Transforming Government Processes; through the Utility Management System for Industrial Development Board, Sri Lanka

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Abstract— Rent and Water Bill management system is a successful attempt taken in order to reduce the recognized problems and increase the effectiveness in organizational rent and water bill calculation and maintenance. The currently available system for the Industrial Estate Division (IED) under the Industrial development board is a manually generated system which requires trained employees and more cost and time consuming. Due to the manual nature it faces many other inconveniences in storing of data, security issues, inflexibility in adaptation etc. The Rent and Water bill management system has been proposed in order to address the above complications through implementing a user friendly web based solution. In the proposed system the eighteen estates of Industrial Estate Division will be linked with the head office by using the cloud computing infrastructure. All the records of the relevant details will be stored in the central database of the system and users can access that information if the system has given the authority to access them. The system will give the access only to the relevant interfaces according to the user levels. The developed system is a fully integrated version comprised of an Android Mobile Application, Short Message Sending (SMS) gateway and a Payment gateway.

*Keywords— **Cloud computing, Android mobile application, SMS and Payment gateways***

I. INTRODUCTION

Automated Web Based Billing Management System can be cited as an essential requirement to achieve the organizational goals of Industrial Estate Division of Industrial Development Board as the traditional paper-based billing operation has experienced high occurrence of errors and inefficiency. The developed computerized system which used the best technologies in the present technological era; mobile android application, cloud computing infrastructure, SMS gateway and payment gateway will help to defeat the problems and limitations of the current manual system. The feasibility of this novel solution mainly plays a major role in the technological arena for a third world country like Sri Lanka (Choi and Kim, 2012). The introduction outlines the objectives, background and motivation for the research, problem in brief, hypothesis, proposed solution and the overview of the rest of the paper.

Invoicing management systems can be defined as a new context of businesses where a large amount of information and services are addressed. Therefore billing management has become a popular research area in the current business world. Since there are many researches that have been done on this topic a speedy and accurate invoicing is necessary to enhance the productivity. This research area is evolving because of the involvement and introduction of novel technologies in worldwide.

Among the Sri Lankan researchers that have been done researches on this subject, the Sri Lanka Institute of Information Technology deserves a prominent place. Universities and Research centres of India, Canada, Ireland and USA have conducted worldwide researches on many areas in invoicing management. A large number of research papers, research documents, magazines and journals have been published and they are available for public to make reviews, comments and further researches. Those researchers have implemented efficient solutions for the problematic issues that are prevailing in the manual billing management systems.

Industrial Development Board (IDB), Sri Lanka which is functioned under the Ministry of Industry and Commerce is the government organization that is responsible for the encouragement, promotion and development of industries in Sri Lanka. Industrial Estate Division (IED) is a major division of IDB that governs the industrial sector in the country. The main official centre of IED is situated in Katubedda and the division has 18 centres island wide. It handles the selection and allocation of Building blocks and develop lands, maintaining Industrial Estates in the country, collecting renters for land blocks and buildings etc. At present, the Industrial Development Board follows a tedious procedure in managing the rent and water bills of the plots of the renters. The manual process consumes high cost and it has faced many security concerns too. The inconsistency that the current manual system has formed, has resulted dynamically in reducing the working performance of the workers and also has resulted in limitation of the analysing. The group undertook the hypothesis as, the efficiency and the accuracy of calculating, generating and distributing rent and water bills and periodic reports would be improved if an Automated Web

based Rent and Water Billing Management System is developed and implemented for Industrial Estate Division of Industrial Development Board.

II.   LITERATURE REVIEW

A.   Early Developments

In last few years, lots of researches have been conducted to study of the security of the SMS gateways to employ the SMS gateways as a trusted technology. The SMS gateway makes users to communicate efficiently (Choi and Kim, 2012). A standard consultation of databases through SQL-SMS Gateway which converts an SMS command in an SQL query is also an effective technology to reduce the risk of online publications (Sbaa et al., 2012). Some researchers have found that most people are likely to adopt electronic payment system as it has lot of advantages. People need such a gateway that fulfil their requirements and provide security as well as privacy (Izhar et al., 2011). In the business fields, collection departments of business companies use sending out reminders to mobile phones or making phone calls as collection actions to collect payments from delinquent payments of clients. There are Mobile Based Electricity billing systems that have been developed with the integration of highly technical based components such as Images processing library, SMS Manager Windows service, WCF REST Services (Meter Reading Service), Customized Adjustable Camera, Walk Order Map Service and Android Map services etc. (Rathnayaka et al., 2013).

B.   Recent Advancements

There are many recent advancements that have been emerged through recent researches and projects conducted in this field. Recent developments in this direction seem to provide Android application that is now has become the most used mobile operating system in the world (Pandey and Dani, 2014) (Ma et al., 2014). Recent developments in this direction seem to provide energy efficient metering technologies that are more precise, accurate and error free. Methodologies for wireless smart automatic meter reading systems (WAMRS) incorporating the widely used GSM/ GPRS network have been developed recently (Sawarkar and Golait, 2015).

Cloud computing has recently emerged as a compelling paradigm for managing and delivering services over the Internet. The rise of cloud computing is rapidly changing the landscape of information technology, and ultimately turning the long-held promise of utility computing into a reality. Google App Engine is the other most important

topic under cloud computing research areas which is the platform for traditional web applications in Google-managed data centres. Currently, the supported programming languages are Python and Java. Apart from those Web frameworks that run on the Google App Engine include Django, CherryPy, Pylons, and web2py, as well as a custom Google-written web application framework similar to JSP or ASP.NET (Stefanadis, 2002).

C.   Future Directions

There are a lot of new trends of the researches of this area to adopt the new technologies to improve the currently available systems. The departmental steering committee of the USA research group that implemented a computerized charge capture system was investigating an alternative method by incorporating handheld billing implementation on personal digital assistants in the near future (Pandey and Dani, 2014). Although cloud computing has been widely adopted by the today's' industries in the world, the research on cloud computing is still at an early stage. Many existing issues have not been fully addressed, while new challenges keep emerging from industry applications. Automated service provisioning, Virtual machine migration, Energy management, Server consolidation, Traffic management and analysis, Data security, Storage technologies and data management and Software frameworks are among the major topics of the challenging research issues in cloud computing where future advancements are expecting (Stefanadis, 2002). Through the literature review, the group identified that there is a major research gap between the above discussed technologies and the currently prevailing technical aspect of Industrial Development Board. Therefore, the group developed an integrated version of novel technologies as a solution to fill this gap.

III.   METHODOLOGY AND EXPERIMENTAL DESIGN

A.   Data Gathering

Qualitative and quantitative data required for designing the requirement specification for the new system were gathered through interviews, questionnaires and document review techniques which were carried out at the IDB head office, Katubedda and other Estate Divisions. Face to face interviews were conducted with the director IED, Superintendent of Ekala Estate and Accountants. Questionnaires were distributed among Katubedda head office and Ekala, Pussella and Horana Industrial Estate offices respectively. Many documents   regarding the current manual system; Tax Invoices, Water Bills, Payment Receipts, Ledgers and monthly income statement which is

an excel sheet were reviewed during data gathering process.

B. Data Analysis

The data which were gathered during the data collection phase described were analysed by using charts and presented in this section. Through analysing the data, the group was able to reveal the extent procedure, problems, limitations, suggestions of the employees regarding the manual process. Consuming much time and cost, low security, mistake probability by employees, limited analysing capabilities, inflexibility are some of the drawbacks the manual procedure empowered. The group identified that, the employees are also willing in implementing an automated system in Rent and Water bill calculation. Concluding the analysis section, the group finally decided in developing an automated business reengineering process for the better function of the IDB.

C. Approach

The users of this system are Estate Administrators, Main Administrator, Water Meter Reader, Renters and the Chairmen, Board of Directors, Director of Industrial Estate Division. There are five major different types of inputs concerning Estate Administrators, Main Administrator, Water Meter Reader, Renters and the Chairmen, Board of Directors, Director of Industrial Estate Division. The outputs from the system are basically rent invoices, water invoices, reminder letters, payment receipts, monthly income statements, and periodic reports and SMS notifications. The novel system receives inputs and executes user requests to generate rent and water bills, reminder letters, payment receipts, monthly income statements and display the output on different devices.

D. Technology adopted

The system receives various inputs and executes user requests to generate rent and water bills, reminder letters, payment receipts, monthly income statements and display the output on different devices. The input processing has been implemented using selected programming languages Html, CSS, JavaScript, Java and PHP. The technology that suits for the system development should be decided by considering the domain and the requirements for the system. It is important to identify most appropriate technological methodologies in order to satisfy the functional requirements and the non- functional requirements of the system in the system development procedure.

In the technological aspect, the group had to move in more technological considerations, since the proposed Rent and Water Bill Management System is a web based system. Time for the production, Efficiency and the performance of the system, Usability and Flexibility of the system and functionality of the system should be considered in developing the system. Programming language is the most important technical factor that should be focused in implementing the system. The programming language should in compatible with the development tools that are used in implementing the system. PHP, HTML, CSS, JavaScript, JQuery were employed as supported programming languages and specialized tools like jQuery library, Bootstrap framework, Highcharts, DataTables and Wamp server were used.

E. Design

The architectural perspective of the developed system breaks into four main components as; software design, database design, module design and the interfaces. The gathered data from the analysis phase was used in creating the system's design.
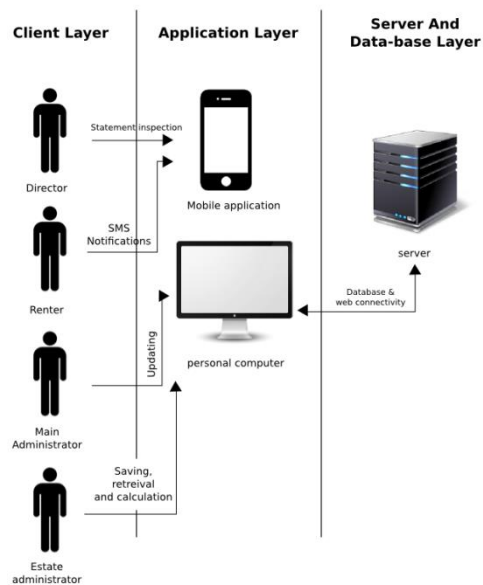
1) Overall System Architecture

Figure1. Overall System Architecture

Client layer: The user accesses the application through the client layer. The developed system provides access for the users in different user levels and each hold the interfaces which satisfy the requirements of each user type. Since there are two main applications, authorized users will be predefined.

Application layer: There are two main applications in the system's application layer. The mobile application benefits for only two types of users; the director will be able to access the system through a mobile application, while the renter will receive SMS notifications through the mobile application. The main administrator can update the system by accessing to the system through a personal computer while the estate administrator will manage the basic operations such as retrieve data & perform calculations.

Server and Database layer: Server and Database layer is responsible to manage the server and the entire database of the system. The server will provide the web connectivity to the personal computers distributed in all eighteen estates .The database will store the data enters to the system by the two main applications after the manipulation of the application layer.

2) Modular Architecture

The discussed modules in the software architecture will elaborated in this section to show how the modules will be dealing with the users' actions in each layer. The main modules and their sub modules are given below.

i.   Login and Authentication Module

Only the authenticated users are able to access with the system.

ii.   Director Login and Authentication Module

IDB director is the person who has the authority to check all reports and all the balances. Amendments in the sense are the rechecks and do the corrections if there are any mistakes happened in the results entering into the system by the administrative staff.

iii. Estate Admin Login and Authentication Module

Here all the administrative staff members authorized to enter to the system and enter the daily information. Each estate admin of the system is given a specific user name and a password to login to the system.

iv.   Rent Invoice Generating Module

Both the main administrator and the estate administrators have the access to this module. The all plot rent information is entered into this module. Before enter the results there are some other procedures to be carried out. Those procedures are done in the below sub modules.

- Land Invoice Generating Module

All the details about renters who rented land are recorded in this module. This tale is maintained in the data layer of the system.

- Building Invoice Generating Module

All the details about renters who rented buildings are recorded in this module. This tale is maintained in the data layer of the system.

- Sending Invoices

Invoices regarding all the monthly rents will be sending via emails and printed documents to the renters.

v.   Water Invoice Generating Module

Both the director and the administrative staff members have the access to this module. The all plot water usage information is entered into this module. Before enter the results there are some other procedures to be carried out. Those procedures are done in the below sub modules.

- Present Water Meter Reader Adding Module

All the updated information about the water meter readings will be recorded in this module.

- Water Invoices Generating Module

All the details about water bill information are recorded in this module. This tale is maintained in the data layer of the system.

- Sending Invoices

Invoices regarding all the monthly rents will be send via emails and printed documents to the renters.

vi.   Reminder Report Generating Module

Information regarding the arrears left to pay by the renters will be generated and informed via selected ways. Sub modules developed under this was to send Emails, SMS and Printed Letters.

vii. Payment Module

This module will be in charge of the collection of the monthly rent values. Mainly the estate administrators and the renters are the most privileged people get to access this module. All the amendments are highly restricted and privacy restrictions heightened in this module. This module has two main modules attached,

- Online Payment

The renters who are already registered are able to pay their bills online right into their accounts.

- Cheque Payments

All the payments paid using the cheques are recorded here for the daily use and for the future use of the organization.

viii. Renters Module

Details regarding all the renters information will be gathered and recorded into database using this module. Mostly the estate administrators will be using this module

daily for their operations. This Module contains two main modules,

- Add ,Modify and Remove Renters

This module option will help the user to add new renters, modify current renter's information and to remove unavailable renter's information.

- Monthly Sorted Info

This option module will help the administrative staff to keep track of their renters' short term payment and their information.

ix.   Updating Rates Module

All the rates regarding the lands and building will be stored in this module for the use of monthly and yearly rent calculation. These rates are updated according to the administrative decisions.

x.   Monthly Income Statement Module

From all the rent values gathered a monthly income statement will be created to summarize the monthly performance. The reports are presented in graphs and charts.

xi.   Periodic Report Generating Module

One of the main functions of the Water Bill and Rent Management System is report generation. And in this module monthly and yearly reports are generated.

The developed Rent and Water bill management system is comprised of 3 main interface categorizations (user-levels) namely interfaces of Estate Administrators, Main Administrator and Chairmen / Board of Directors / Director of Industrial Estate Division, Water Meter Reader interfaces and Renters interfaces. All of the above users can login via the cloud to access the relevant interfaces. User-friendly interactive interfaces including both Sinhala and English languages were designed and it benefited the users in ease of using and ease of learning.
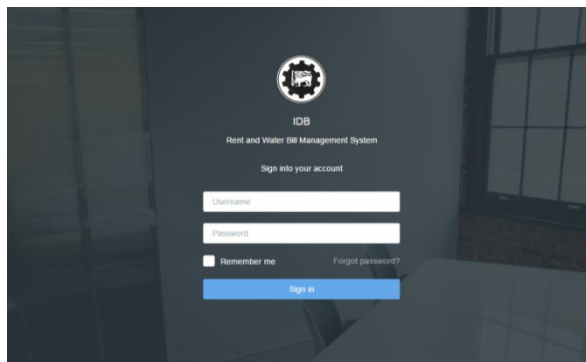

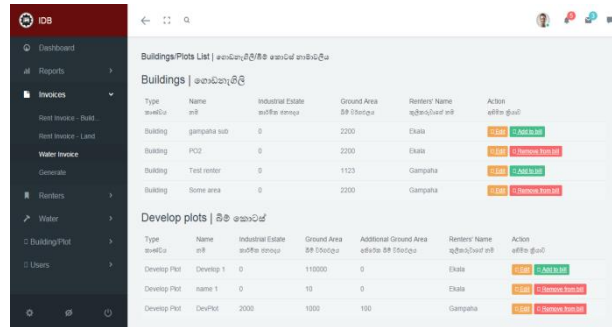Figure2.   Login Interface
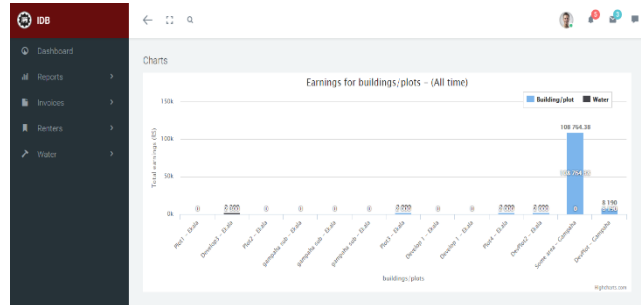

Figure3. Viewing Building and Develop Plots

Figure4. Data representation through charts

IV. EVALUATION AND DISCUSSION

Summative evaluation was used as the evaluation method to find how the system functions and whether it is up to the expected level to fulfil the clients' requirements. At the system finalizing stage this evaluation is done to evaluate the product's stability. In summative evaluation a prototype with most stable build is shown to the client and the feedback is taken to find how far the system is success. In here the using prototype must be very much alike to the final product's functions and features.

The overall Evaluation of the product was carried to verify whether the system's final outcome meets the functional requirements of the clients and the successfulness of the system tasks and the functions of each component are also evaluated here. This was done by comparing the functions of the new system against the problems and limitations addressed during the Requirements analysis process, also considering the functional requirements specified by the system specifications.

The knowledge that gained from the discussion and the questionnaire session done with the IDB officers, the group identified that the accuracy and the effectiveness of the overall management procedures in the estate division has been drastically improved through the implementation of the new system. The stationary cost and the other costs implemented by the manual system has been successfully

overcome by the automated rent management system. The developed system has reduced manual errors taking place in the data entry processes and the presence of database has eliminated from rechecking data. The generation of monthly and yearly reports are now created automatically with summarized and statically manner. They specially appreciated that the reliability of their reports has been highly improved through this implementation. The user friendly interfaces consisting of native language also has reduced the complexity of the procedures and the content understandability is at higher level at the present.

User level access has made the management of IDB well organized compared to the prevailed traditional file accessing system. Thus the cloud based system and the android app could be accessed from anywhere, at any time, especially the management can get interacted with the processes easily. Following table and the figure depicts the overall results from the evaluation. The group reviewed the responses from seventeen employees at IDB. According to the results, more than 95% of them have been satisfied by the below mentioned parameters taken by the group for analysing the developed system.

Table 1. Evaluation Results

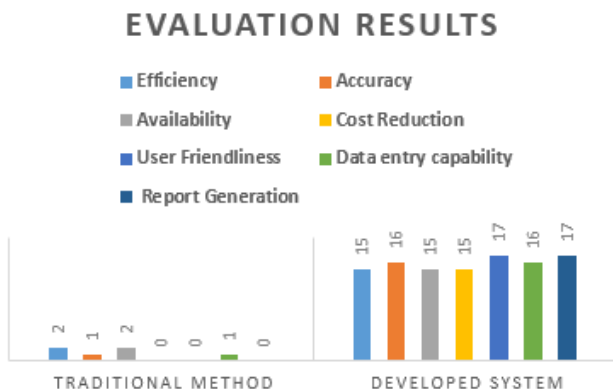| Parameter	Traditional Method	Developed System
Efficiency	2	15
Accuracy	1	16
Availability	2	15
Cost Reduction	0	15
User Friendliness	0	17
Data entry capability	1	16
Report Generation	0	17

Figure 5. Chart representation of evaluation results

V. CONCLUSION AND FURTHER WORK

The project's ambition was to develop an effective and efficient web based Rent and Water Bill Management System for the IED to overcome the limitations of the current manual system. In the proposed system the 18 estates of IED will be linked with the head office by using the cloud computing infrastructure. The records will be stored in a central database of the system. Different user levels will control the access areas and the obtainable interfaces to each user.

The five categories of users or the active user-levels of the system are unswervingly favourable with the system implementation. The implemented Management Information Systems (MIS) will provide a better solution for the process of making management decisions for strategic purposes in a government company like Industrial Development Board. Employing Automated Web Based Billing Management Systems in Sri Lanka, which is a third world developing country, will automatically be a power for the enhancement of E-governance arena of the country. The complete project procedure concludes an effective development of Rent & Water Bill Management System for IED (Industrial Development Estate) of the IDB (Industrial Development Board).

Further enhancement proposed on a system will expand the achieved scope of the development of the system. The group identified Automatic meter reading meters (AMRs), that automatically collect consumption, diagnostic, and status data from water meter and transferring that data to a central database for billing, troubleshooting and analysing, as further enhancements that could be integrated along with the developed system.

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