

IMPLEMENTATION OF WEB BASED WASTE DISPOSAL MANAGEMENT SYSTEM WITH INTEGRATED PAYMENT

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ABSTRACT: *Solid Waste Management in Lagos state today is a largely manual process. From the initial process of user waste evacuation down to the payment method, the entire value chain of waste management is fraught with irregularities. Some of these issues include inconvenient customer onboarding process, cumbersome and fraud-prone payment process, and a disjointed waste collection and revenue collection systems. The non-dynamic nature of waste truck deployment creates inconsistencies and failure of waste evacuation, thereby creating environmental pollution and occasional disease outbreak issues. Aim: the aim of the work is to create a database that will enable storage and management of data related to the solid waste and to integrate online payment capability into the web portal to be designed Method: Site visitation and Questionnaires were used to study the current system of Waste Management process and Waterfall model was used to developed the system. The system is Web-based application and it was developed using the Microsoft Visual Studio 2010 with VB programming language used for coding of the application logic. MS Access Server was used for the database. Results: This project implemented a convenient, comfortable, and secure web platform for both users and managers of waste to achieve their joint aims; efficient and value-added waste evacuation process.*

KEYWORDS: *Solid waste, Solid Waste Management and Integrated Payment*

1. INTRODUCTION

Waste management issues are coming to the forefront of the global environmental agenda at an increasing frequency, as population and consumption growth result in increasing quantities of waste (Christos C. and Katia L. [17]). Adekunle et al [4] supported the assertion posit that Waste Management is a globally challenging issue especially in developing countries, due to its adverse environmental effects. The issue caused varies from pollution to loss of revenue, lack of proper work process, lack of database, insecurity and e.t.c. The problem is more acute in developing nations than in developed nations as the economic growth as well as urbanization is more rapid (Christos C. and Katia L.[17]).

Waste generation and management is an integral part of human activities. Mankind by design generates solid, liquid and gaseous waste by every activity in every second of his existence. According to the World Bank, about 2.01 billion metric tons of solid wastes are produced annually worldwide and it is estimated to reach 3.4 billion metric tons by the year 2050. (Ellis [19]). Nigeria as a country, like most of its developing nation peers, consequently has a huge challenge in the area of waste management given her teeming and ever increasing population.

Waste management remains a topical issue in Nigeria and all over the world, especially in Mega-Cities with large populations. Constant rural urban migration for a better living standard has led to population explosion in most Nigerian cities like Lagos, Kano and Abuja. This huge population of Lagos in turn generates an over 16 million tonnes per annum of estimated waste on a daily basis. The high level of urban consumption and improvement in manufacturing technology also contributes to growth in waste volume. The aforementioned points necessitate the need to look into the operation of the waste disposal system to improve revenue collection of the government.

Currently, the world generates around 3.5 million tons of waste per day or 1.3 billion tons per year among which 54.02% come from developing countries [22]. The more wastes created, the more area is required for disposal. This problem in turn affects the environment and the health of ecosystems and biodiversity of Cosmopolitan city like Lagos. The large volume of waste in Lagos has to be collected in an efficient and productive manner. This task has currently overwhelmed the waste management agencies of the State and Local governments who are saddled with this responsibility of maintaining a clean, healthy and habitable environment for the citizens.

The waste management system is currently not properly and optimally managed. The logistics of waste collection is clumsy and very unpredictable. Customers are made to strictly use manual payments

channels and are charged flat rates irrespective of volume of waste generated and collected. These inefficiencies in waste truck scheduling and customer payments have created a loophole for revenue loss and leakage, due to lack of proper payment/pick up matching, revenue accountability, automated payment and scheduling system. It was published recently that a multi-million-naira fraud rocks Lagos waste Agency [47]. The publications ascribed some of the problems to inflated wage bills of the operators and sharp corrupt practices in the agency.

In order to make the entire value chain from waste generation to waste disposal a far more productive one, there is a pressing need to automate the customer onboarding, create online payment system and automate the waste collection truck scheduling. This study shall focus on the implementation of a web based waste disposal management and revenue collections system.

The remaining part of this paper is organized as follows: Section 2 discusses related works, Section 3 discusses the methodology applied in the research, Section 4 shows the results of the developed system and Section 5 shows the concluding part of the research.

2. RELATED WORKS

Akpotuzor Sylvia A, Ofem Ajah O, Agana Moses A (2020) developed a Web-based Monitoring System for Optimal collection and Disposal of Solid Waste using Geographic Information System (GIS). The project adopted the Y-model web-GIS Development Methodology (YWDM) in developing the system with the aim of improving an effective waste management system and also providing a geographical view of waste collection bins and their locations in the study area.

Mohd Aizat Saiful Bahri et al (2019) Development of GIS Database and Facility Management System: Asset and Space in ukm. The paper described the implementation of integrated GIS solution in information system in UKM Bangi, especially for spatial data collation, spatial database creation, development on so called one-stop-GIS-portal that hosted the targeted modules. The system is not web based.

C.C. Ike *et al* (2018) did a research paper titled Solid Waste Management in Nigeria: Problems, Prospects, and Policies. This study examines the problems and prospects of solid waste management in some selected Nigerian cities using the mixed method of data collection. The findings revealed that waste management in Nigerian cities is largely monopolized by the agencies of state governments (sub-national governments) which have limited capacity to tackle the problems of solid waste

management in their cities. Although the problems of solid waste management in Nigeria range from poor collection and disposal methods; lack or poor waste management database; insufficient financial resources; non-compliance to laws and lack of awareness on dangers of poor sanitary habits, this paper argues that a robust waste data base, strict policies and regulation are important for effective solid waste management in Nigeria.

In [8] research titled Innovative Waste Management Technique Via Garbage Collecting Robotruck developed a model using Aduino code computer program, Interfacing between Microcontroller ultrasonic sensor and the RF module. The system is fully automated in which the garbage car moves automatically when it gets a signal via RF Module from the Garbage bin, when it gets completely filled. The RF module will send a signal to the garbage when the bin is filled. The system is fully automated in which the garbage car moves automatically when it gets a signal via RF Module from the Garbage bin, when it gets completely filled. The RF module will send a signal that will activate the Garbage car to response.

[42] developed a GIS based optimal route analysis for the transportation of solid waste- a case study from hyderabad city. The research focused on developing optimal transportation route maps for efficient, safe and economic disposal of solid waste. The final optimal route is obtained using arc view network analyst extension available in arc view GIS. The model is not a web based.

[24] developed a Web Based GIS Waste Disposal Management System for Nigeria. This research developed a web based GIS waste disposal management system, with aim of achieving an effective waste management system and a spatial view of waste collection locations in any local government area in Nigeria. This works is only primarily focused on easing the job of the waste management unit of the local government areas in Nigeria. The work did not center on the consumers and users of the waste management service.

Pooja V. Garach, Rikin Thakkar (2018) published a paper titled Design and Implementation of Smart Waste Management System using FOG computing. This system uses ultrasonic sensor for sensing the level of waste and using Arduino node MCU it will send the data to the server and from which it will analyze the filled level and according to which the collector truck will go for collection as per the optimized route generated. The paper developed an efficient system using **Arduino IDE**. The Arduino integrated development environment (IDE) and **ifogSim** tool for modelling IoT and Fog environments.

[28] presented research topic titled A Web-based Solid Waste Management System for Sierra Leone for his master thesis. This research developed a web based solid waste management system with the aim to promote a sustainable waste management system in Sierra Leone. The system is a ASP.NET Web-based application and it was developed using the IDE Microsoft Visual Studio 2015 with C# as the programming language. Extensive Software packages or technologies used for the development of the application are MySQL, Microsoft SQL Server Management Studio 17, GITHUB and GIT.

3. THEORETICAL REVIEW

3.1 Data collection

This is a fact-finding technique that was used to studied the current system to determine the need for an improved system of operation. The techniques used were site visitation of work environment and Questionnaire.

The following points were noticed during site visitation

- The refuse is collected from house to house using privately owned trucks, in addition to those belonging to the local government
- Refuse payment bills are generated manually
- Payment of refuse is made to “Lagos State Waste Disposal Board” account.
- Bills are circulated quarterly to residences as payment due.
- The customers proceed to the bank to make payments.
- A copy of the teller for payment is then pasted on the gates of such houses.

Questionnaires

A total of 100 questionnaires were printed out and distributed among some of the staffs, customers in the local government. The responses and answers on the need for an improved method of operation yielded 70% for YES, 25% for NO, while 5% abstained. Based on the response and comment from the questionnaires sent out generally, there is a very high recommendation that there is need for the implementation of web based disposal management system in the local government waste agency.

3.2 System design

This project is aimed at Implementation of web based disposal management system through a series of waste management business processes using information technology.

This web-based system will allow customers to register on the web portal. A registration ID is generated which is unique in the system. Subsequently the user makes refuse collection request and payment for the collection. The amount payable by the customer depends on the property type. The user is then advised to print out the payment receipt as proof of payment.

The administrator of the web portal upon a receipt of request and payment confirmation in the system will subsequently approve or reject the waste collection request as the case may be. The admin will then assign truck for the collection base on the home address submitted by the customer during registration. Once the truck driver or officer gets the allocation schedule, the waste is collected and the customers or resident is made to sign as proof of collection of waste. Every activity is tracked up to even the billing mechanism.

The web pages created for the output module includes:

- a. **Login module:** For users to login to the system
- b. **Customers platform module:** This is the customers landing page of the engine after authentication. User can then manage his or her account from here
- c. **Admin Module:** This is the module where the admin or the designated officer will create and allocate the staff department and create other users.
- d. **The Supervisor module:** This is the module for the waste agency supervisors in charge of all the trucks for waste collections. He or she allocates truck in the system for waste collection and can also, check waste payment history for each customers and waste collection processes.

Design Architecture

System flows

The main process flow of the web-based integrated payment for waste disposal is as follows: First, the login verification checks if the user has registered and activated an account; if not, the user is asked to register a new account. Then, the system determines the identity of the user (administrator or customers) according to the account information. After that, the relevant permissions are given to the user for he/she to use the modules.

The system flow is explained in Figure 1 below.

FLOW CHART OF THE IMPLEMENTATION OF WASTE DISPOSAL MANAGEMENT AND PAYMENT SYSTEM

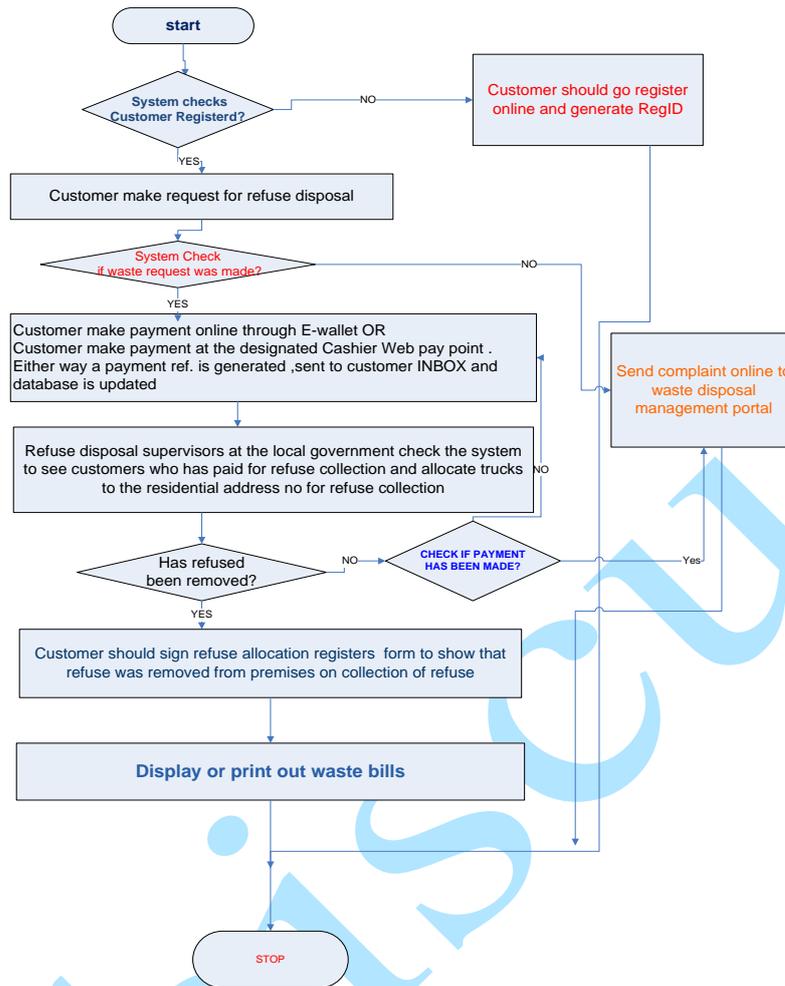


Figure 1: Flow Chart Diagram

IMPLEMENTATION WEB BASED WASTE DISPOSAL MANAGEMENT SYSTEM CLASS DIAGRAM

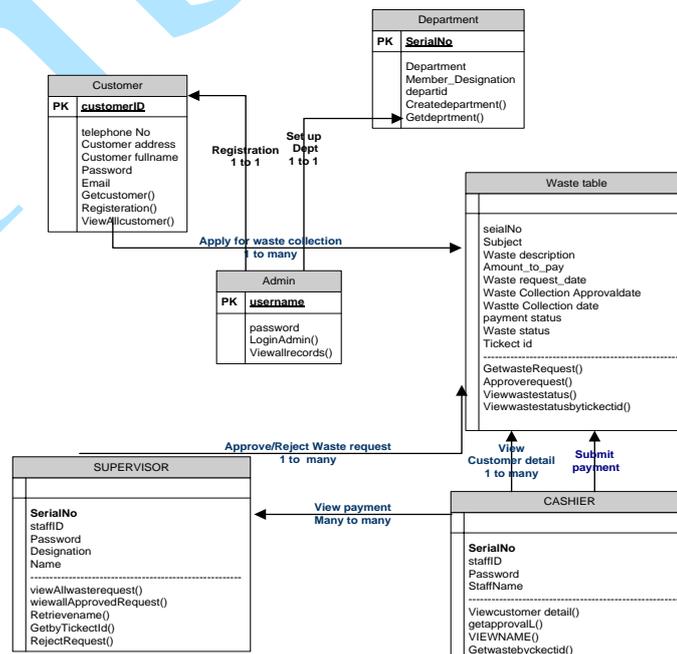


Figure 2: Class diagram

4. IMPLEMENTATION AND EVALUATION

The system is to make customers to register online on the portal of the waste agency using their unique username (Email) and password. It will allow the customer to fill their details and proceed to generate a payment reference wherever and whenever they need waste disposal. It helps administrators and customers to keep track of transaction statuses and provide a much better and improved working relationship.

4.1. System Requirements

In order to effectively run this application, the required minimum hardware specifications are:

System Hardware Requirements

- P111.133 GHz and a system internet ready/full multimedia
- Minimum 128 MB RAM
- 52 max CD drive
- SVGA or VGA monitor
- 40 gigabytes hard disk

System Software Requirements

- Visual studio 2010 code used for the programming platform
- VB programming language used for coding of the application logic
- MS Access 2013 for the database
- Microsoft Window 7 OR above as the operating system

4.2. Description of the Web Based Waste Disposal Management System

The main/home page is the first page of the web portal. It gives an overview of what the web portal is all about, what it contains and also links to other pages such as the admin, other staff login page, confirm logging page, customer's registration page, supervisor module, truck officer module, the customers etc. Most of these pages and module are only accessible to authorized staff and customers required to provide their login credentials before accessing the application.

This web-based system will allow customers to register on the web portal. A unique registration ID is generated for each user. The user places a refuse collection request and pay for the collection. The amount to be paid by the customer depends on the property type. The user then prints out the payment receipt as proof of payment.

The staff of the waste management agency collates the requests at the back end of the web portal after payment confirmation. The officers would then assign truck for the collection based on the requests that were submitted. After the waste evacuation by

the truck driver or officers the customers or resident is made to sign as proof of waste evacuation. Every activity is tracked up to even the billing mechanism.

4.3. User Manual

The system user manual comprises of the users of the application and what they do in the system as shown below.

SUPERVISOR (STAFF): These are the staffs of the waste management company that have been created in the system using their staff id and password. They can also view the customer's request for refuse collections, payment history and equally assign truck for refuse collections in the system. They can equally examine and reject any customers request when necessary. They can view all customer complaints and give response as the case may be.

ADMINISTRATOR: This is the officer that manages the software application and uses it to make him more productive. He performs administrative tasks such as configuring the application; to set up all the parameters necessary before the application could run. Some of the things the administrator can do include

- User Registration
- Records Management
- Manages Messages
- View Transaction Histories

While he can update records, insert records, modify, retrieves records, he cannot delete records of staff already tied to a record for audit trail purpose.

CUSTOMERS: These are customers that have registered for waste collections on the web portal. They can request for waste collections and make payments using credit cards or use any of the designed web pay point in the system. Payment receipts are printed out each time payment is made. They can send in complaints and view responses in the inbox created.

Sample Implementation Input Snapshots

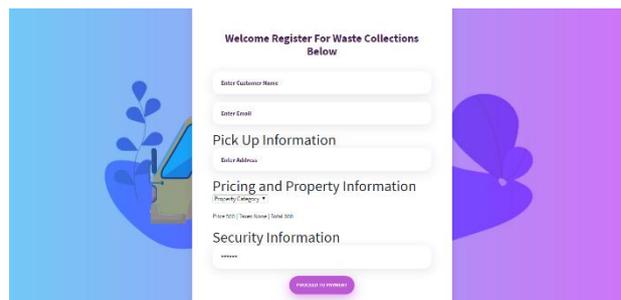


Figure 3: Registration.php (Source: Implementation of a Web Based Waste Disposal Management System with Payment Integration (A Case Study of Mushin Local Government, Lagos State)



Figure 4: main.php (Source: Implementation of a Web Based Waste Disposal Management System With Payment Integration (A Case Study of Mushin Local Government, Lagos State)

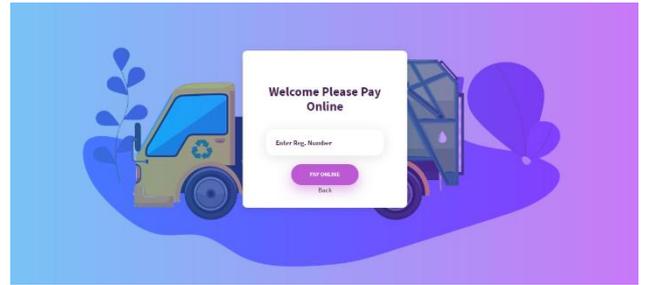


Figure 8: payonline.php (Source: Implementation of a Web Based Waste Disposal Management System with Payment Integration (A Case Study of Mushin Local Government, Lagos State)

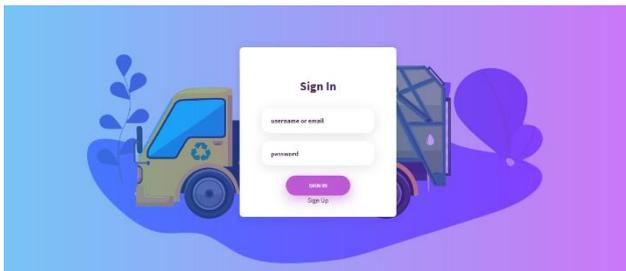


Figure 5: Loign.php (Source: Implementation of a Web Based Waste Disposal Management System with Payment Integration (A Case Study of Mushin Local Government, Lagos State)

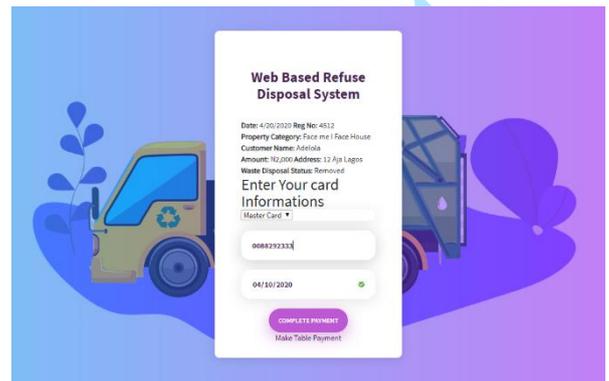


Figure 9: paymentpage.php (Source: Implementation of a Web Based Waste Disposal Management System)

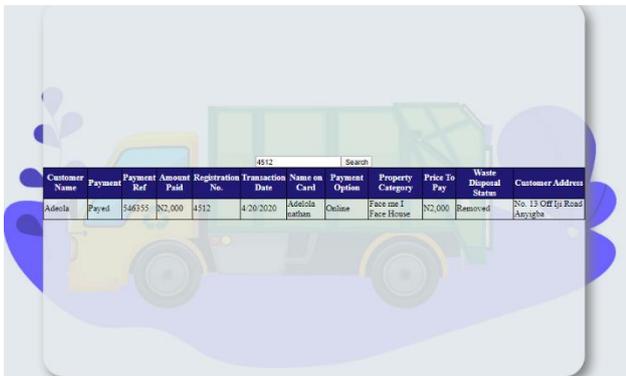


Figure 6: Search.php (Source: Implementation of a Web Based Waste Disposal Management System with Payment Integration (A Case Study of Mushin Local Government, Lagos State).

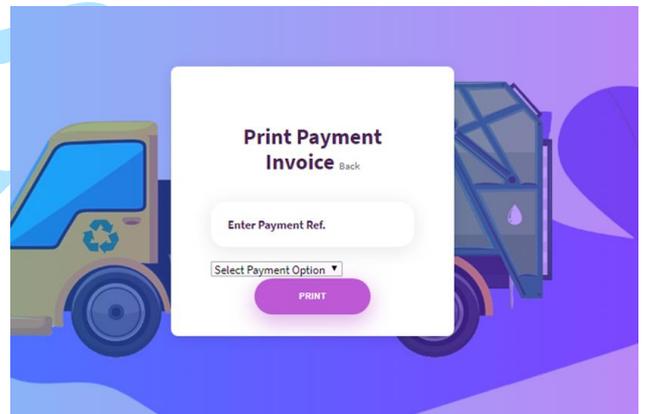


Figure 10: Print.php (Source: Implementation of a Web Based Waste Disposal Management System (A Case Study of Mushin Local Government, Lagos State)

Sample Implementation Output Snapshot

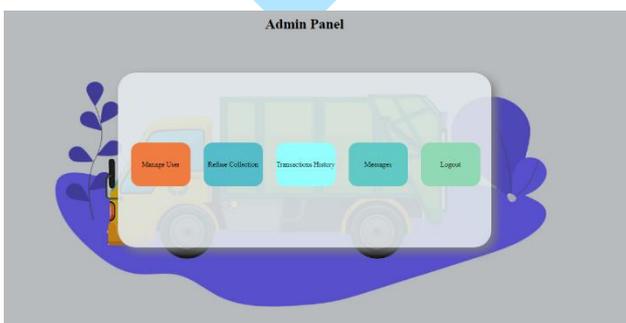


Figure 7: Adminhome.php (Source: Implementation of a Web Based Waste Disposal Management System with Payment Integration (A Case Study of Mushin Local Government, Lagos State)



Figure 11: printresult.php (Source: Implementation of a Web Based Waste Disposal Management System (A Case Study of Mushin Local Government, Lagos State)

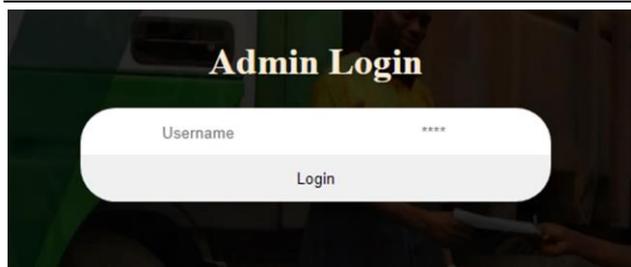


Figure 12: Adminlog.php (Source: Implementation of a Web Based Waste Disposal Management System (A Case Study of Mushin Local Government, Lagos State)

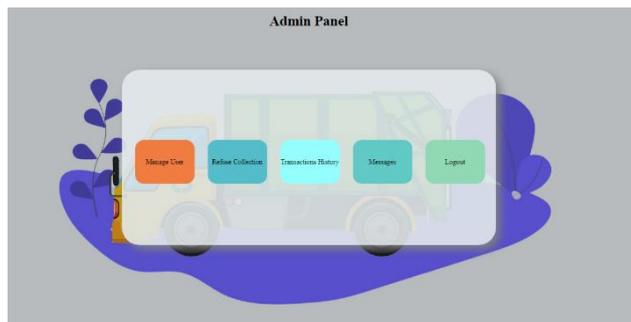


Figure 13: Adminhome.php (Source: Implementation of a Web Based Waste Disposal Management System (A Case Study of Mushin Local Government, Lagos State)

4.4. EVALUATION OF RESULTS

The software developed was evaluated against quality assurance and durability and was found to be good and reliable. It also met software requirements based on the new automated business process. These includes the customer registration form, web based payments form, software product output and setup by the admin. The overall workflow process was also evaluated and is working well. The evaluation was performed to determine the level of functionality and operability of the solution developed. However, it was tested based on the requirements model for the new solution. The aim is to see the user-friendliness of the new web based waste disposal management system developed compare to other existing software and it was found to be durable and rugged. It mostly addresses all the existing challenges mentioned in chapter three. Although some functionalities were not captured due to limitations mentioned in chapter

DISCUSSION AND CONCLUSION

This project has been able to achieve the set objectives. The web based waste disposal management system despite the limited time has been fully automated with desired results. The application has three principal actors Administrators, Waste supervisors, Truck officers and the customers.

Customers can register details online, request for refuse collections, view payment history and be able to pay online using credit card or any web pay points. Among other things the customer can do, they can view and monitor waste status collections. The

supervisors can approve or reject waste collections request. Various reports can be generated on the application using various parameters while the system developed gives room for scalability. The database system is such that it fully integrates with the business workflow making generation of ad-hoc reports from the database archives possible.

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