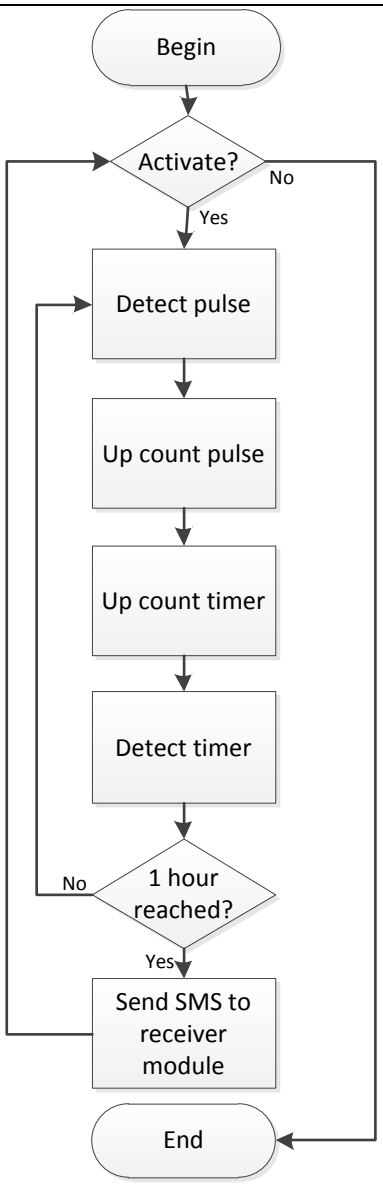


Figure 3.5: Transmitter Module

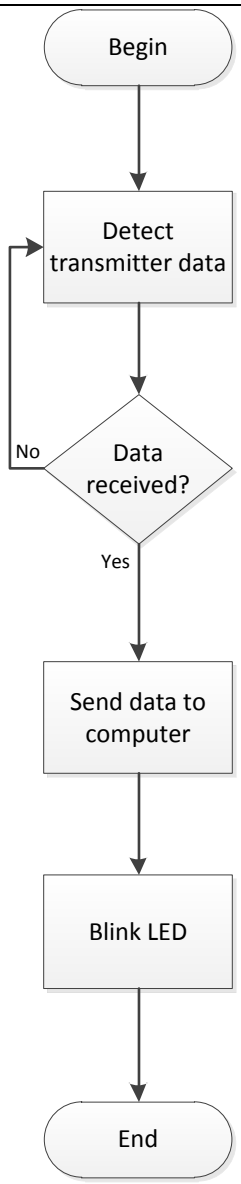


Figure 3.6: Receiver Module

Figure 3.5 shows the process flow of transmitter, which is GSM integrated with meter. It starts from reading the meter values after it connected. Next, the value read from meter and then counts it for a specified time. For this device, it sets the data send to the server in hourly. So, it will reset hourly after it sent in a single SMS to receiver module (center).

Figure 3.6 shows the process of receiver module, which is micro controller attached with computer. After received the value from transmitter module, then it sent to computer while the LED blinked.

3.4.2 Database Design

Database design is a process of developing a database design or data model that meets user requirements. Database design is divided into conceptual database design, logical database design and physical database design.

For conceptual database design of SOEBIMS, data models are rendered into graphical format using an Entity Relationship Diagram (ERD). The ERD shows that SOEBIMS consists of eight entities, which are STAFF, CUSTOMER, TARIFF, CATEGORY, METER_READING, BILL, ACCOUNT, and PREMISE as shown in Figure 3.7.

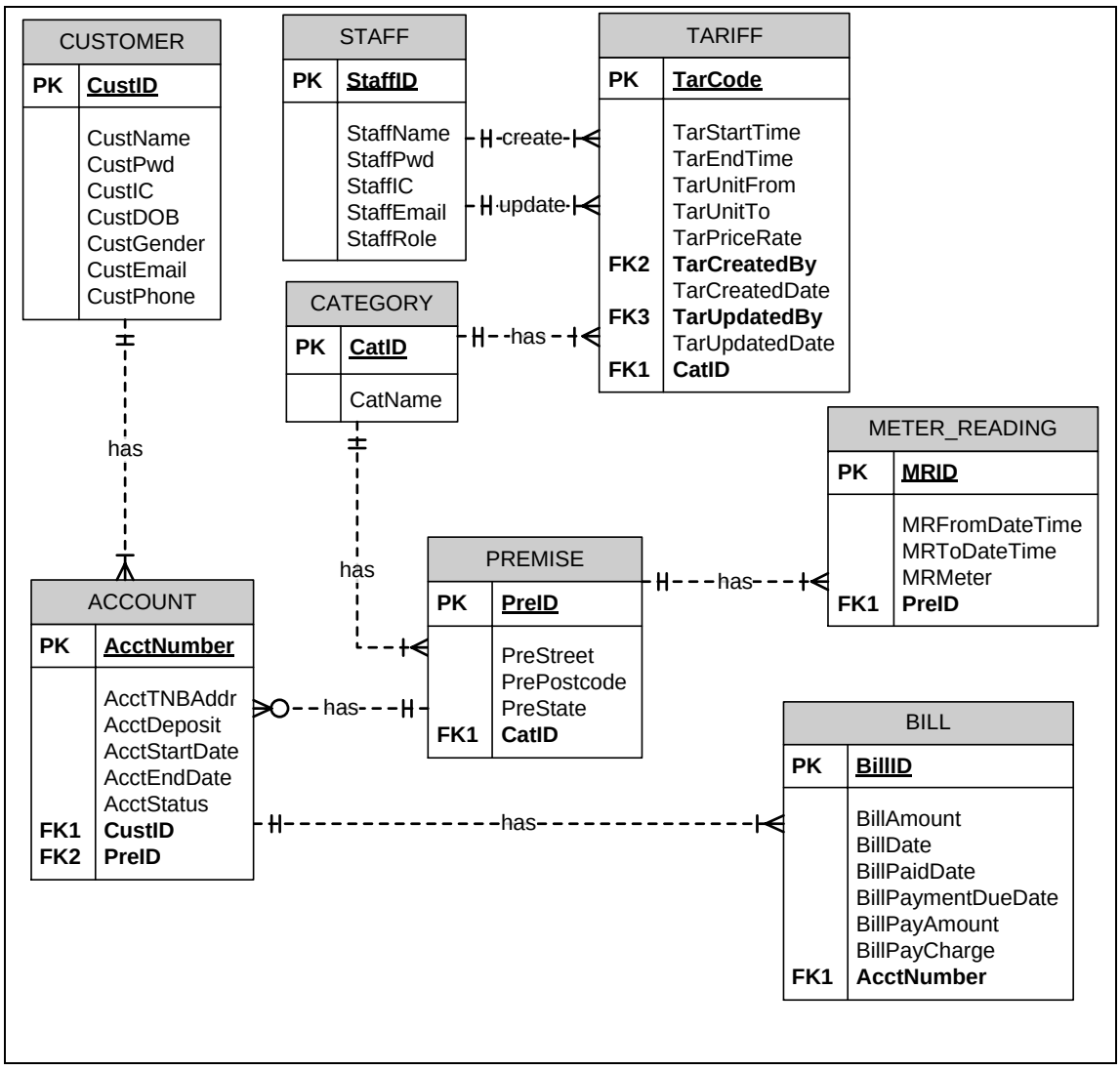


Figure 3.7: Entity Relationship Diagram (ERD)

Design Assumption:

(i) A customer has one or more accounts.

(ii) An account is belongs to one customer.

(iii) An account has one or many bills.

(iv) A bill is belongs to the particular account only.

(v) An account is belongs to one premise.

(vi) A premise may have many accounts.

(vii) A premise has one or more meter reading.

(viii) A meter reading is belongs to the particular premise.

(ix) A premise is belongs to one category.

(x) A category has many different type of premise.

(xi) A category has many different rate of tariff.

(xii) A tariff is belongs to one category.

(xiii) A tariff is created and updated by the staff.

(xiv) A staff creates one or more different rate of tariff.

(xv) A staff updates one or more different rate of tariff.

The logical database design of SOEBIMS is modelled using relational data model as shown in Figure 3.8.

CUSTOMER (CustID, CustName, CustPwd, CustIC, CustDOB, CustGender, CustEmail, CustPhone)
STAFF (StaffID, StaffName, StaffPwd, StaffIC, StaffEmail, StaffRole)
ACCOUNT (AcctNumber, AcctTNBAddr, AcctDeposit, AcctStartDate, AcctEndDate, AcctStatus, CustID, PreID)
PREMISE (PreID, PreStreet, PreState, CatID)
TARIFF (TarCode, TarStartTime, TarEndTime, TarUnitFrom, TarUnitTo, TarPriceRate, TarCreatedBy, TarCreatedDate, TarUpdatedBy, TarUpdatedDate, CatID)
CATEGORY (CatID, CatName)
METER_READING (MRID, MRFromDateTime, MRToDateTime, MRMeter, PreID)
BILL (BillID, BillAmount, BillPaidDate, BillPaymentDueDate, BillPayAmount, BillPayCharge, AcctNumber)

Figure 3.8: Logical Database Design

SOEBIMS physical database design transforms logical terms in relational data model to physical objects. Entities in relational data model are transformed to tables and attributes are transformed to columns. SOEBIMS has eight tables as shown in data dictionary of SOEBIMS shown as follow.

Table 3.3: Table of STAFF

Field Name	Data Type	Size	Description	Contraints
StaffID	String	5	Unique identifier for staff.	Primary Key
StaffName	String	40	Name of staff.	
StaffPwd	String	20	Staff's password.	
StaffIC	String	20	IC / passport number of staff.	
StaffEmail	String	30	Staff's email.	
StaffRole	String	12	The role of staff, either "Staff" or "Staff, Admin"	

Table 3.4: Table of CUSTOMER

Field Name	Data Type	Size	Description	Contraints
CustID	String	5	Unique identifier for customer.	Primary Key
CustName	String	40	Name of customer.	
CustPwd	String	20	Customer's password.	
CustIC	String	20	IC / passport number of customer.	
CustDOB	Date	-	Customer's date of birth.	
CustGender	String	6	Customer's gender.	
CustEmail	String	30	Customer's email.	
CustPhone	String	12	Customer's phone.	

Table 3.5: Table of ACCOUNT

Field Name	Data Type	Size	Description	Contraints
AcctNumber	Integer	14	Unique identifier for account number.	Primary Key
AcctTNBAddr	String	100	TNB's station address of the particular account.	
AcctDeposit	Decimal	-	Account's deposit.	
AcctStartDate	DateTime	-	Account active of the date and time.	
AcctEndDate	DateTime	-	Account deactivate of the date and time.	
AcctStatus	String	10	Account's status, either	

			“active” or “deactivate”.	
CustID	String	5	Unique identifier for customer.	Foreign Key
PreID	String	5	Unique identifier for premise.	Foreign Key

Table 3.6: Table of CATEGORY

Field Name	Data Type	Size	Description	Contraints
CatID	String	5	Unique identifier for category.	Primary Key
CatName	String	50	Category’s name.	

Table 3.7: Table of METER_READING

Field Name	Data Type	Size	Description	Contraints
MRID	String	5	Unique identifier for Meter_Reading.	Primary Key
MRFromDateTime	DateTime	-	From the current date and time of meter reading.	
MRToDateTime	DateTime	-	To the current date and time of meter reading.	
MRMeter	Integer	9	The consumed value of meter reading.	
PreID	String	5	Unique identifier for premise.	Foreign Key

Table 3.8: Table of TARIFF

Field Name	Data Type	Size	Description	Contraints
TarCode	String	5	Unique identifier for tariff.	Primary Key
TarStartTime	Time	-	The period time start of power consumption.	
TarEndTime	Time	-	The period time end of power consumption.	
TarUnitFrom	Integer	5	The unit consumption of meter read start from.	
TarUnitTo	Integer	5	The unit consumption of meter read end until.	
TarPriceRate	Decimal	-	The price rate of meter read.	
TarCreatedBy	String	5	Unique identifier for staff who created tariff rate.	Foreign Key
TarCreatedDate	Date	-	The date of created the tariff rate.	
TarUpdatedBy	String	5	Unique identifier for staff who edited tariff rate.	
TarUpdatedDate	Date	-	The tariff rate updates date.	
CatID	String	5	Unique identifier for	Foreign Key

			category.	

Table 3.9: Table of PREMISE

Field Name	Data Type	Size	Description	Contraints
PreID	String	5	Unique identifier for premise.	Primary Key
PreStreet	String	80	The street of premise.	
PrePostCode	Integer	5	The postcode of premise.	
PreState	String	25	The state of premise.	
CatID	String	5	Unique identifier for category.	Foreign Key

Table 3.10: Table of BILL

Field Name	Data Type	Size	Description	Contraints
BillID	String	5	Unique identifier for bill.	Primary Key
BillAmount	Decimal	-	The bill amount of each month.	
BillDate	Date	-	The bill statement date created.	
BillPaidDate	Date	-	The paid bill statement date.	
BillPaymentDueDate	Date	-	The due date of bill payment.	
BillPayAmount	Decimal	-	The amount of bill payment.	
BillPayCharge	Decimal	-	The charge of bill payment.	
AcctNumber	Integer	14	Unique identifier for account number.	Foreign Key

3.4.3 Interface Design

SOEBIMS consists of three types of interfaces, which interfaces are Admin Module, Staff Module and Customer Module. However, those 3 interfaces are using 1 master login page to verify and access to the particular module as shown from Figure 3.9 to Figure 3.17.

Figure 3.9: Home Page

Figure 3.10: Login Page

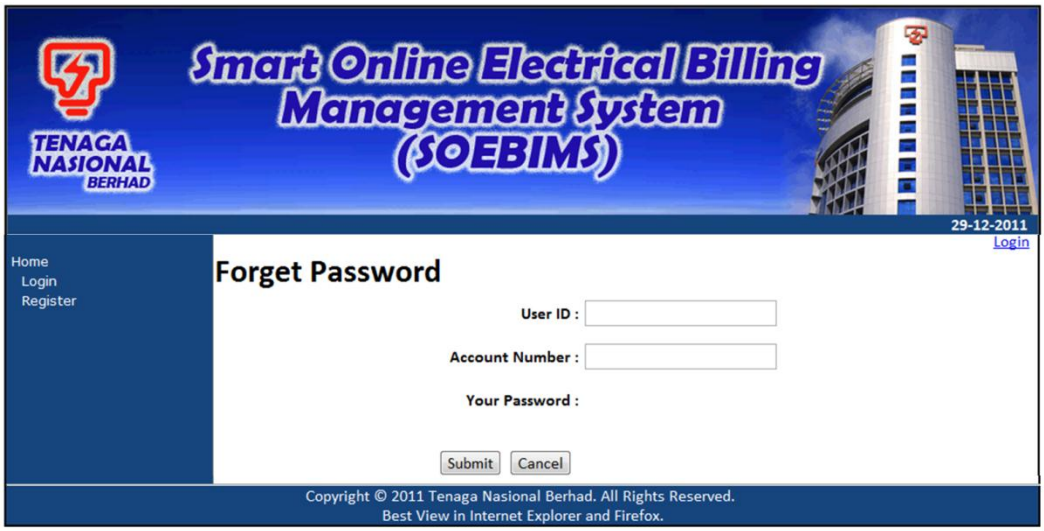


Figure 3.11: Forget Password Page

Figure 3.12: Register Page

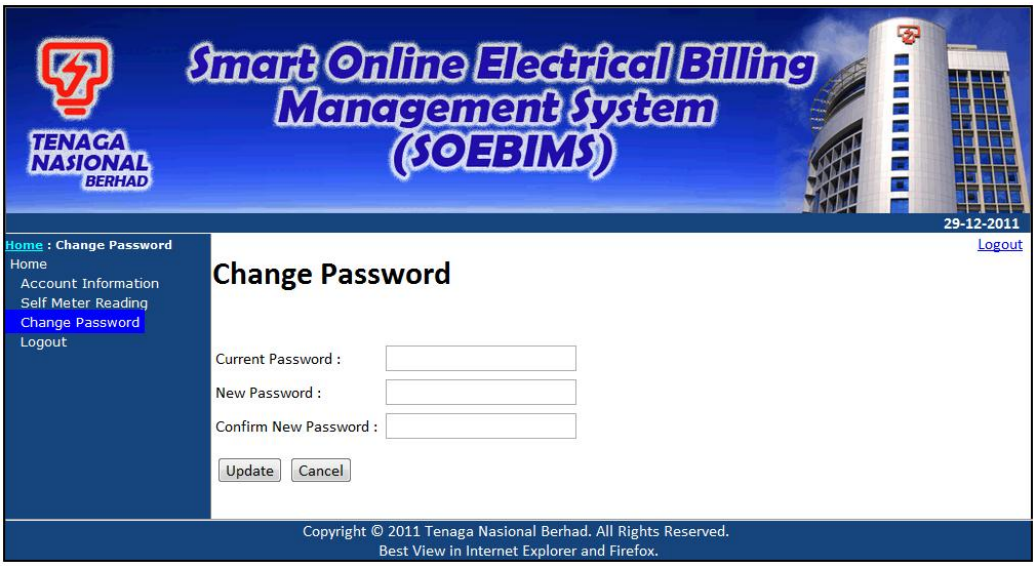


Figure 3.13: Change Password Page

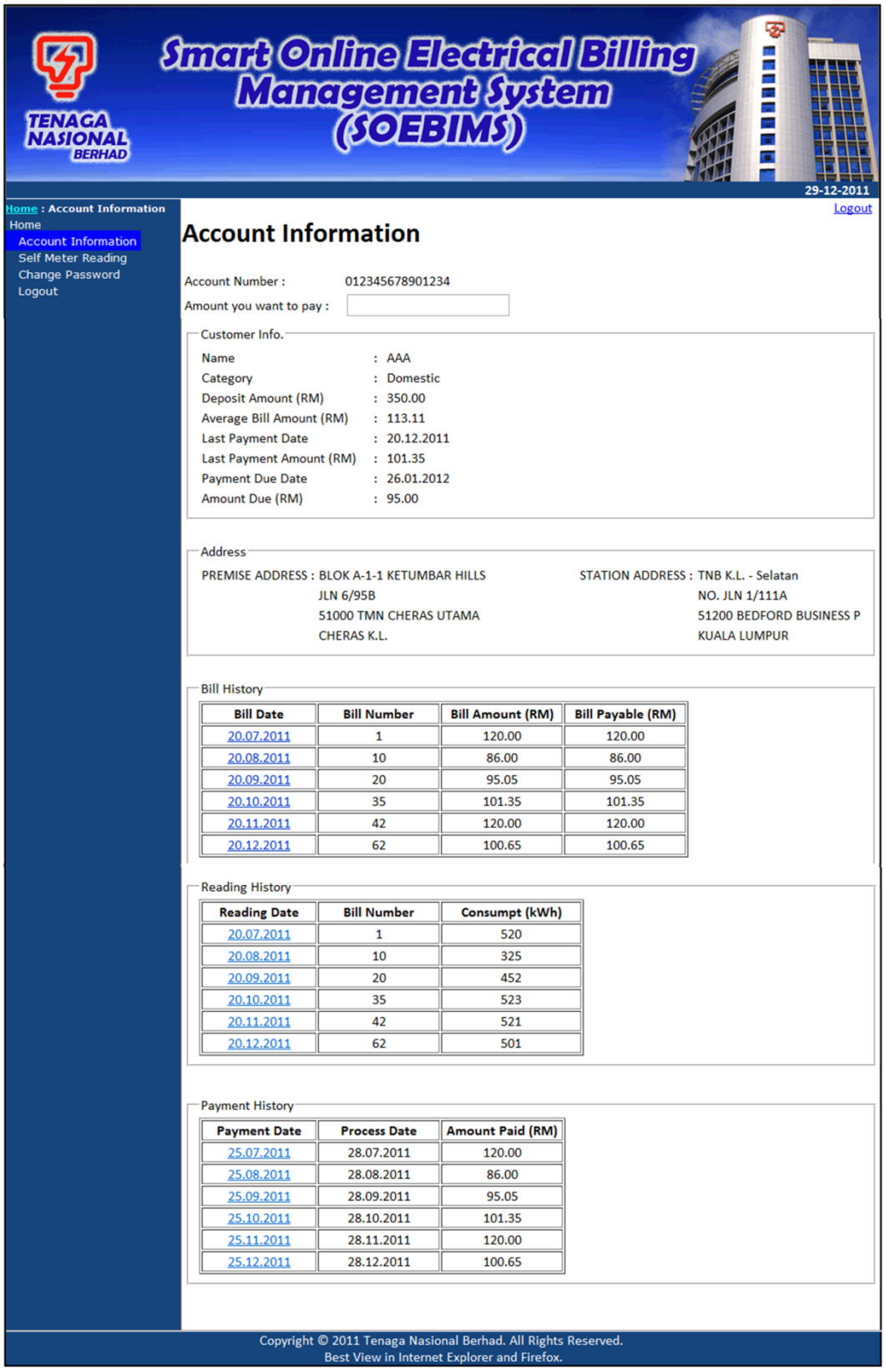


Figure 3.14: Account Information Page (Customer Module)

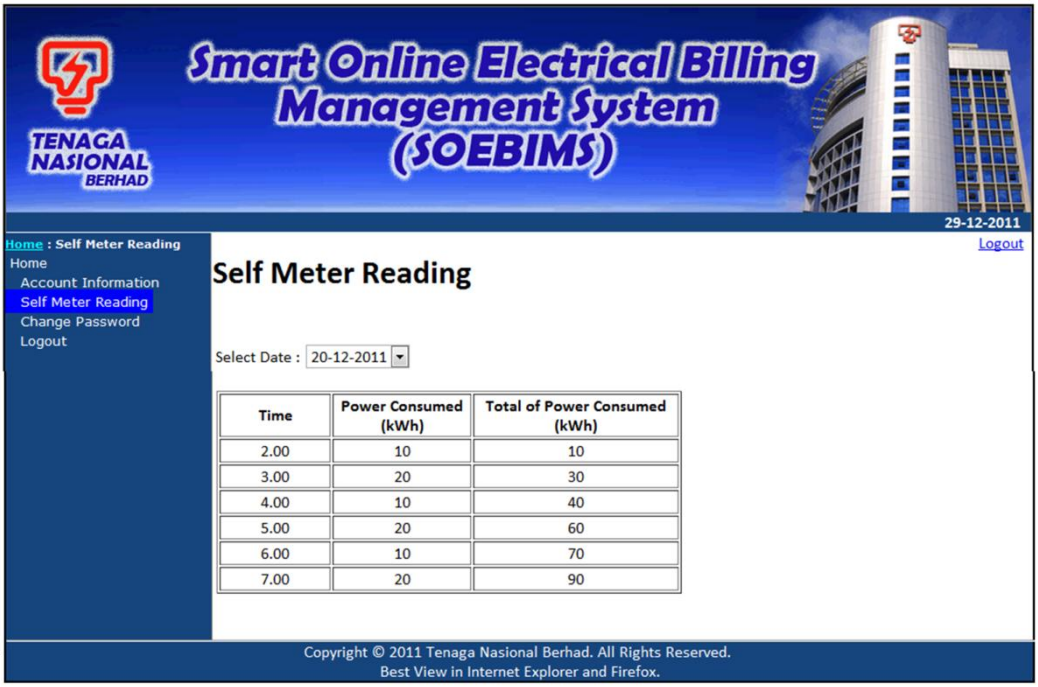


Figure 3.15: Self Meter Reading Page (Customer Module)

Figure 3.16: Check Status and Make Payment Page (Admin and Staff Module)

Figure 3.17: Edit Staff Page (Admin Module)

3.5 Implementing and Unit Testing

At system implementation stage, a functional system was developed and tested to ensure the system fulfils business and design requirements. Testing was performed incrementally, as unit testing on individual modules of a system. Both black-box and white-box testing were used as testing techniques at this stage. For unit testing process of SOEBIMS, the following aspects were considered:

(i) Code

Program codes were examined by reading through it, while spotting algorithm, data and syntax faults. Codes were compared with requirement specifications and design to make sure that all relevant cases have been considered.

(ii) Interface

Interfaces were tested to ensure that information flow properly into and out of each program unit under test.

(iii) Error Handling

All error handling paths were checked to ensure all fatal errors during system execution detect and recover. Routine for all error handling were tested to ensure it works properly as programmed.

(iv) Input/Output

The system was tested to determine whether it produces expected output when input is inserted.

The test cases in unit testing of SOEBIMS are listed in Table 3.11.

3.6 Integration and System Testing

In integration and system testing phase, individual program units were integrated and tested as a complete system to ensure that software requirements have been met.

Bottom-up testing was adopted as system testing technique for SOEBIMS. Using bottom-up testing, lower level modules were coded and tested first and integration moves upwards. Then, higher level modules were integrated and tested together with lower level modules. This was repeated until all modules were tested.

Table 3.11: Test Process in Unit Testing

Module	Process	Description
Staff	Login	Ensuring only authorized users are allowed to login. Ensuring password is not displayed in readable form on screen.
	Set Tariff Rate	Ensuring the tariff rate has been set correctly based on the time period with the customer's consuming units.
	Register Customer	Staff allows helping customer to enter all the information details. Customers can get the information of power consumption through staffs if do not have any internet connection at home. Ensuring customer information has to register through an online registration form provided. Ensuring customer information can be saved into database.

	Maintain User Profile	Ensuring the staff information updates or modifies correctly and stores it into database.
Customer	Login	Ensuring only authorized users are allowed to login. Ensuring password is not displayed in readable form on screen.
	Register Customer	Ensuring customer information has to register through an online registration form provided. Ensuring customer information can be saved into database.
	Read Meter	Ensuring the customer's consume units has read and stores it into database.
	Generate Bill Payment	Ensuring the value retrieve from database and the calculation of bill statement is correct. Besides, the figure of bill payment is correctly store in database.
	Generate Report	Ensuring report can be generated and view it on interface.
	Maintain User Profile	Ensuring the customer information updates or modifies correctly and stores it into database.
Admin	Maintain User Profile	Ensuring the staff or customer information updates or modifies correctly and stores it into database.

3.7 System Operation and Maintenance

For operation, SOEBIMS was implemented as a prototype for TNB website. This implementation process is done for the purpose of this project presentation. The implementation process uses dummy data saved in database and meter values were read from a pulse meter with GSM. A laptop was configured as a server with database installed and another laptop was used as a client workstation. A pulse meter with GSM modem able to read and retrieve the value of meter used was connected to client workstation through USB port. Client workstation was connected to a database server through a WAN. Besides, it allows doing maintenance on user profile and tariff rate.

CHAPTER 4

IMPLEMENTATION

The main purpose of this chapter is to document all the process that involved in developing the system. Generally, this chapter explained project development that has been designed for SOEBIMS.

4.1 Introduction

This section describes the whole processes in the project development and the implementation of SOEBIMS. This chapter includes detailed design on architecture of the system development such as database structure and the tables' design which used SQL command to insert data into the database, and tools for SOEBIMS.

4.2 The Functions

Below are the explanations on the coding of functions that are provided by SOEBIMS. The critical functions of the system are:

i. Customer registration function
ii. Login function
iii. Setting tariff rate function

iv. Meter reading function

v. Bill payment generating function

vi. Report generating function

vii. User profile maintenance function

4.2.1 Customer Registration Function

The customer has to register through administrator before they can access and view the data through the application. Figure 4.1 shows the registration interface for the admin. Figure 4.2 shows how to get and store the customer registered data using SQL server.

Figure 4.1 Registration Interface

```
//Customer Table
            string sqlCust = "INSERT INTO    " +
                             "CUSTOMER (CustID, [CustName], CustPwd,
CustIC, CustDOB, CustGender, CustEmail, CustPhone)   " +
                             "VALUES (@CustID, @CustName, @CustPwd,
```

```
@CustIC, @CustDOB, @CustGender, @CustEmail, @CustPhone)  ";

            SqlCommand cmd = new SqlCommand(sqlCust, con);
            cmd.Parameters.AddWithValue("@CustID", lblnum.Text);
            cmd.Parameters.AddWithValue("@CustName",
txtFullname.Text);
            cmd.Parameters.AddWithValue("@CustPwd", lblnum.Text);
            cmd.Parameters.AddWithValue("@CustIC", txtICNo.Text);
            cmd.Parameters.AddWithValue("@CustDOB", txtDOB.Text);
            cmd.Parameters.AddWithValue("@CustGender",
rblGender.SelectedValue);
            cmd.Parameters.AddWithValue("@CustEmail",
txtEmailAddress.Text);
            cmd.Parameters.AddWithValue("@CustPhone",
txtMobilePhone.Text);

            con.Open();
            cmd.ExecuteNonQuery();
            con.Close();
```

Figure 4.2 Function Code for Registration

4.2.2 Login Function

In order to perform any other functions, the customer and the admin have to login into the website with the registered user name and password. Figure 4.3 shows the login interface of SOEBIMS. Figure 4.4 shows how to login into website. Before the user login to the system, it will check the user id, password entered by user and the role of user whether is staff or customer. If everything is matched with the database, then it can successfully login to the system. Besides, if the checkbox is ticked by user, then it will remember the user id and password respectively.

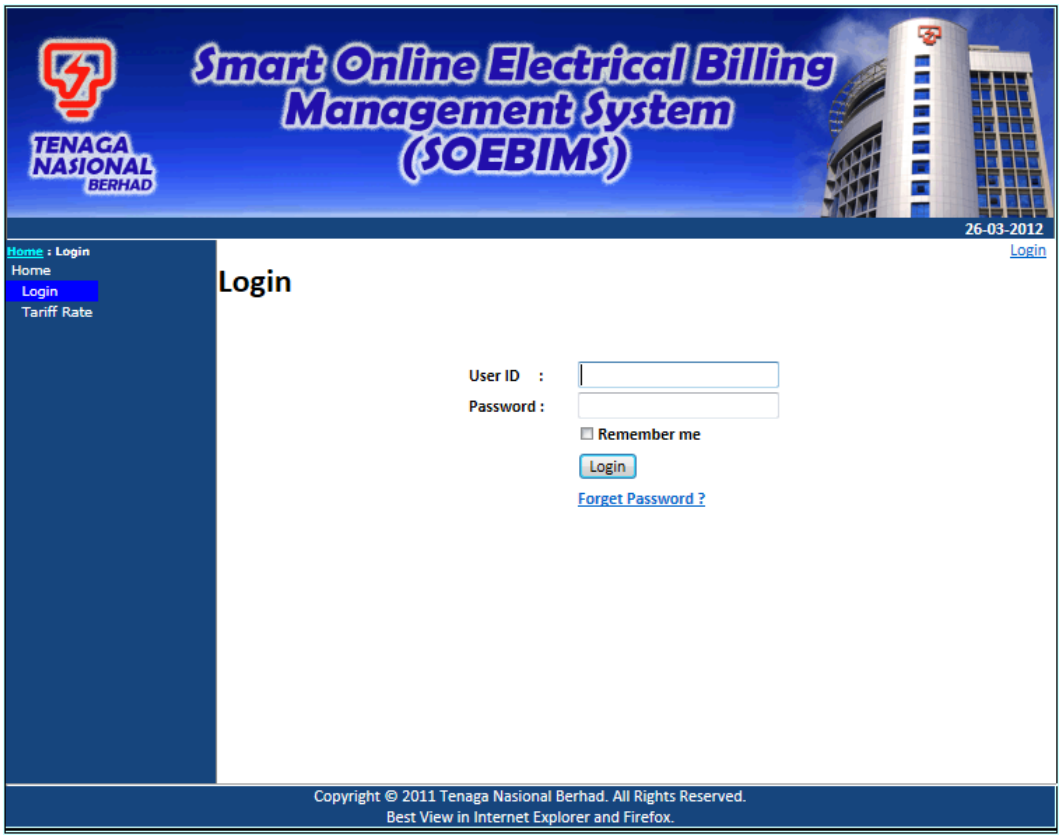


Figure 4.3 Login Interface

```
        if (Page.IsValid)
        {
            FormsAuthentication.RedirectFromLoginPage(userID,
remember);

            string sqlRoleStaff = "SELECT StaffName,StaffRole FROM
STAFF WHERE StaffID = @StaffID AND StaffPwd = @StaffPwd";

            //SqlConnection conRoleStaff = new SqlConnection(cs);
            SqlCommand cmdRoleStaff = new SqlCommand(sqlRoleStaff,
con);
            cmdRoleStaff.Parameters.AddWithValue("@StaffID",
userID);
            cmdRoleStaff.Parameters.AddWithValue("@StaffPwd",
password);

            con.Open();
            SqlDataReader drRoleStaff =
cmdRoleStaff.ExecuteReader();
            if (drRoleStaff.Read())
            {
                userName = drRoleStaff["StaffName"].ToString();

                Session["userID"] = User.Identity.Name;
                Session["userName"] = userName.ToUpper();
                Session.Timeout = 1200;

                string roleStaff =
drRoleStaff["StaffRole"].ToString();
```

```
                HttpCookie authCookie =
FormsAuthentication.GetAuthCookie(userID, remember);
                FormsAuthenticationTicket orgTicket =
FormsAuthentication.Decrypt(authCookie.Value);
                FormsAuthenticationTicket newTicket = new
FormsAuthenticationTicket(
                        orgTicket.Version,
                        orgTicket.Name,
                        orgTicket.IssueDate,
                        orgTicket.Expiration,
                        orgTicket.IsPersistent,
                        roleStaff
                    );
                authCookie.Value =
FormsAuthentication.Encrypt(newTicket);
                Response.Cookies.Add(authCookie);

                string redirectUrl =
FormsAuthentication.GetRedirectUrl(userID, remember);
                Response.Redirect(redirectUrl, true);

                drRoleStaff.Close();
                con.Close();
                //Application["StartPretest"] = true;
                //Application["StartPosttest"] = true;
            }
            else
            {
                con.Close();
                string sqlRoleCust = "SELECT CustID, CustName,
CustIC, CustGender FROM CUSTOMER WHERE CustID = @CustID AND CustPwd
= @CustPwd";

                //SqlConnection conRoleCust = new SqlConnection(cs);
                SqlCommand cmdRoleCust = new SqlCommand(sqlRoleCust,
con);
                cmdRoleCust.Parameters.AddWithValue("@CustID",
userID);
                cmdRoleCust.Parameters.AddWithValue("@CustPwd",
password);

                con.Open();
                SqlDataReader drRoleCust =
cmdRoleCust.ExecuteReader();
                if (drRoleCust.Read())
                {
                    userName = drRoleCust["CustName"].ToString();
                    userIC = drRoleCust["CustIC"].ToString();
                    userGender =
drRoleCust["CustGender"].ToString();

                    Session["userID"] = User.Identity.Name;
                    Session["userName"] = userName.ToUpper();
                    Session["userIC"] = userIC;
                    Session["userGender"] = userGender;
                    Session.Timeout = 12000;

                    string roleCust =
drRoleCust["CustID"].ToString();
```

```
                    HttpCookie authCookie =
FormsAuthentication.GetAuthCookie(userID, remember);
                    FormsAuthenticationTicket orgTicket =
FormsAuthentication.Decrypt(authCookie.Value);
                    FormsAuthenticationTicket newTicket = new
FormsAuthenticationTicket(
                            orgTicket.Version,
                            orgTicket.Name,
                            orgTicket.IssueDate,
                            orgTicket.Expiration,
                            orgTicket.IsPersistent,
                            "customer"
                        );
                    authCookie.Value =
FormsAuthentication.Encrypt(newTicket);
                    Response.Cookies.Add(authCookie);

                    string redirectUrl =
FormsAuthentication.GetRedirectUrl(userID, remember);
                    Response.Redirect(redirectUrl, true);
                    }
                    drRoleCust.Close();
                    con.Close();
                }
            }

        if (chkRememberMe.Checked == true)
        {
            HttpCookie c = new HttpCookie("UserID");
            c.Value = txtUserID.Text;
            c.Expires = DateTime.Now.AddDays(7);
            Response.Cookies.Add(c);
        }
        else
        {
            HttpCookie c = new HttpCookie("UserID");
            c.Expires = DateTime.Now.AddYears(-100);
            Response.Cookies.Add(c);
        }
```

Figure 4.4 Function Code to Login

4.2.3 Setting Tariff Rate Function

This is the function for the admin to set the tariff rate for the electricity. Figure 4.5 shows the interface of setting tariff rate. Figure 4.6 shows how to store the data to centralized database. **T** is the initial of tariff code. **001** is the number of the record. If wish to add a new data, the tariff code is automatic generate and the start time and end time with the price rate of the current market able to set it. The variable time pricing can to monitor and modify dynamically.

Figure 4.5 Tariff Rate Interface

```
    protected void insertTariff(string sqlTable, string code, string
startTime, string endTime,
                                string priceRate, string createdBy,
string createdDate, string Catid)
    {
        DateTime dtStartTime =
Convert.ToDateTime(ddlStartTime.Text);
        DateTime dtEndTime = Convert.ToDateTime(ddlEndTime.Text);
        DateTime dtNow =
Convert.ToDateTime(DateTime.Now.ToString());

        string sql = "INSERT INTO " + sqlTable +
                     " ([" + code +
                     "], [" + startTime +
                     "], [" + endTime +
                     "], [" + priceRate +
                     "], [" + createdBy +
                     "], [" + createdDate +
                     "], [" + Catid + "])" +
                     " VALUES (@" + code +
                     ",@" + startTime +
                     ",@" + endTime +
                     ",@" + priceRate +
                     ",@" + createdBy +
                     ",@" + createdDate +
                     ",@" + Catid + ")";

        SqlCommand cmd = new SqlCommand(sql, con);
        cmd.Parameters.AddWithValue("@" + code, lblnum.Text);
        cmd.Parameters.AddWithValue("@" + startTime, dtStartTime);
        cmd.Parameters.AddWithValue("@" + endTime, dtEndTime);
        cmd.Parameters.AddWithValue("@" + priceRate,
Convert.ToDouble(txtPriceRate.Text));
        cmd.Parameters.AddWithValue("@" + createdBy,
User.Identity.Name);
```

```
        cmd.Parameters.AddWithValue("@" + createdDate, dtNow);
        cmd.Parameters.AddWithValue("@" + Catid, "C001");

        con.Open();
        cmd.ExecuteNonQuery();
        con.Close();
    }

    protected void updateTariff(string sqlTable, string code, string
startTime, string endTime, string priceRate, string updatedBy,
string updatedDate, string Catid)
    {
        string sql = "UPDATE " + sqlTable +
                     " SET [" + startTime + "] = @" + startTime +
                        ", [" + endTime + "] = @" + endTime +
                        ", [" + priceRate + "] = @" + priceRate +
                        ", [" + updatedBy + "] = @" + updatedBy +
                        ", [" + updatedDate + "] = @" + updatedDate
+
                        ", [" + Catid + "] = @" + Catid +
                     " WHERE [" + code + "] = @" + code;

        SqlCommand cmd = new SqlCommand(sql, con);
        cmd.Parameters.AddWithValue("@" + startTime,
Convert.ToDateTime(ddlStartTime.Text));
        cmd.Parameters.AddWithValue("@" + endTime,
Convert.ToDateTime(ddlEndTime.Text));
        cmd.Parameters.AddWithValue("@" + priceRate,
Convert.ToDouble(txtPriceRate.Text));
        cmd.Parameters.AddWithValue("@" + updatedBy,
User.Identity.Name);
        cmd.Parameters.AddWithValue("@" + updatedDate,
Convert.ToDateTime(DateTime.Now.ToString()));
        cmd.Parameters.AddWithValue("@" + Catid, "C001");
        cmd.Parameters.AddWithValue("@" + code, lblnum.Text);

        con.Open();
        cmd.ExecuteNonQuery();
        con.Close();
    }
}
```

Figure 4.6 Function Code to Store Data

4.2.4 Meter Reading Function

This is the function to get the meter reading for the electricity. Figure 4.7 shows the interface of meter reading. Figure 4.8 shows how to retrieve the data from centralized database. It can select the date which customer wish to view the power consumed for the specific day. The **Power Consumed (kWh)** is the power consumed per hour. For the **Total of Power Consumed (kWh)** is added up from column to column until the end, which is the last column is the total of power consumed per day.

Figure 4.7 Meter Reading Interface

```
            string sql = @"SELECT CU.CustName, C.CatName
                                                    FROM CUSTOMER AS CU,
CATEGORY AS C, METER_READING AS MR,
                                                                PREMISE
AS P
                                                    WHERE P.PreID =
MR.PreID AND P.CatID = C.CatID
                                                                AND
CU.CustName LIKE '%' + @CustName + '%'";

            SqlCommand cmd = new SqlCommand(sql, con);
            cmd.Parameters.AddWithValue("", txtCust.Text);

            con.Open();
            SqlDataReader drUser = cmd.ExecuteReader();

            if (drUser.Read())
            {
                lblName.Text = drUser["CustName"].ToString();

            }
            drUser.Close();
```

```
            con.Close();
```

Figure 4.8 Function Code to Retrieve Data

4.2.5 Bill Payment History Function

This is the function to generate the bill payment history. Figure 4.9 shows the interface of bill payment history. Figure 4.10 shows how to retrieve the data from centralized database and generate the history of bill payment. In order to check the monthly payment history by selecting the year then it will show the amount paid and the date paid the electrical bill for every month. So, it able to notice the user whether the bill has been paid and also able to notice the power consumed and total amount of bill payment per month.

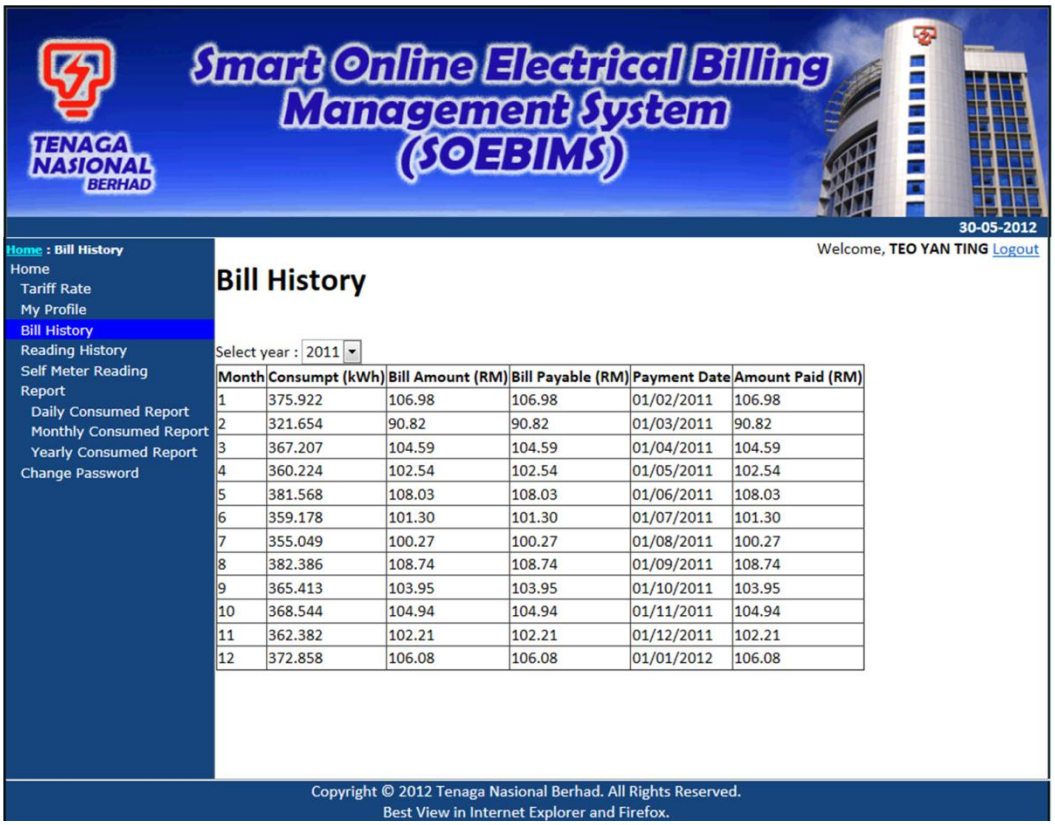


Figure 4.9 Bill Payment History Interface

```
con.Open();

// 1. create a command object identifying  the stored procedure
SqlCommand cmd = new SqlCommand("getBillAmount", con);

// 2. set the command object so it knows execute a stored procedure
```

```
cmd.CommandType = CommandType.StoredProcedure;

// 3. add parameter to command, which will be passed to the stored
procedure
cmd.Parameters.Add(
     new SqlParameter("@P1", yr));
cmd.Parameters.Add(
     new SqlParameter("@P2", month));

rdr = cmd.ExecuteReader();
// iterate through results, printing each to console
double amt = 0.0;

while (rdr.Read())
{
    ListBox1.Items.Add(rdr["BillAmt"].ToString());
    amt += double.Parse(rdr["BillAmt"].ToString());
}
return amt;
```

Figure 4.10 Function Code to Retrieve Data

4.2.6 Report Generating Function

This is the function to generate the report for the SOEBIMS to keep track of electrical usage. Figure 4.11 shows the report interface. Figure 4.12 shows how to generate report. The type of reports have been shown in the report based on the list provided, below is one of the example which is based on the year, month and day selected to display the pattern of the power consumed. The x-axis is based on the type of report generated, where the y-axis is the power consumed of user's houses.

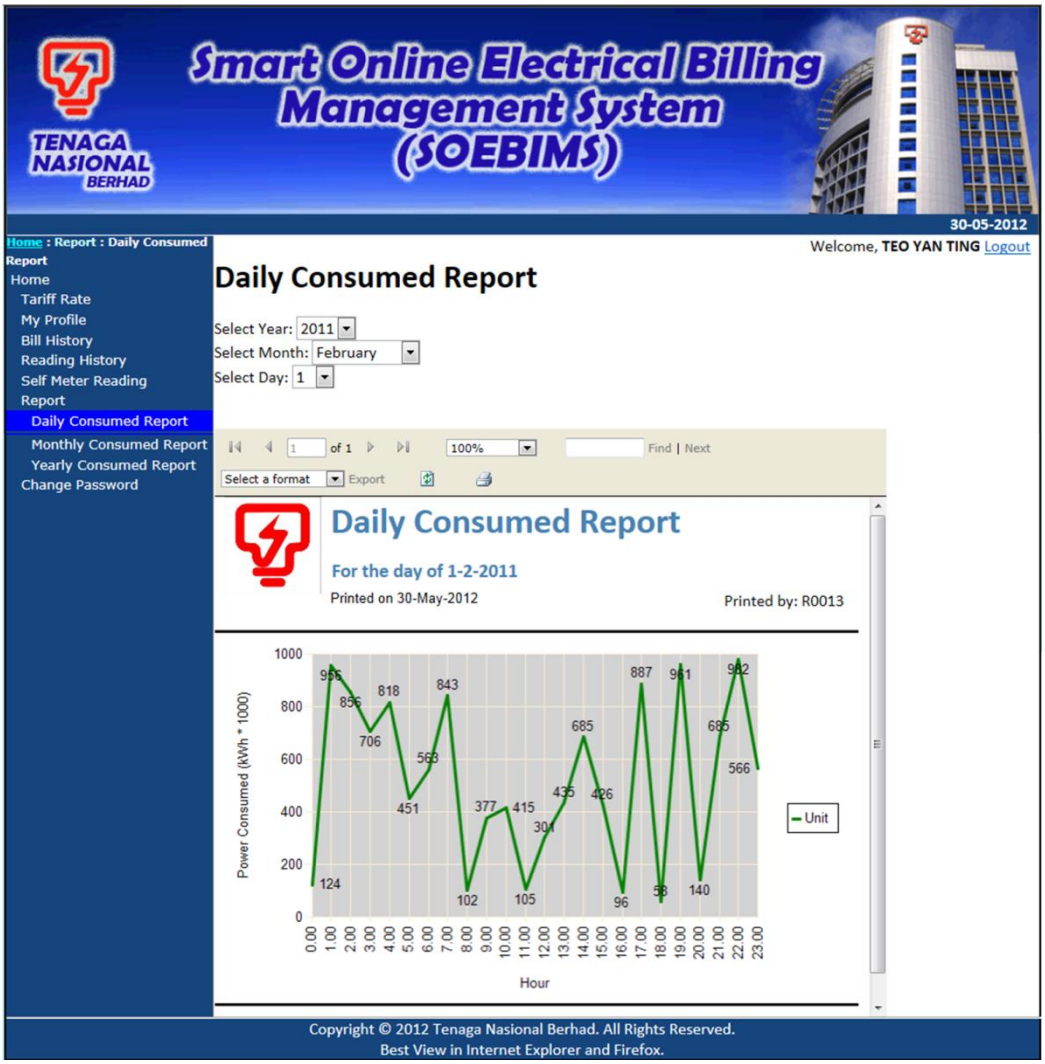


Figure 4.11 Report Interface

```
        // Read input
          string day = ddlDay.SelectedValue;
          string month = ddlMonth.SelectedValue;
          string year = ddlYear.SelectedValue;
          string printedBy = User.Identity.Name;

          SqlCommand cmd = new SqlCommand("getDailyPwrConsumedReport",
con);

          cmd.CommandType = CommandType.StoredProcedure;

          cmd.Parameters.Add(
              new SqlParameter("@P1", year));
          cmd.Parameters.Add(
              new SqlParameter("@P2", month));
          cmd.Parameters.Add(
              new SqlParameter("@P3", month));

          DataTable dt = new DataTable();

          // Read record
          con.Open();
```

```
        dt.Load(cmd.ExecuteReader());
        con.Close();

        // Prepare report data source
        ReportDataSource rds = new ReportDataSource();
        rds.Name = "dsCustReport_dtDailyPwrConsumed";
        rds.Value = dt;

        // Prepare report parameters
        ReportParameter[] parameters = {
            new ReportParameter("Day", day),
            new ReportParameter("Month", month),
            new ReportParameter("Year", year),
            new ReportParameter("PrintedBy", printedBy)
        };

        // Display report
        ReportViewer1.Reset();
        ReportViewer1.LocalReport.ReportPath =
"report/DailyConsumedReport.rdlc";
        ReportViewer1.LocalReport.SetParameters(parameters);
        ReportViewer1.LocalReport.DataSources.Add(rds);
```

Figure 4.12 Function Code for Report

4.2.7 User Profile Maintenance Function

This is the function to maintain the user profile. Figure 4.9 shows the interface of user profile. Figure 4.10 shows how to store and retrieve the user data at centralized database. So, it able to keep up-to-date of the user profile.

Figure 4.13 User Profile Interface

```
        // Get the DataKey value associated with current Item Index.
        string custID =
Convert.ToString(DataList1.DataKeys[e.Item.ItemIndex]);

        // Get updated value entered by user in textbox control for
those fields.
        TextBox custName = (TextBox)e.Item.FindControl("txtName");
        TextBox custPwd = (TextBox)e.Item.FindControl("txtPwd");
        TextBox custIC = (TextBox)e.Item.FindControl("txtICNo");
        TextBox custDOB = (TextBox)e.Item.FindControl("txtDOB");
        DropDownList custGender =
(DropDownList)e.Item.FindControl("ddlGender");
        TextBox custEmail = (TextBox)e.Item.FindControl("txtEmail");
        TextBox custPhone =
(TextBox)e.Item.FindControl("txtPhoneNo");
        //Label custID = (Label)e.Item.FindControl("lblCustID");

        // string variable to store the connection string
        // retrieved from the connectionStrings section of web.config
        string connectionString =
ConfigurationManager.ConnectionStrings["soebimsCS"].ConnectionString;

        // sql connection object
        SqlConnection mySqlConnection = new
SqlConnection(connectionString);

        // sql command object initialized with update command text
        SqlCommand mySqlCommand = new SqlCommand("UPDATE [CUSTOMER] "
```

```
+
                                                    "SET [CustName] =
@CustName, [CustPwd] = @CustPwd, [CustIC] = @CustIC, [CustDOB] =
@CustDOB, " +
                                                        "[CustGender] =
@CustGender, [CustEmail] = @CustEmail, [CustPhone] = @CustPhone " +
                                                    "WHERE [CustID] =
@CustID", mySqlConnection);

        mySqlCommand.Parameters.Add("@CustName",
SqlDbType.VarChar).Value = custName.Text;
        mySqlCommand.Parameters.Add("@CustPwd",
SqlDbType.VarChar).Value = custPwd.Text;
        mySqlCommand.Parameters.Add("@CustIC",
SqlDbType.VarChar).Value = custIC.Text;
        mySqlCommand.Parameters.Add("@CustDOB", SqlDbType.Date).Value
= custDOB.Text;
        mySqlCommand.Parameters.Add("@CustGender",
SqlDbType.VarChar).Value = custGender.Text;
        mySqlCommand.Parameters.Add("@CustEmail",
SqlDbType.VarChar).Value = custEmail.Text;
        mySqlCommand.Parameters.Add("@CustPhone",
SqlDbType.VarChar).Value = custPhone.Text;
        mySqlCommand.Parameters.Add("@CustID",
SqlDbType.VarChar).Value = custID;

        // check the connection state and open it accordingly.
        if (mySqlConnection.State == ConnectionState.Closed)
            mySqlConnection.Open();

        // execute sql update query
        mySqlCommand.ExecuteNonQuery();

        // check the connection state and close it accordingly.
        if (mySqlConnection.State == ConnectionState.Open)
            mySqlConnection.Close();

        // Revert the DataList back to its pre-editing state
        DataList1.EditItemIndex = -1;
        DataList1.DataBind();
```

Figure 4.14 Function Code to Maintain Data

CHAPTER 5

RESULTS AND DISCUSSION

This chapter briefly discusses about the expected results in the performance and accuracy of Smart Online Electrical Billing Management System using GSM (SOEBIMS). The discussion consists of the effect and benefits of SOEBIMS.

5.1. Results

The developed application (SOEBIMS) has met all the objectives of this project, which are:

i. To develop an online system to manage electrical billing for the administrator and customer.
ii. To collect the power consumption information and integrate with centralized database system via GSM device.
iii. To calculate the electrical bill and generate a report on the power consumption information through online.

5.1.1. Justify the first objective

SOEBIMS has been successfully developed where it enables to manage electrical billing through online. Besides, it is based on the role to access and manage the information respectively after login, which is either admin, staff or customer.

5.1.2. Justify the second objective

The power consumption information is based on the customer's consume units at their home respectively. The meter operates and sends the data of consumption values to centralize database hourly via GSM device. Besides, it allows customer to view the consumption units with price through online application.

5.1.3. Justify the third objective

After SOEBIMS collects the power consumption information via GSM device to centralize database, it calculates the electrical bill automatically through online application. Besides, the report generates automatically that allows customer to enter the specific date to view the report through online.

5.2. System Constraints

SOEBIMS requires .NET framework to be installed on a computer before it can be executed. Source code for SOEBIMS has been written to call the functions from DLL libraries in order to retrieve data from GSM device. Thus, it cannot be guaranteed that data can be retrieved from GSM device if other types of GSM devices are being used.

Every client workstation must be equipped a GSM device with meter before SOEBIMS can be used. SOEBIMS of power consumption is based on the GSM device with meter only can read the meter value and send it to centralize database then only can perform calculation of power consumption hourly.

SOEBIMS can only generate three types of report, which are hourly, daily and monthly report. User is unable to redefine the layout of the report and thus need to follow the existing template used.

5.3. Further Research

There are a few enhancements that can be carried out for future improvement of SOEBIMS.

i. Implementing the online application that looks more attractive and dynamically. This allows user to use it in more satisfaction in using the online system.
ii. Implementing other devices like the device able to use wireless that allow user to save cost in sending and retrieving value.
iii. Develop in more secure in order to prevent those attacker or hacker to attack through the system.
iv. Design more different types of report that needed or requested by those users, which are administrator, staffs and customers.
v. Implementing distributed computer systems to analyse the data that retrieve from each house based on the specific headquarter respectively. This able to analyse the data in more effectively and efficiency.
vi. Implementing hardware that able to integrate and suit to every meter device even in foreign country.

CHAPTER 6

CONCLUSION

Smart Online Electrical Billing Management System (SOEBIMS) is an online billing system which is developed for the purpose to reduce human errors and save time for finding the customer's particular details. SOEBIMS achieves the objective of this project as documented in Chapter 4 at Section 4.1. Besides, it allows customers allow receiving or viewing the personal information, meter value with price rate through online application. The report generates based on the customer selection of date and time.

SOEBIMS is an online web application. The staffs need to setup and configure the GSM device in order to use retrieve the real time meter value. The centralized server keeps the database. It allows database to be accessed by more than one client at a time, while data integrity is maintained and data redundancy is avoided. The web application is chosen to access the data easily from anywhere at any time and it is very convenience for everyone.

SOEBIMS is developed using Microsoft Visual C# .NET for interface design and programming as it provides a visual development environment for building application rapidly. Microsoft SQL Server 2008 is used as database management system placed on database server as it provides rich features in manipulating, securing and managing data.

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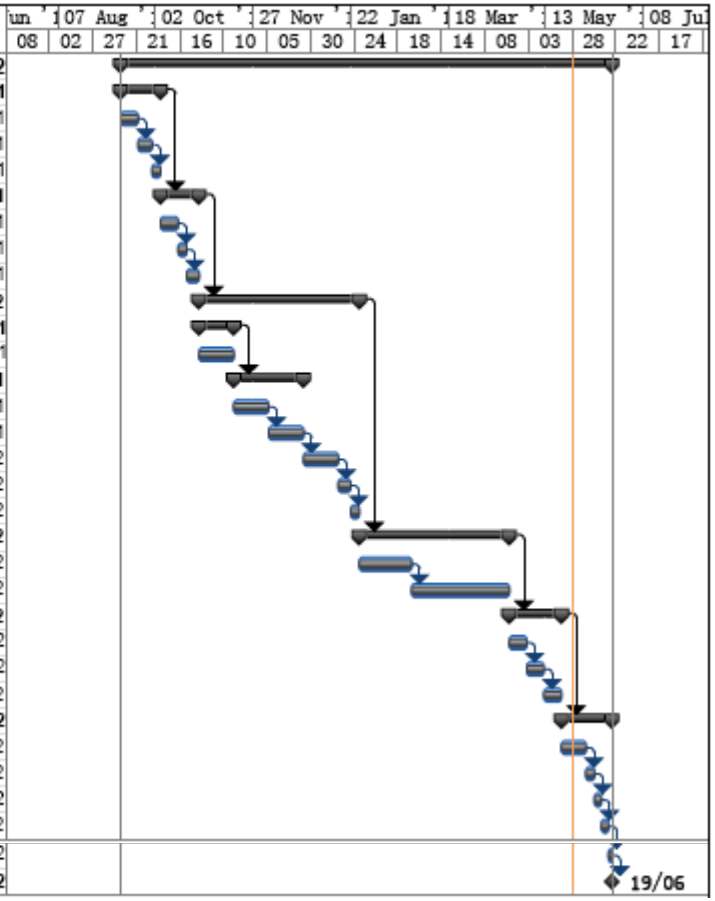
APPENDIX A

Project Gantt Chart

ID	Task Name	Duration	Start	Finish
1	**SOEBIMS**	**282 days**	**Mon 12/09/11**	**Tue 19/06/12**
2	**Define the project**	**23 days**	**Mon 12/09/11**	**Tue 04/10/11**
3	Plan the project	10 days	Mon 12/09/11	Wed 21/09/11
4	Research on the project title	8 days	Thu 22/09/11	Thu 29/09/11
5	Propose the project title	5 days	Fri 30/09/11	Tue 04/10/11
6	**System analysis**	**22 days**	**Wed 05/10/11**	**Wed 26/10/11**
7	Research for the project	10 days	Wed 05/10/11	Fri 14/10/11
8	Interview with the users	5 days	Sat 15/10/11	Wed 19/10/11
9	Arrangement on the information gathered	7 days	Thu 20/10/11	Wed 26/10/11
10	**System design**	**92 days**	**Thu 27/10/11**	**Thu 26/01/12**
11	**System interface design**	**20 days**	**Thu 27/10/11**	**Tue 15/11/11**
12	Design the system interface	20 days	Thu 27/10/11	Tue 15/11/11
13	**Database design**	**40 days**	**Wed 16/11/11**	**Sun 25/12/11**
14	Define the data needed	20 days	Wed 16/11/11	Mon 05/12/11
15	Design E-R Diagram and Database Schema	20 days	Tue 06/12/11	Sun 25/12/11
16	GUI Design	20 days	Mon 26/12/11	Sat 14/01/12
17	Prepare proposal	7 days	Sun 15/01/12	Sat 21/01/12
18	Submit proposal	5 days	Sun 22/01/12	Thu 26/01/12
19	**System development**	**86 days**	**Fri 27/01/12**	**Sat 21/04/12**
20	Database	30 days	Fri 27/01/12	Sat 25/02/12
21	Interface / coding	56 days	Sun 26/02/12	Sat 21/04/12
22	**System testing**	**30 days**	**Sun 22/04/12**	**Mon 21/05/12**
23	Unit testing	10 days	Sun 22/04/12	Tue 01/05/12
24	Integrate testing	10 days	Wed 02/05/12	Fri 11/05/12
25	System testing	10 days	Sat 12/05/12	Mon 21/05/12
26	**Finalize the Project**	**29 days**	**Tue 22/05/12**	**Tue 19/06/12**
27	Prepare report and user manual	14 days	Tue 22/05/12	Mon 04/06/12
28	Press Release	5 days	Tue 05/06/12	Sat 09/06/12
29	Submit project and related documents	4 days	Sun 10/06/12	Wed 13/06/12
30	Prepare slides	4 days	Thu 14/06/12	Sun 17/06/12
31	Presentation	2 days	Mon 18/06/12	Tue 19/06/12
32	**Complete SOEBIMS**	**0 days**	**Tue 19/06/12**	**Tue 19/06/12**



APPENDIX B

Interview Transcript

Interview Transcript

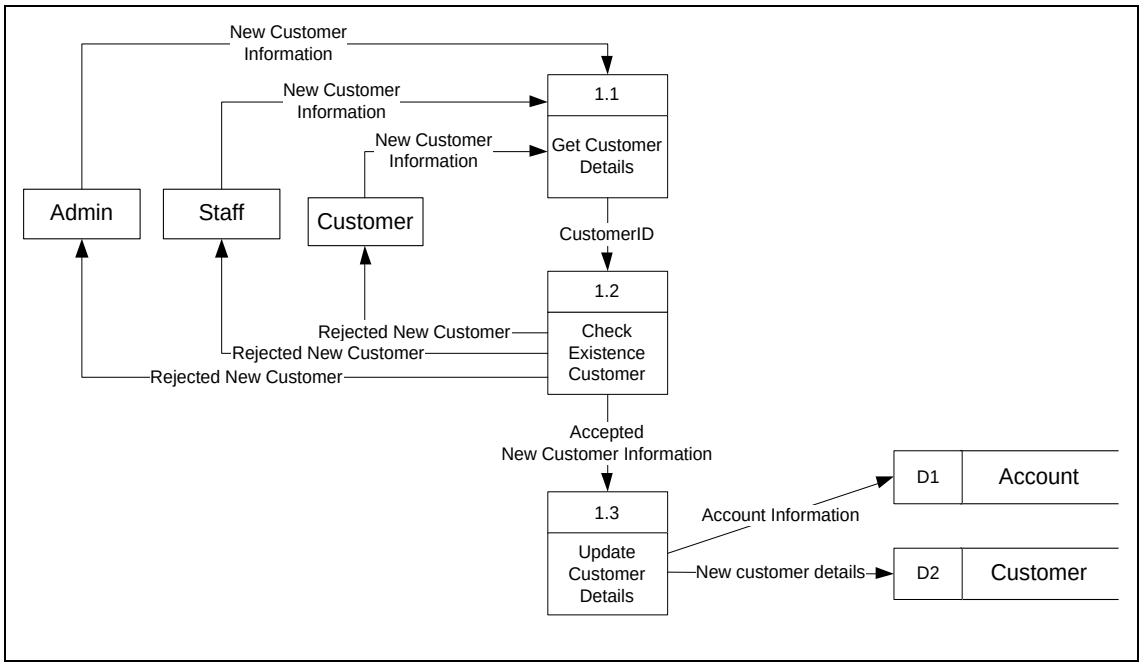
Questions:

1) What type of electrical billing system do you prefer?
2) Why do you prefer that type of electrical billing system?
3) What function do you wish to have in electrical billing system?
4) Who are the users of electrical billing system?
5) What kind of information do you need in electrical billing system?
6) What do you perceive as problems of the current Billing system?
7) Briefly outline the solutions you would suggest for the above Billing problems.
8) How often do you produce the above reports? (daily, weekly, monthly, annually)
9) What reports do you produce in line with the role in (8) above?
10) Do you have any suggestions about the billing system?
11) What is your company's current system?
12) When is your company's office hour?
13) What are the methods used for cost operation and the billing system?
14) Which system do your company prefer? (current or new)
15) Can it reduce the cost? (related with question 1)

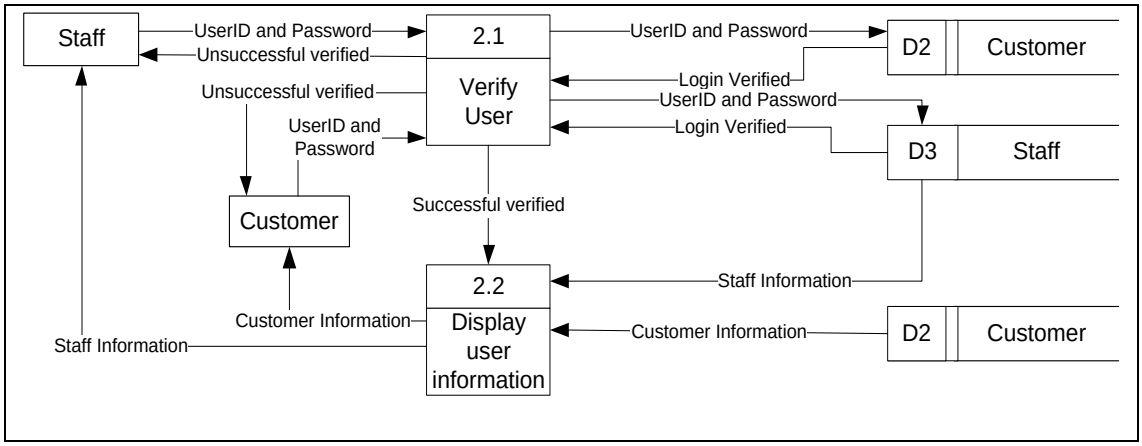
APPENDIX C

SOEBIMS Data Flow Diagram (DFD) Level-1

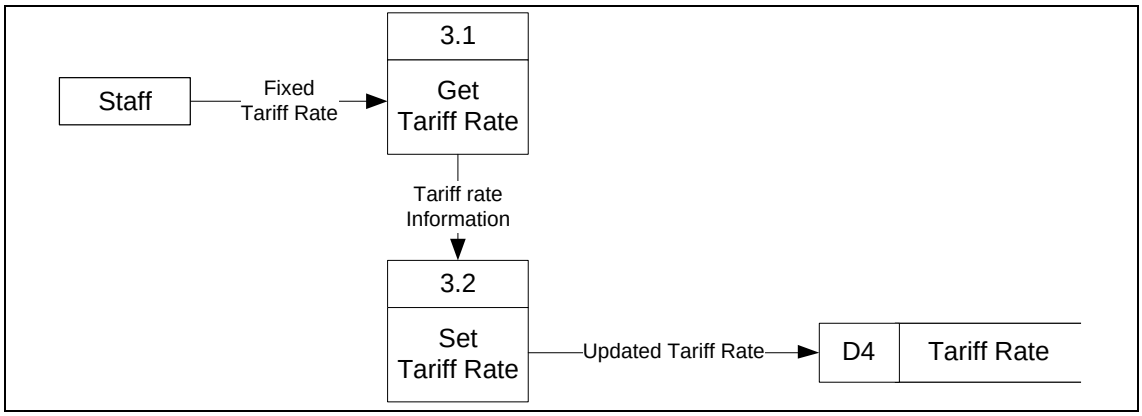
Data Flow Diagram (DFD) Level-1 for SOEBIMS



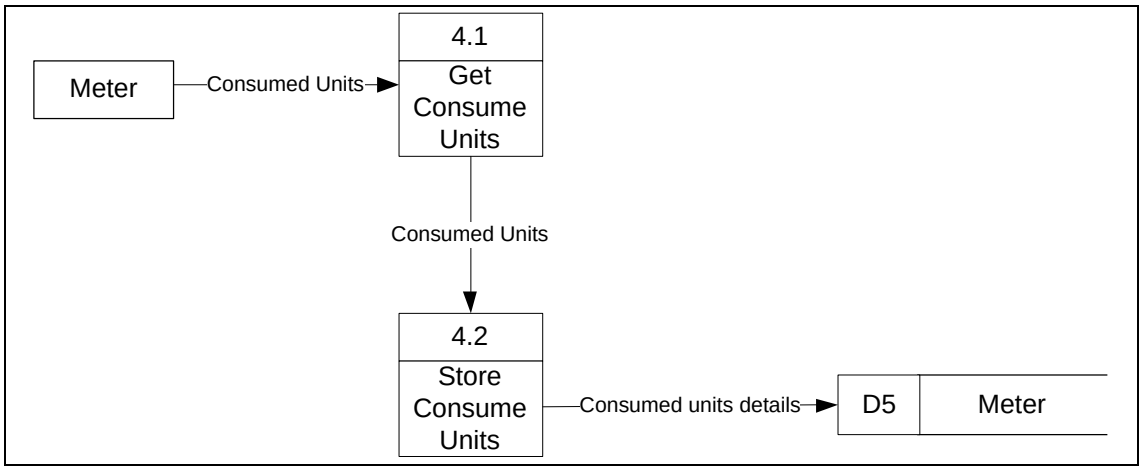
Process 1.0: Register Customer



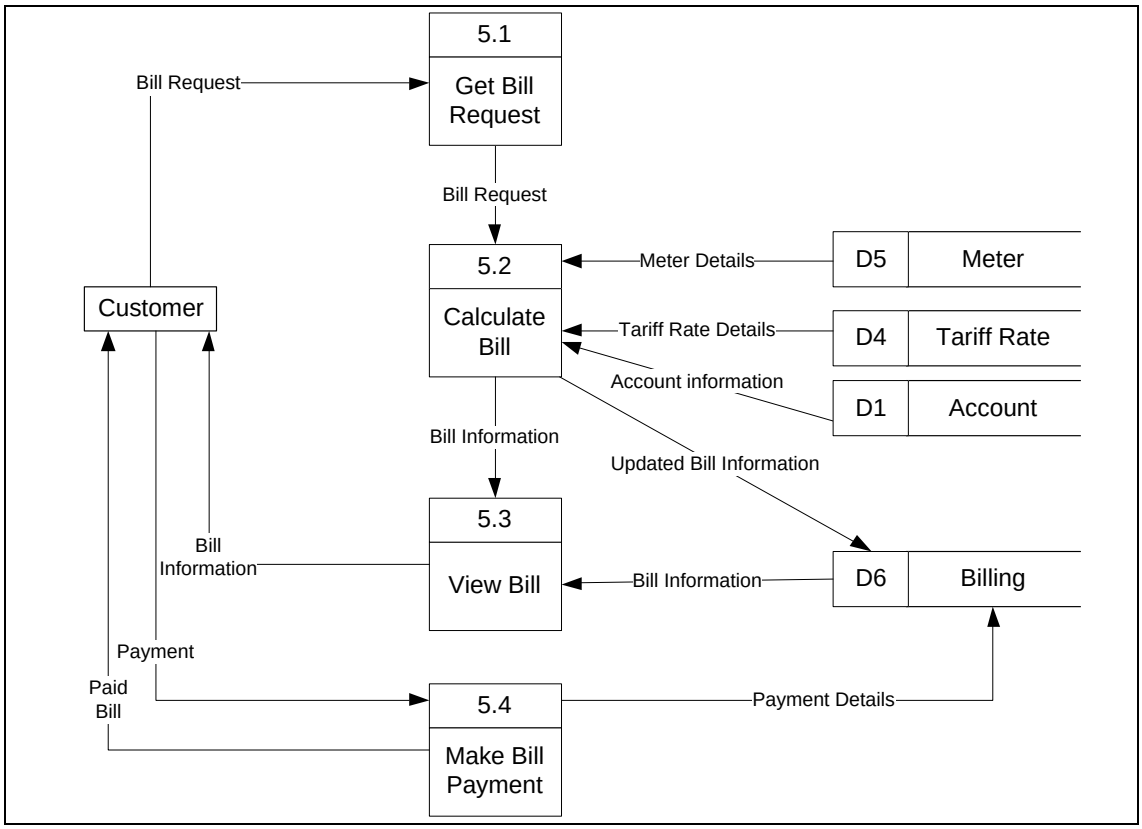
Process 2.0: Validate Login



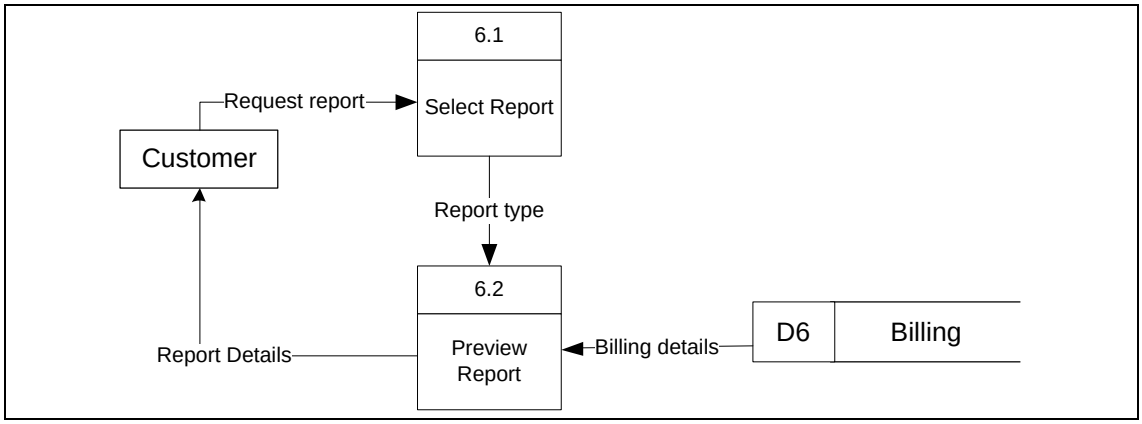
Process 3.0: Set Tariff Rate



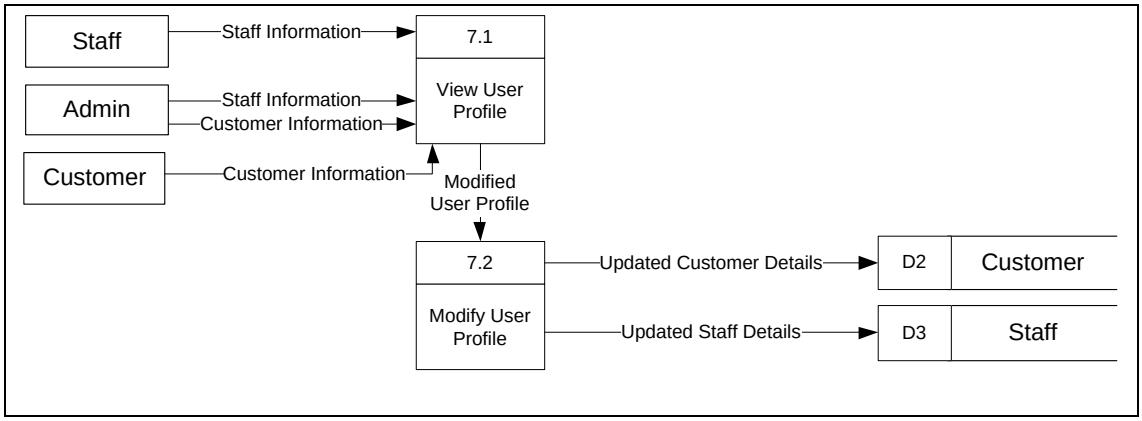
Process 4.0: Read Meter



Process 5.0: Generate Bill Payment



Process 6.0: Generate Report



Process 7.0: Maintain User Profile

APPENDIX D

Recommendation Letter

Profesor Madya Dr. Ahmed N. Abd. Alla
Fakulti Kejuruteraan Elektrikal & Electronik,
Universiti Malaysia Pahang,
25500 Kuantan, Pahang

Kepada:
Dekan,
Fakulti Sains Komputer & Kejuruteraan Perisian,
Universiti Malaysia Pahang,
25500 Kuantan, Pahang

25 March 2012

Prof,

PERAKUAN PROJEK TAHUN AKHIR KEJURUTERAAN PERISIAN
PELAJAR WONG YING YIN

Adalah dengan hormatnya merujuk kepada perkara di atas. Berdasarkan kepada hasil kerja pelajar berkenaan, saya berpuas hati dengan prestasi pelajar ini menghasilkan perisian electrical billing system yang pertama di Malaysia.

Berikut adalah maklumat lanjut projek pelajar berkenaan:

Nama : Wong Ying Yin
IC : 901101-02-5468
ID : CA10107
Fakulti : Fakulti Sistem Komputer & Kejuruteraan Perisian (FSKKP)
Tajuk PSM : Smart Online Electrical Billing Management System using GSM
Supervisor : Profesor Madya Dr. Noraziah Binti Ahmad

Saya yakin, insya Allah perisian ini jika terus diperbaiki, ia akan mempunyai nilai pasaran yang tinggi dan boleh digunakan oleh masyarakat. Saya berharap agar pelajar berkenaan boleh bersama-sama kumpulan penyelidik electrical billing untuk meneruskan projek penyelidikan yang dilaksanakan.

Sekian, terima kasih.

Yang benar,

Ahmed

Profesor Madya Dr. Ahmed N. Abd. Alla,
Lecturer
Fakulti Kejuruteraan Elektrikal & Electronik,

s.k pelajar: Wong Ying Yin

APPENDIX E

SOEBIMS User Manual

TABLE OF CONTENT

1.0 Introduction

This user manual is only for Smart Online Electrical Billing Management System Using GSM (SOEBIMS). It highlights all features of SOEBIMS with brief instructions, with the purpose is to guide users on how to setup and operate SOEBIMS.

SOEBIMS is an online system that keeps track of customer's power consumption by using GSM. This system will be used by the admin, staff and customer to manage the electrical billing system. There are seven main functions in this system, which are:

i. Login function
ii. Customer registration function
iii. Setting tariff rate function
iv. Meter reading function
v. Bill payment history function
vi. Report generating function
vii. User profile maintenance function

2.0 Hardware & Software Requirements

This part of the user manual aims to guide user on the hardware and software requirements to setup SOEBIMS.

2.1 Hardware Requirements

Hardware requirements refer to the computer specification of the client- and server-side of SOEBIMS. The workstations should comprise of a desktop computer or a notebook, which meets the following specifications:

(i) At least Pentium 800 Mhz (or equivalent)
(ii) At least 192 MB RAM
(iii) A minimum of 2 GB of available disk space
(iv) Network Card
(v) USB port
(vi) CD-ROM drive
(vii) GSM

The specification given is a guideline in order for the application to run smoothly.

2.2 Software Requirements

User software requirement refers to the software needed to access SOEBIMS and to run it smoothly. For client-side workstation, the software required is Microsoft Windows Vista Professional as operating system and Microsoft .NET framework version 3.5. For server-side, the software required is Microsoft Windows Vista Professional, Microsoft .NET framework version 3.5, and Microsoft SQL Server 2008 for database management.

3.0 Setup

This part of the user manual aims to guide user on how to setup GSM device on the server-side workstation.

3.1 GSM Device

The following shows the picture of GSM Device.

Figure 3.1: GSM Device

3.2 Setup GSM Connector

The following shows the steps to setup RS232 GSM Connector.

1. Install the RS232 driver on the server-side workstation by inserting the driver installation CD that comes together with RS232 Connector.
   Note: Please ensure the RS232 GSM Connector is not connected to the workstation during the driver installation process.

2. When installation completed, click <Finish> button to close the installation process and restart the computer.

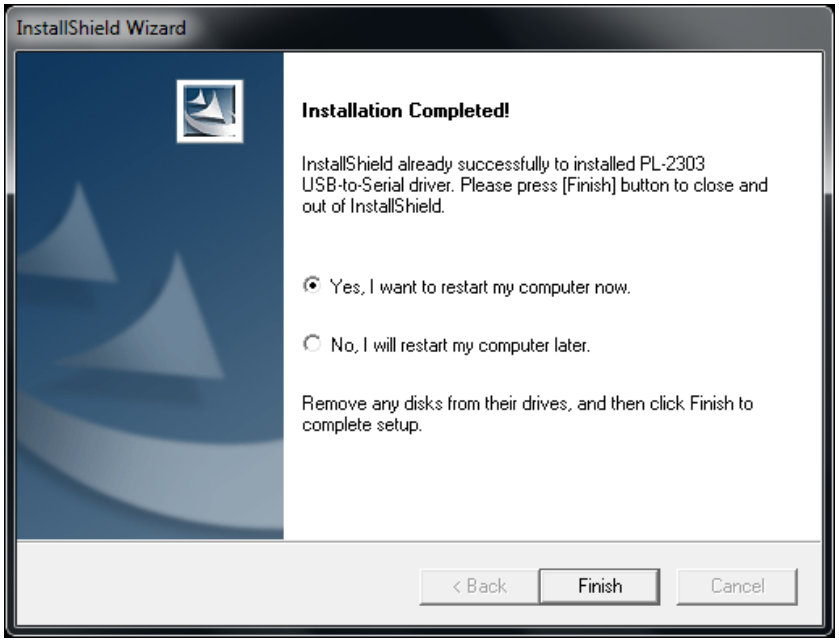


Figure 3.2: Message box after installation

3. Connect the RS232 to a spare USB port on your PC. The Microsoft composite device driver is automatically loaded silently in the background.

4. Check installed device on Start-Control Panel-System-Hardware-Device Driver. Select “View>Device by connection”, the device appears as a “USB Serial Converters” with an additional COM port with the label “USB Serial Port” as shown in Figure 3.2 if device has been successfully installed.

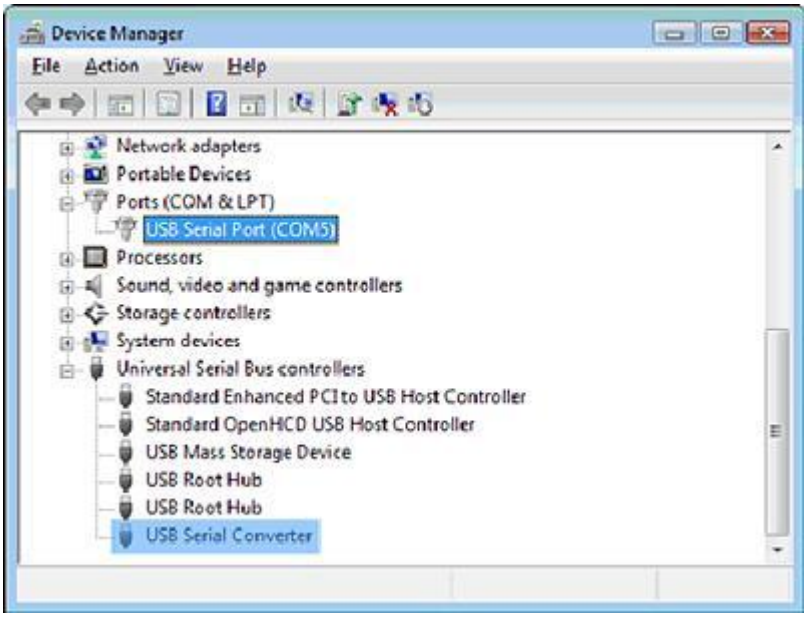


Figure 3.3: Device Manager

5. If the device driver is installed properly, the red LED on the device will be lighted at power-on.

4.0 Functions

This is the main section to show how to use the functions for SOEBIMS website. Figure 4.1 shows the main page of SOEBIMS web site.

Figure 4.1: Main Page of SOEBIMS Website

4.1 Login Function

This is one of the main functions for SOEBIMS because it will restrict the user to it access controls and control the security. All the user of SOEBIMS must login to the website in order to use the functions on the website. To login, the user has to provide the registered user ID and password and click Login button. Figure 4.2 shows the login page of SOEBIMS.

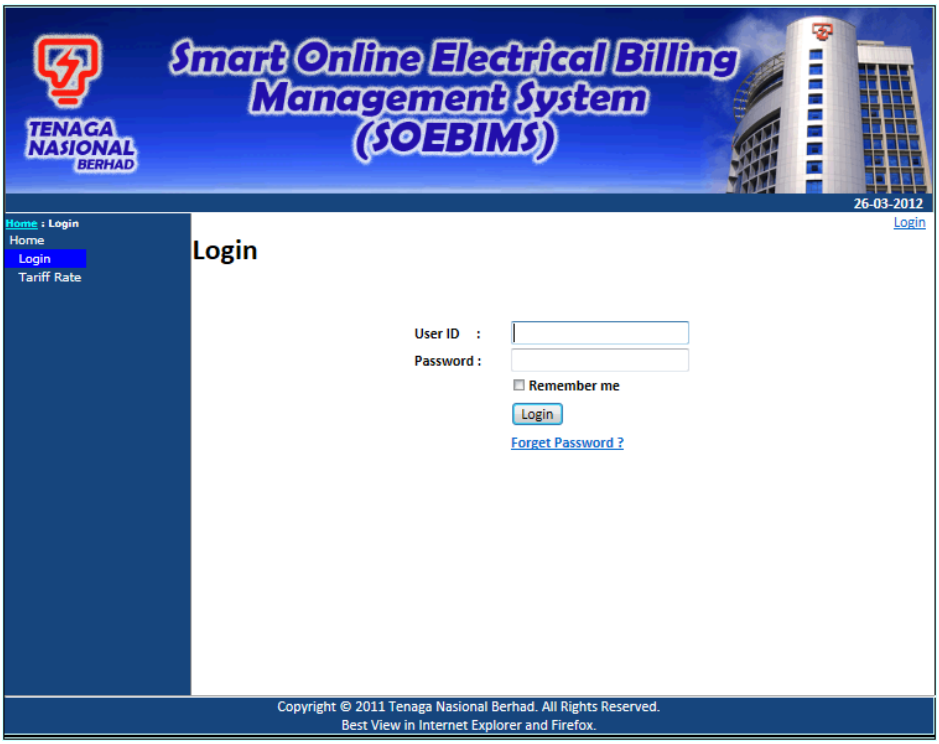


Figure 4.2: Login Page

4.2 Customer Registration Function

After login, follow the steps below to register new customer.

1. Click on the Register Menu at the main page as shown in Figure 4.3.

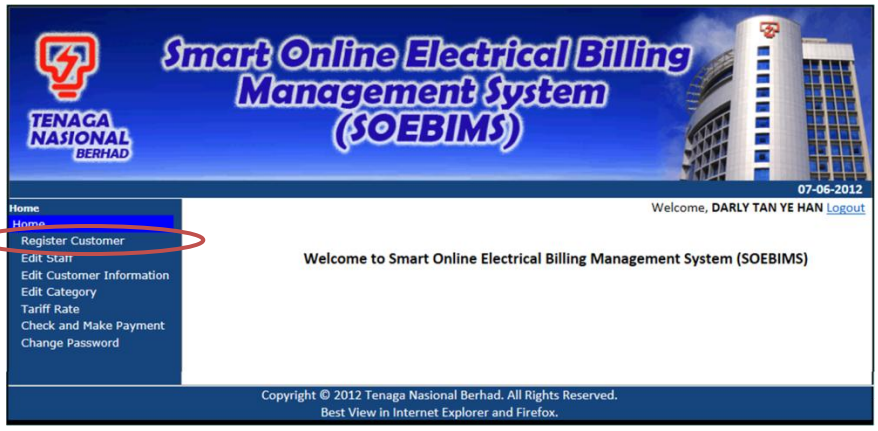


Figure 4.3: Main Page

2. Then, the registration interface is shown as Figure 4.4.

Figure 4.4: Registration Page

3. Fill in the required details.

4. Click “Register” button after finish.

4.3 Setting Tariff Rate Function

After login, follow the steps below to set the tariff rate.

1. Click on the Tariff Rate Menu at the main page as shown in Figure 4.5.

Figure 4.5: Main Page

2. Then, the tariff rate interface is shown as Figure 4.6.

Figure 4.6: Tariff Page

3. Click “Edit” button or “Add” button. Then, fill in the required details.

4. Click “Save” button after finish.

4.4 Meter Reading Function

After login, follow the steps below to get meter reading.

1. Click on the Self Meter Reading Menu at the main page as shown in Figure 4.7.

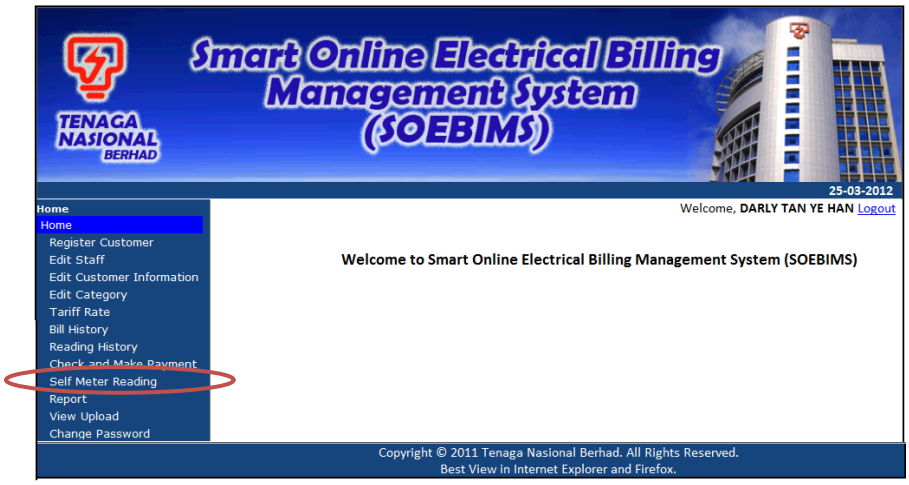


Figure 4.7: Main Page

2. Then, the meter reading interface is shown as Figure 4.8.

Figure 4.8: Meter Reading Page

4.5 Bill Payment History Function

After login, follow the steps below to generate the bill history.

1. Click on the Bill History Menu at the main page as shown in Figure 4.9.

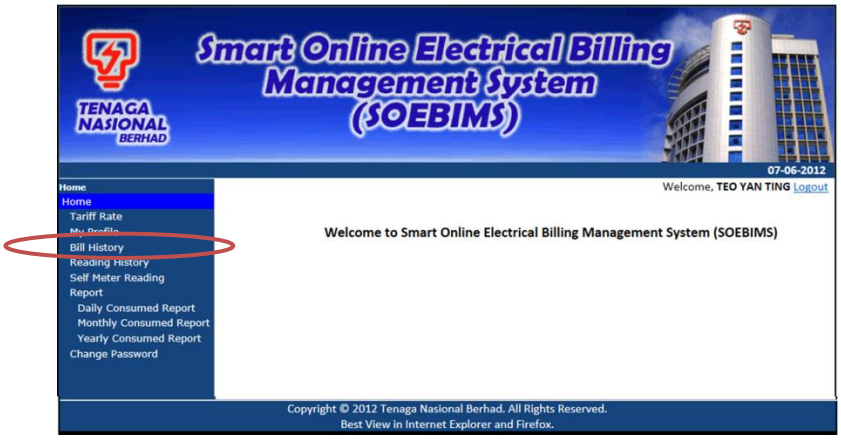


Figure 4.9: Main Page

2. Then, the list of bill payment history interface is shown as Figure 4.10.

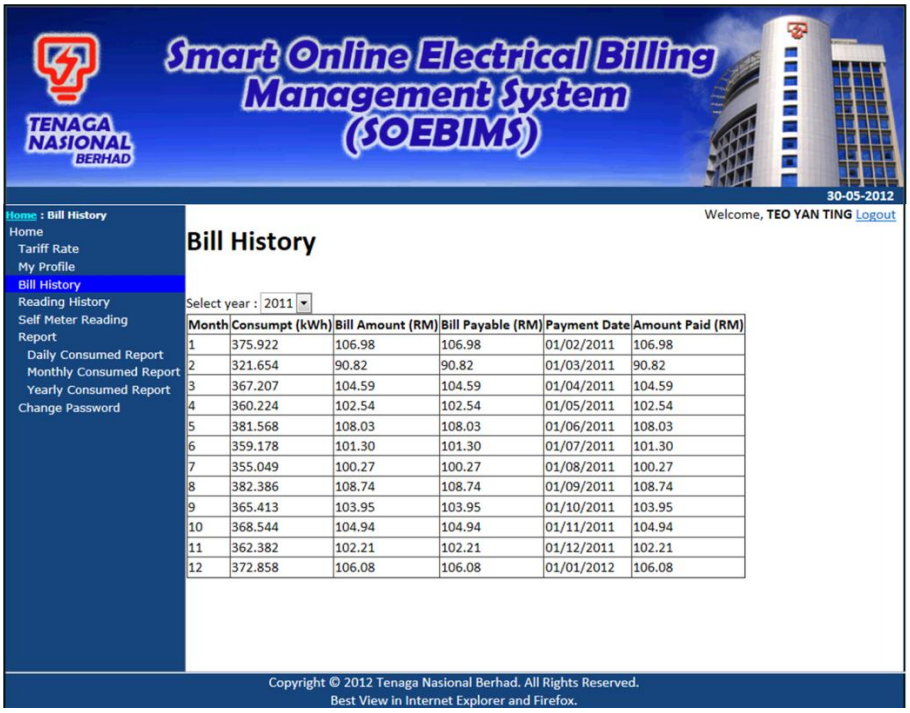


Figure 4.10: List of Bill History Page

4.6 Report Generating Function

After login, follow the steps below to generate report.

1. Click on the Report Menu at the main page as shown in Figure 4.11.

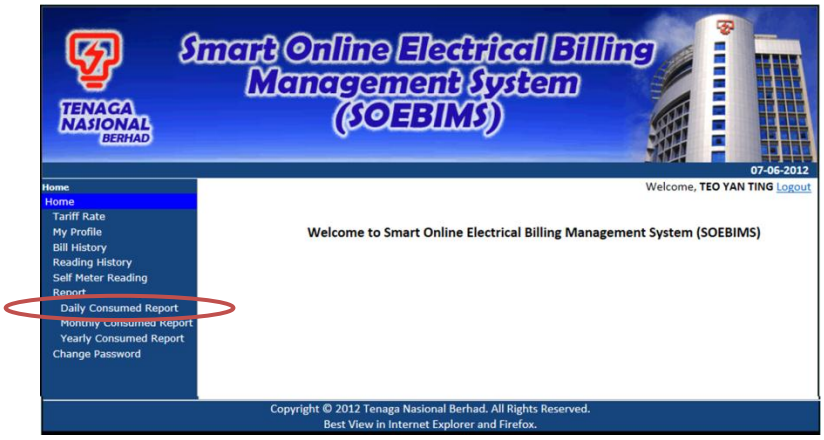


Figure 4.11: Main Page

2. Then, the report interface is shown as Figure 4.12. Provide necessary details by selecting the year, month and day at the dropdown list.

Figure 4.12: Report Page

4.7 User Profile Maintenance Function

After login, follow the steps below to edit customer profile.

1. Click on the Edit Customer Information Menu at the main page as shown in Figure 4.14.

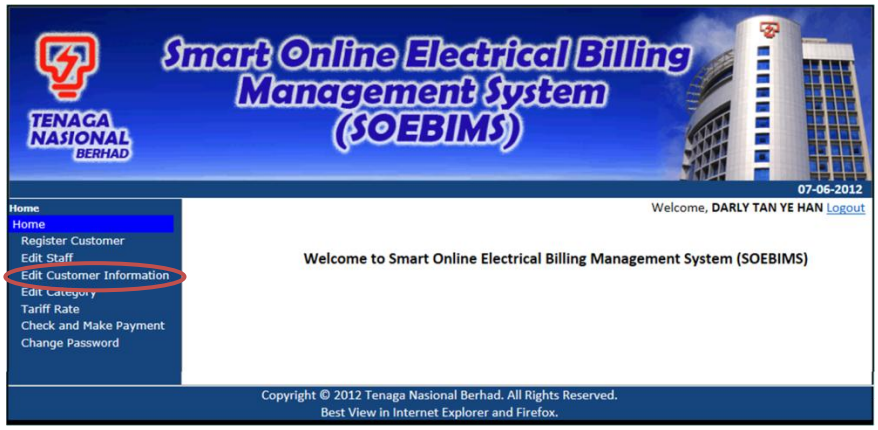


Figure 4.14: Main Page

2. Then, the customer profile maintenance interface is shown as Figure 4.15. Click "Edit" button.

Figure 4.15: Customer Profile Maintenance Page

3. Fill in the required details.

4. Click "Update" button after finish.

Figure 4.16: Customer Profile Maintenance Page