Sustainable Application of Versatile Electronic System of Billing of Electricity and other Utilities Software and Technology

Ivy Joy U. Aguila
Institute of Computer Science
College of Arts and Sciences
University of the Philippines
Los Baños
iuaguila@up.edu.ph

Joseph Anthony C. Hermocilla
Institute of Computer Science
College of Arts and Sciences
University of the Philippines
Los Baños
jchermocilla@up.edu.ph

Susan G. Tolentino
Utilities Billing Section
RGDO-OVCPD
University of the Philippines
Los Baños
sgtolentino@up.edu.ph

ABSTRACT
Billing and collection of fees are essential activities in an organization that provides services because they directly affect the income generated and doing the processes manually is more prone to errors particularly in encoding data. We present in this paper the design and implementation of SAVES-BEST, a web application that automates the billing and collection activities for utilities, such as electricity and water, provided by an academic institution to its constituents. In this system, after a single data entry, bill and receipt preparation transactions can be made easily, and reports are generated instantly. Feature and transaction processing evaluations of SAVES-BEST show that stakeholders are more likely to use it compared to the system currently being used.

General Terms
Information systems∼Enterprise applications,
Applied computing∼Business process management systems,
Social and professional topics∼Automation

Keywords
utilities billing, collection monitoring, process automation, web application

1. INTRODUCTION
Since the time that computers are used in offices, useful programs for staff have been created to lessen their manual labor. Vouchers are typed on a text editor, printed out with a printer and then passed to be signed and approved. In accounting, ledgers are typed on a spreadsheet editor which automatically computes with the given formula. But this scenario is from 40 years ago. In addition to that, a survey result [17] shows that almost one working week was lost per employee just because they were finding lost hard copy documents. There is also a bigger chance of having errors and inconsistencies on data since it is to be copied manually from one office section to another.

Nowadays, the trend is to make every office paperless, to automate processes as much as possible, and to help ease decision making of the management. Many solutions company offer this kind of all-around business process automation system already. But because of the costly amount of these products and associated maintenance costs, the university decided to create its in-house system for automating billing and collection activities.

This paper describes the design, implementation, and evaluation of a billing and collection system that will be used by the UPLB Utilities Billing Section. The in-house system will not just automate the office processes but also save the university thousands of pesos in costs from purchasing existing solutions. The monitoring and reporting modules included in the system can also be used to alert the administration so that problems can be resolved immediately which will also help the university save some resources.

2. BACKGROUND
The Utilities Billing Section is in charge of billing electric, water, and garbage of more than 340 clients subscribing to UPLB utilities services and are also in charge of monitoring payments of such services. The responsibilities of this office section are very crucial because the university's monthly collection is more than a million pesos, which is a major source of income for the university.

The stakeholders are composed of Utilities Billing Section staff and the consumers of utilities under the university. The Utilities Billing Section has a personnel for preparing the bills for each month and the reports related to the billing process. There is also a personnel who takes care of making receipts and monitoring consumer payments. As part of the staff, three meter readers collect meter readings every 22nd day of the month along their assigned routes. They also deliver the printed bills at a later date. The consumers are grouped according to price per unit of consumption: Res-

idential, Commercial and Institutional. Consumers under the Residential type are further divided into Employee and Non-employee of UPLB. Employees of UPLB pay their utility bills through automatic salary deduction done in the Accounting Unit. Figures 1 and 2 describe the manual processes for billing and collection as practiced by the office section.

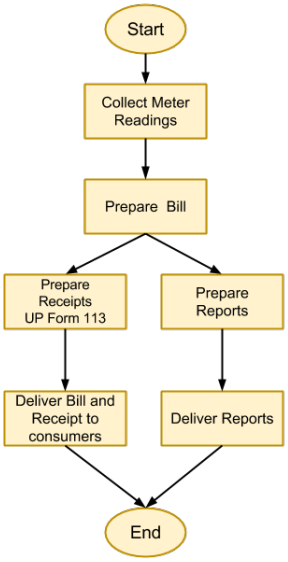

Figure 1: Manual process flowchart for billing

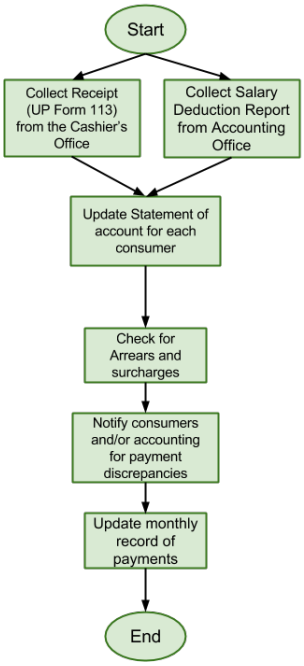

Figure 2: Manual process flowchart for monitoring collection

At present the Utilities Billing Section is using a program that was developed in 1987 using Microsoft Visual FoxPro (Figure 3). FoxPro is an old language for data processing popular in the 1980's [6]. The current system is already obsolete technology-wise, thus a new system was conceptualized not only to solve the problems being encountered by the Utilities Billing Section but also to address the need of expediting the preparation of bills and easy monitoring of payments. The software should be versatile that it can be modified to support Utilities Billing Section's future requirements. Moreover, the data generated by the system can be used to rationalize utility service fees increases.

In addition to the problems mentioned above, the following are issues encountered with the Visual FoxPro Application:

1. No regular maintenance because the software developer retired a few years ago.
2. No provision to save the records of utilities readings, consumption, and bills data in the system, billing information are printed and copies are filed in the office.
3. It only accepts whole figures for electric meter with Current Transformation Ratio (CTR - multiplier). Some of the consumers have meters with CTRs of 4.8, so the computation of bill for these need to be done manually.

Figure 3: Billing officer using the Visual FoxPro Application on an old Windows 98 PC

Table 1: User access level to SAVES-BEST modules.

User	Module
Super Admin	has access to all modules
Admin/Chief	Reports, Settings
Billing Officer	Statement of Account and Readings
Collection Officer	Collection and Statement of Account
Meter Reader and Consumer	Readings

4. The program regularly stops functioning while being used (on a monthly basis when encoding the meter readings) for unknown reasons.

Our system, Sustainable Application of Versatile Electronic System of Billing of Electricity and other Utilities Software and Technology (SAVES-BEST), combines two essential functionalities: billing and collection. It is designed to simplify user operations, expedite bill preparation, and improve payment monitoring.

SAVES-BEST does not automate yet the whole process that includes automatic meter reading. In this paper we only compare the transaction processing time of billing and collection between two different methods:the Visual FoxPro Application and SAVES-BEST.

3. METHODOLOGY

3.1 Development Process

We followed the Agile Methodology [13] for SAVES-BEST implementation. This allowed us to incrementally deploy functionality right after they are completed and tested. We developed SAVES-BEST as a Web Application [1] rather than standalone for its advantages. First, a networked application is needed for the Billing section to complete their tasks simultaneously (e.g. while one staff is making the reading entry per consumer the other one can double check the reading entry for a consumer then print the bill). In addition, using a client-server approach will ease application deployment since users will only need a web browser to access the application. But the application will only be available within the local area network of the Utilities Billing Section office.

3.2 Architectural Design

We implemented functional modules for each user of SAVES-BEST. Table 1 shows the access level to the modules for each user. Figure 4 shows the relationships among the modules. The following are the modules implemented.

- **Consumers Module**
  This module has the functions for creating, retrieving and updating consumer details. Consumer details are archived,instead of permanently deleted.

- **Readings Module**
  This module allows the user to add utility readings for the current month. The meter reader and billing officer can edit readings as long as the bills produced are not yet printed and seen by the consumers. This module is also the one responsible for bill and receipt production.

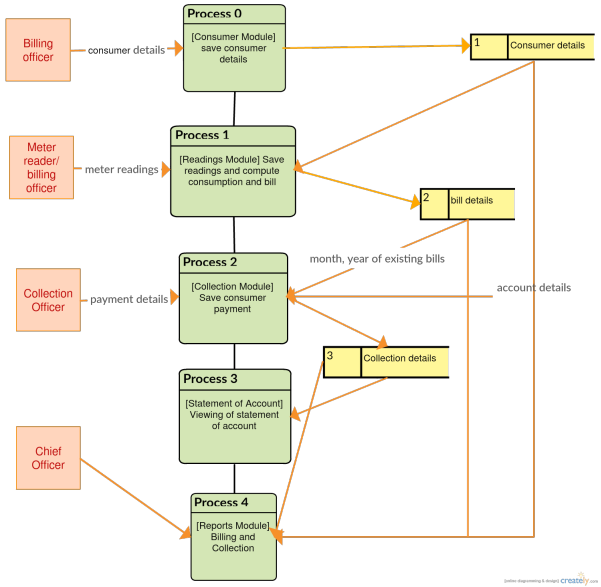

Figure 4: Data Flow Diagram for SAVES-BEST

- **Collection Module**
  The collection module is mainly for the collection officer to input the payments of the consumers. Once the collection entry is saved, that entry can only be edited within the day or else the collection officer needs to call the attention of their chief.

- **Statement of Account Module**
  The statement of account is for retrieving both the collection and bills per consumer. This is where the collecting officer can view the total balance of a consumer and relay it to them.

- **Reports Module**
  Reports generation are done with this module. The following are the important reports that can be generated monthly:

  1. Accounting Report for salary deduction of consumers who are also employees of the university
  2. Consumer list with the bill for the current month per space type.
  3. Special reports for IRRI and SEARCA's management with the list of consumers and their bills for the month.

  Yearly reports can also be generated in this module. The chief of the billing section can see the year's trend on consumption, bills, and collection as well as the reports by space type or by utility type.

- **Settings Module**
  The settings module is for configuring the price per unit of each utility.

3.3 Database Design

Figure 5 shows the database schema for persistent storage in SAVES-BEST. There are 9 tables in the schema. Database normalization techniques were applied to ensure data coherency and consistency.

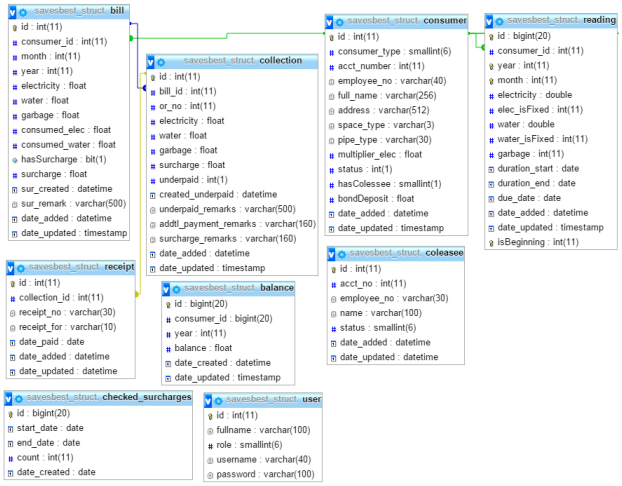

Figure 5: SAVES-BEST database schema

3.4 Implementation Technologies

Table 2: Technologies used in creating SAVES-BEST

Component	Technology Used
Front End	BackboneJS [3], JQuery 1.7.2 [9] and Bootstrap 2.2.2 [7]
Charting	HighCharts [8] 3.0.10
PHP Application Framework	CodeIgniter [5] on PHP 5.5
Web Server	Apache 2.4
Database	MySQL 5.5

Table 2 describes the implementation technologies used in the development of SAVES-BEST. CodeIgniter was used as a REST API so that data can be easily retrieved from the database by authorized applications. Since the application is only for the use of a small group of people, the requirements are the following for the server computer:

- At least 4GB of RAM for the computations to run smoothly;
- Minimum hard drive size is 500 GB so that there will be enough data space for at least a year; and
- Operating System is at least Windows 7 or Ubuntu 12.04.

For the client side, the required browser is at least Google Chrome v.44 or Chromium Browser v.32. RAM should also be at least 2 GB. Bigger amount of RAM is recommended because the application uses client side rendering which includes computations of values specially in the part of reports generation.

3.5 Transaction Processing Times Comparison

In order to assess if there is an improvement in the transaction processing times for the office section, we gathered measurements on how long it takes for the staff to complete their tasks using the current system and SAVES-BEST. To gather data with the current system, we interviewed the staff on how long, per consumer, does it take to do the following:

1. Readings Encoding
2. Bill Preparation
3. Receipt Preparation
4. Collection Encoding

4. RESULTS AND DISCUSSION

Figures 6, 7, 8, 9, 10 and 11 show some of the application screens for the modules as seen in the desktop. Originally the project was slated to be completed in 16 weeks, but due to some issues we delivered the product within 24 weeks.

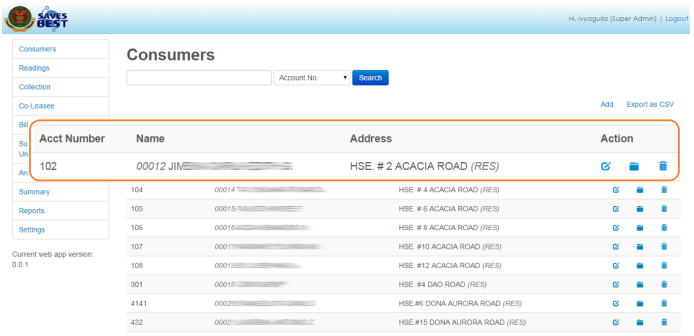

Figure 6: Consumers Module

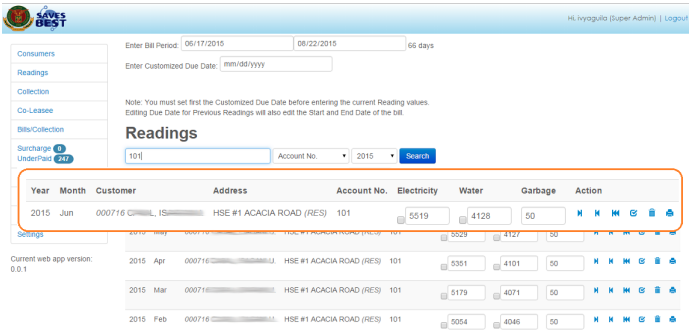

Figure 7: Readings Module

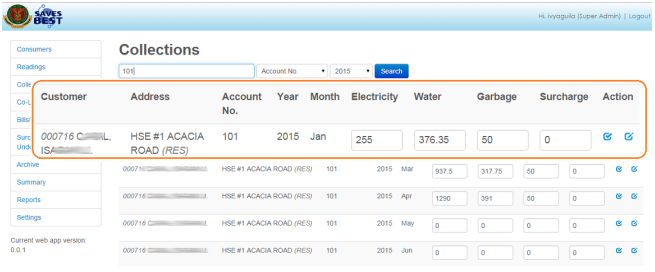

Figure 8: Collection Module

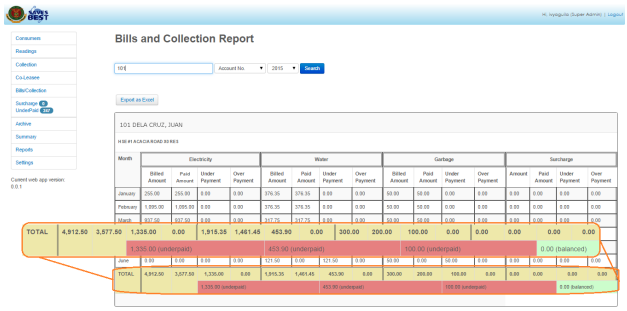

Figure 9: Statement of Account Module

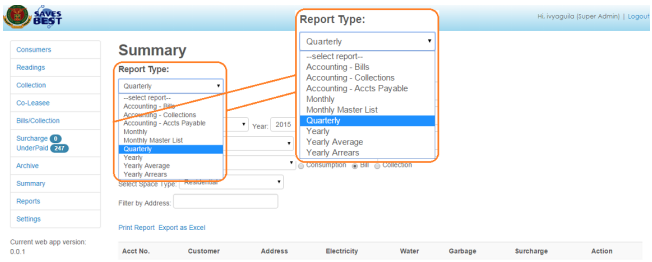

Figure 10: Reports Module

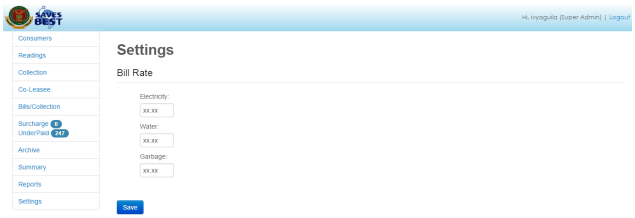

Figure 11: Settings Module

One of the key features of SAVES-BEST is the comprehensive set of reports for top management. Figures 12, 13, and 14, show some of these reports. In Figure 12 , the total amount of electricity consumption for a given year is presented using a bar graph. There is also a graph for the bill, collection, and arrears for all the utilities. The bill in Figure 13 shows the yearly consumption of the consumer as a bar graph. This bill can be directly printed.

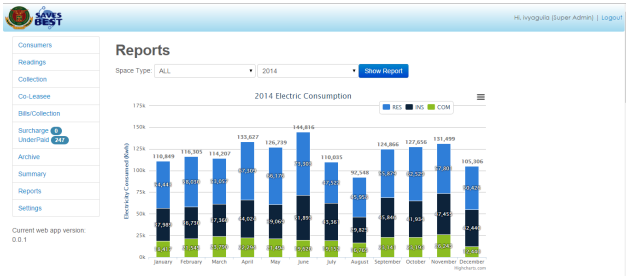

Figure 12: 2014 Electric Consumption report showing the month of June having the highest consumption.

Table 3 shows the speedup using SAVES-BEST for the transactions listed.

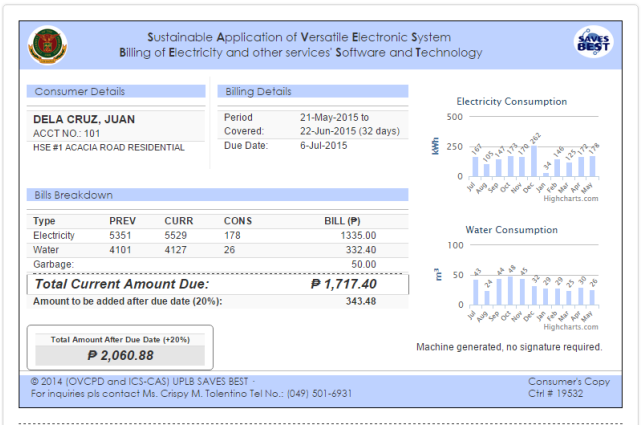

Figure 13: A sample printable bill produced by SAVES-BEST

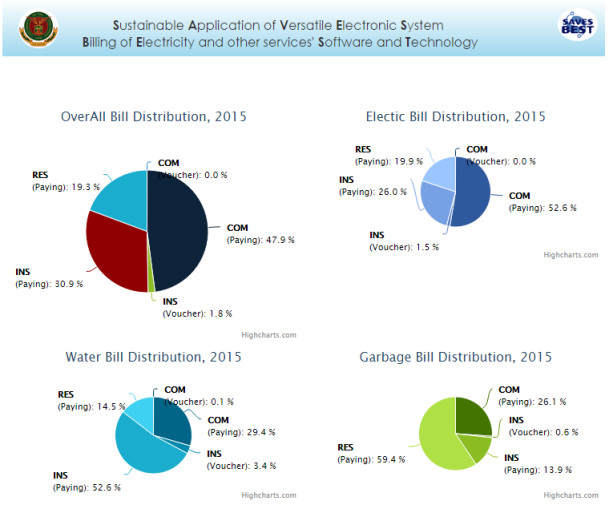

Figure 14: Bill Distribution Report

Table 3: Comparison of transaction processing times when using the Visual FoxPro Application and SAVES-BEST

Transaction	Visual FoxPro Application (sec/consumer)	SAVES-BEST (sec/consumer)	Speedup
Readings Encoding	5	5	0
Bill Preparation	55	30	1.83
Receipt Preparation	85	12	7.083
Collection Encoding	30	12	2.5

In the Visual FoxPro Application, the Readings Encoding step includes inserting readings entry of all the consumers and manually computing the consumption for consumers whose meters have a CTR Multiplier.

The Bill Preparation step includes double checking the readings and printing all the bills with the dot-matrix printer.

In Receipt Preparation (UP Form 113), the collecting officer

needs to retype all the bills in the form with the use of an electric typewriter.

After the consumers paid their bills, the collecting officer will encode all the payments on a Microsoft Excel spreadsheet and the officer also keeps track of a hard copy ledger. The collection report will be from the spreadsheet of all the payments received for the month.

The four processes described above are all done in SAVES-BEST. In Readings Encoding and Bill Preparation, the user only needs to input the figures, save, double check the values then click the print button. When the user decides to print the bill, two files will be printed: the bill and the receipt. The printer used in the testing environment was an InkJet printer.

In Collection Encoding, the user will just have to search for the consumer through the search box then encode the payment figures for the month and year the payment has been made.

The main concern of creating SAVES-BEST is for the automation of billing and collection process in the university. Although the Utilities Billing section of the university already has a FoxPro Application, it is only used for the billing process. The data saved is limited to the current month and previous month, enough only to compute for the data needed to generate the bills. There are only monthly hard copy reports as backup for the past months.

Some non-functional features were also added in SAVES-BEST. One of them is security, which is of course needed in a networked application.

Table 4: Comparison of features between the Visual FoxPro Application and SAVES-BEST.

FEATURE	Visual FoxPro Application	SAVES-BEST
Bill Generation	YES	YES
Saves and maintains historical records	NO	YES
Data Export (.xlxs, .pdf, etc)	NO	YES
Authentication and Authorization	NO	YES
Comprehensive Report Generation	Partial	YES
Graphical Interface	NO	YES
Commnad-Driven	YES	NO
Backup and Logging	NO	YES

In summary, Table 4 shows all the features that has been captured by the new system that is lacking in the current system.

5. RELATED WORK

Some people from all around the world tried to solve the same problem: how to use the latest technology to automate the process of utilities billing and collection and why it is important. The question is answered in many ways and at different levels. Radecki and Wenniger in 1999 [14] emphasized that electronic billing and payment systems will change the way households pay their monthly bills. These systems will reduce costs for the biller and provide convenience to consumers. E-billing eliminates transfer of information stored electronically and back.

Kim and Rohmer [10] compared paper-based billing and payment(PBP) to electronic-based billing and payment (EBP) in terms of environmental impact using the life cycle assessment(LCA) method. Their results showed that environmental impact of EBP systems are much lower than PBP systems.

A white paper from Summation360 [16] discussed twelve characteristics that make a successful e-billing and e-payment system. They also discussed the main reasons why there is slow adoption, both for the customer and the utility company.

Compared to our level of automation, which focuses on the billing and collection processes, other researchers automate starting from meter reading itself. It is because there are various ways to remotely access a utility meter nowadays.

Brahmanandan, et. al in 2008 [4] , did a few changes in their own existing system for a more efficient billing and collection process. Their system upgrade ensured data integrity, security, and privacy. With their modifications, they were also able to automate consumer management and complaint management.

In a team project in 2015 by Anjana, et. al.[2], they designed a system that automates billing procedure in department stores. Their system produces reports that will help the owner and also make the process faster. Another difference with their study is that they used proprietary tools to create their project while this paper presents a system with the use of open source tools. Also mentioned in this study was that users, specially the department store staff, were adamant in using the newly developed system since they are used with the old, manual way of doing it. Unfortunately, the same is true for SAVES-BEST.

Another solution used in solving the same kind of problem was by adding Android Mobile Application called MoBEBIS to a web-based one. This is done by Rathnayaka, et. al. in 2013 [15]. In their solution, meter readers used mobile phones to capture an image of the readings. Once the image is captured, the consumer's house was automatically marked in the map, which is a feature in their application. After all the readings have been captured, another web-based system will process those images and compute for the consumption then it will automatically send bills to the consumers.

One group of researchers [12] in year 2013 solved the problem of automation from making their own modification to the existing meters. There was another group [11] also in 2013 who used the GPRS/IP to remotely monitor meter readings.

These studies are inspiring the future of the billing systems we have today not just university-wide but more importantly, in the country. These systems offered close monitoring of the meters so that consumers can efficiently use their utilities. Meters with problems can also be spotted and reported immediately.

6. CONCLUSION AND FUTURE WORK

In this paper we have presented the design, implementation, and evaluation of SAVES-BEST. Electronic billing and

collection systems, like SAVES-BEST, provide solutions to the problems encountered as with the FoxPro Application. SAVES-BEST was able to produce a more comprehensive bill format and more report types. Statement of accounts can be automatically tracked and can easily be given to consumers who request for one.

In the future, we will automate the process of meter reading and add predictive reporting. This will help the management in knowing the months of the year when the consumption is in its highest and lowest. The payment process will be automated so that receipt preparation and collection encoding will be eliminated from the list of transactions.

7. ACKNOWLEDGMENT

We would like to thank the Utilities Billing Section staff for cooperating while we gathered data.

8. REFERENCES

[1] Acunetix. What are web applications? `http://www.acunetix.com/websitesecurity/web-applications/`, 2015.

[2] B. L. A. Anil Kumar Anjana and S. Jain. Billing system for a departmental store in asp.net + sql. Technical report, 2015.

[3] BackboneJS.com. Backbonejs. `https://backbonejs.org/`, 2015.

[4] A. Brahmanandan, J. Abraham, and D. S. Babu. Web-enabled consumer management and 401 energy billing system. In P. Gupta and R. K. Bagga, editors, *Compendium of e-Governance Initiatives in India*. Universities Press (India) Private Limited, Hyderabad 500 029 (A.P.), India, 2008.

[5] CodeIgniter.com. Codeigniter. `http://codeigniter.com/`, 2015.

[6] W. F. Community. The history of foxpro. `http://www.foxprohistory.org/`, October 2001.

[7] GetBootStrap.com. Bootstrap. `http://www.getbootstrap.com/`, 2015.

[8] HighCharts.com. Highcharts. `http://www.highcharts.com/`, 2015.

[9] jQuery.com. Jquery. `https://jquery.com/`, 2015.

[10] J. Kim and S. Rohmer. Electronic billing vs. paper billing: Dematerialization, energy consumption and environmental impacts. In *Electronics Goes Green 2012+ (EGG), 2012*, pages 1–4, Sept 2012.

[11] A. Malviya. An approach to automate power meter reading & billing system. *Global Journal of Management and Business Studies*, 3(9):943–948, 2013.

[12] P. Mondal, M. R. Ali, N.Paul, P. K. Halder, M. Rahman, M. A. Rob, and T. Ghosh. Cost effective digital water billing system. *Global Journal of Researches in Engineering General Engineering*, 13(3), 2013.

[13] A. M. Organization. Agile methodology. `http://agilemethodology.org/`, October 2014.

[14] L. J. Radecki and J. Wenninger. Current issues in economics and finance Paying electronic bills electronically. *Federal Reserve Bank of New York*, 5(1), Jan. 1999.

[15] M. Rathnayaka, I. Jayasinghe, E. Jayanth, S. Swarnajith, M. Manamendra, and G. Wimalaratne. Mobile based electricity billing system (MoBEBIS). *International Journal of Scientific and Research Publications*, 3(4), Apr. 2013.

[16] Summation360. Essentials for successful utility/e-billing e-payment programs. Feb 2012.

[17] C. Thierry, R. Al-Jaar, and Etelesolv. Reaping the gains of business process automation, March 2014.