



## 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 on boarding 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. 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. 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. The methodology is preferable because it is easy to out and the programming language is flexible, integrated and easy to code. This project implemented a convenient, comfortable, and secure web platform for both users and managers of waste to meet their joint aims; efficient and value-added waste evacuation process.

**Keywords:** Solid waste, solid waste management and integrated payment

### 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 and Katia, 2011). Adekunle *et al.* (2011) supported the assertion posit that Waste Management is a globally challenging issue especially in developing countries, due to its adverse environmental effects. The issues caused vary from pollution to loss of revenue, lack of proper work process, lack of database, insecurity, bad road etc. The problem is more acute in developing nations than in developed nations as the economic growth as well as urbanization is more rapid (Christos and Katia, 2011).

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, 2018). 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 cause 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 (Hoorne and Bhada-Tata, 2012). 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 way. 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 (Punch Newspaper June 16, 2020). 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 study of the current system using Mushin local government area of Lagos State and implementation of a web based waste disposal management with revenue collections system.

Akpotuzor *et al.* (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 providing a geographical view of waste collection bins and their locations in the study area. Mohd Aizat *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. 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 of 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.

Akshaya and Selvakumar (2019) in their 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 where the garbage car moves automatically when it gets a signal via RF Module from the Garbage bin, when it gets 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.

Ramesh Kumar and Ramakrishna (2015) 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. Idowu *et al.* (2012) 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 work 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.

Islam *et al.* (2016) published a paper titled published a research paper titled Municipal Solid Waste Management using GIS Application in Mirpur Area of Dhaka City, Bangladesh. The paper proposed a Geographical Information System (GIS) to identify proper waste dumping site and prevent contamination and an efficient scenario with relocating the existing waste collecting containers. It also proposed an increased number of containers (73) to obtain 93.68% collection efficiency including optimization and selection of waste collecting routes for the waste study area. This study also show that the application of GIS is an efficient and low cost tool to study. The short comings of the paper are Lack of integrated payment platform and it is not web based.

Pooja and Rikin (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. Kisimi

(2018) 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.

### **Materials and Methods**

The research was carried out through site visitation to the Local government to examine and check the work processes. Questionnaires were administered to the staff of Lagos State Waste Agency (LAWMA) represented by Private Sector Participation (PSP) to validate the need for an improved and better system of operation. There are several tools or programming languages that could be employed for the development or design of a system but the choice of the programming language and tools used depend greatly on so many factors or conditions e.g. flexibility, goals of the system, ease of use, ease of understanding, targeted end users, size of the industry for which the system was proposed and lots more (Idowu *et al.*, 2012). In this research work, visual basic 2010 was used for the coding. Microsoft Visual Basic 2010 is a fully object-oriented programming language implemented on the NET Framework. It was chosen because it not only a language but also primarily an integrated and interactive development environment (IDE). It is very simple particularly the execution of code and provision of comprehensive interactive and context-sensitive online help system. When editing program texts the 'intelliSense' technology informs you in a little popup window about the types of constructs that may be entered at the current cursor location. Microsoft access was installed and used as the database management system, but the application was designed and created using visual studio 2010 platform within windows 7 operating system environment. To access the application Debugging must be done to make sure that all errors were fixed before launching, NET Framework 3.5 must be available on the deployment machine since it was developed using visual studio 2010.

### **Site visitation**

A fact-finding technique of site visitation was done to study the current system to determine the need for an improved system of operation.

### **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 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.

**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

**i. Login module:** For users to login to the system

**ii. Customers platform module:** This is the customers landing page of the engine after authentication. User can then manage his or her account from here

**iii. Admin Module:** This is the module where the admin or the designated officer will create and allocate the staff department and create other users.

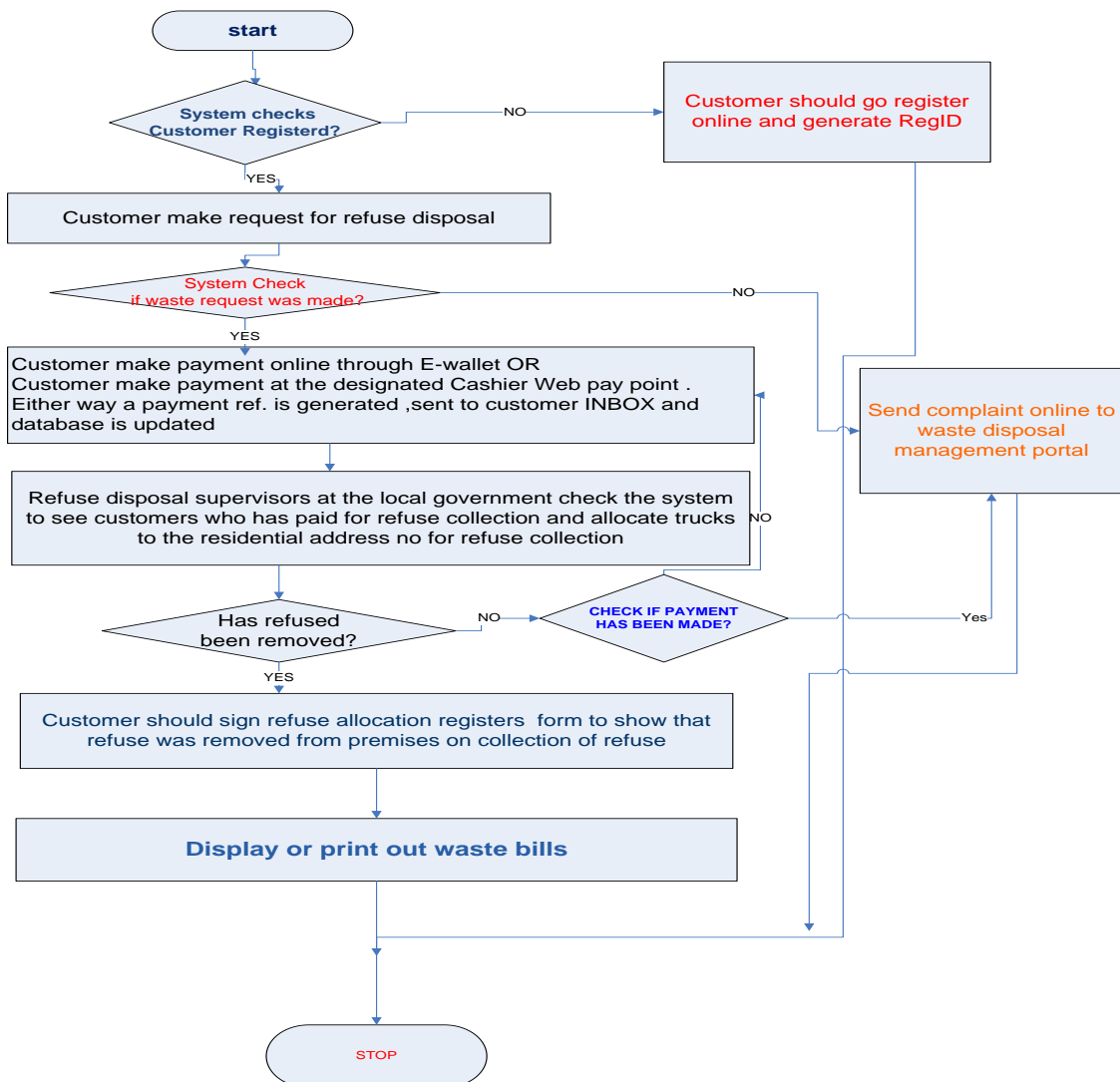
**iv. The Supervisor module:** This is the module for the waste agency supervisors in charge of all the trucks for waste collections. He or she allocates truck in the system for waste collection and can also, check waste payment history for each customers and waste collection processes.

**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 Fig. 1.

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



**Fig. 1: Flow chart diagram**

**IMPLEMENTATION WEB BASED WASTE DISPOSAL MANAGEMENT SYSTEM  
CLASS DIAGRAM**

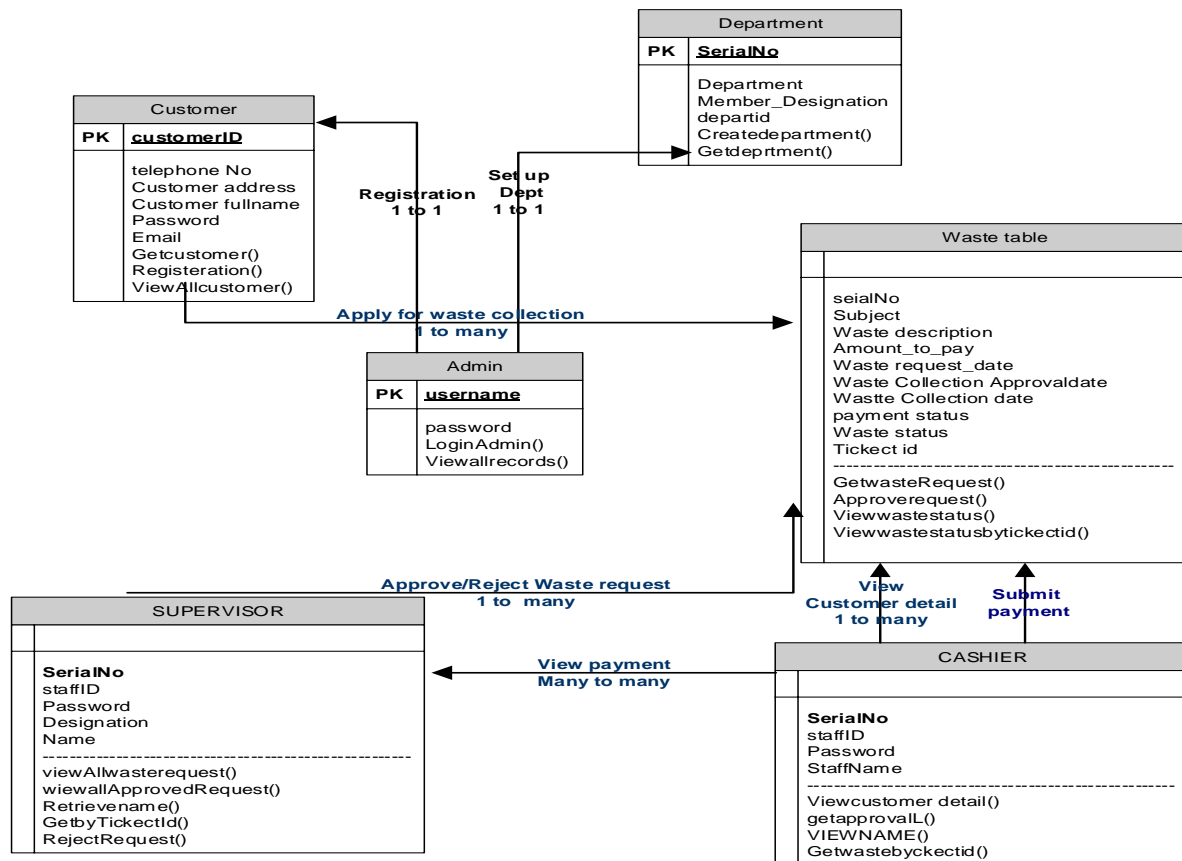


Fig. 2: Class diagram

**Class diagram**

Class diagrams are used to display the main actors or building block in object-oriented modelling. It displays the attributes, operations and the relationship among objects. It is a static structures of classifiers in a system and helpful for developers, business analyst and other members of the model. The model displays in Fig. 2 consist of the following main blocks

1. Customers – Customer ID is the unique identify/key that is assigned to all customers that log on to the platform. Other attributes are address of the customer, full name, email, password e.t.c
2. Admin – The primary key is the username that must not be duplicated on the platform. Others are password, login Admin e.t.c
3. Supervisor – The supervisor can be classified under the block of Admin through Inheritance. The supervisor will be able to check request, get ticket ID, grant approval and follow status of evacuation.
4. Cashier – they can also log on to the system to validate payment records of customers. Cashiers will view amount paid, waste request and all others records on the waste table block for verification and accounting purposes

**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 offer better and improved working relationship.

**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

**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 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 collate 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.

#### 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.

**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

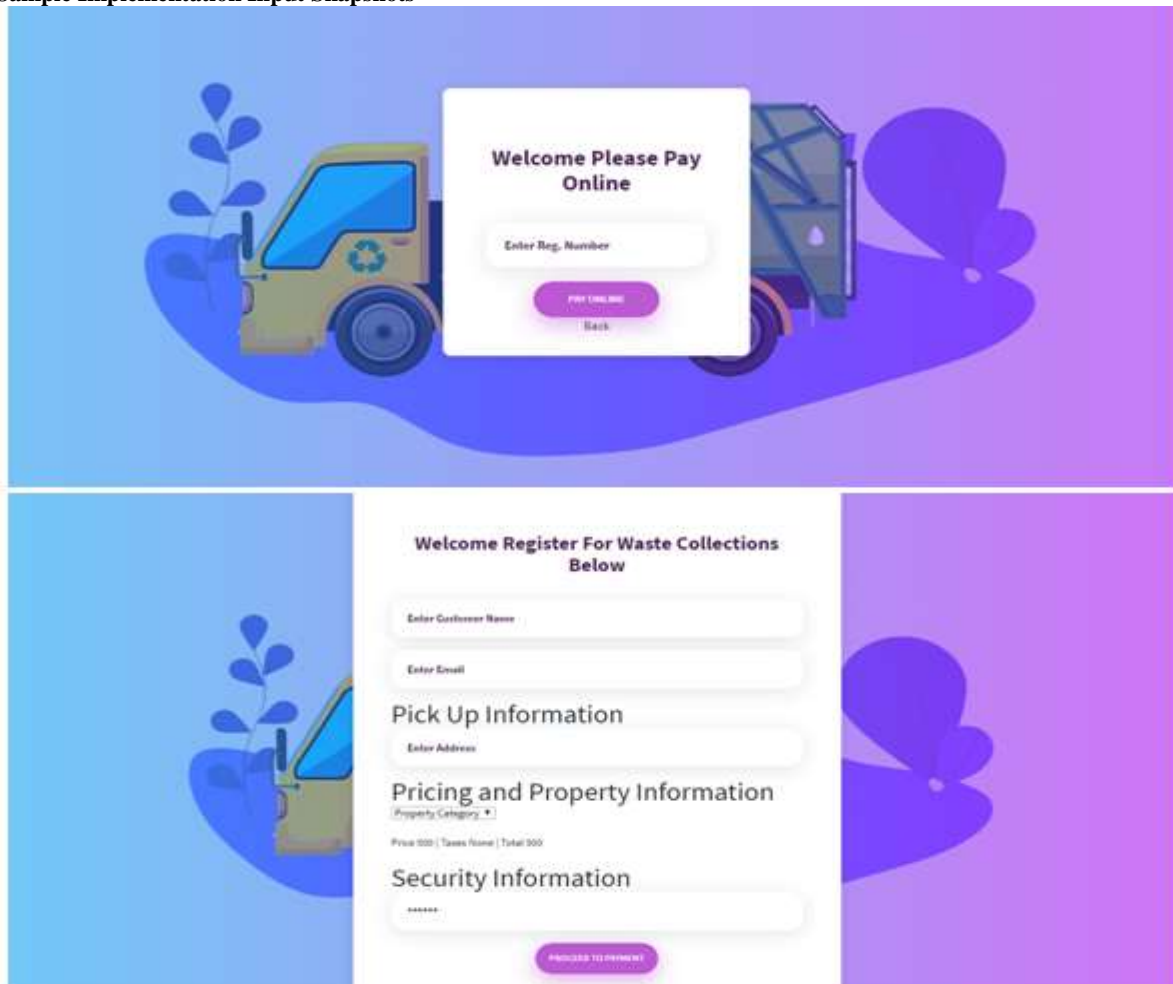
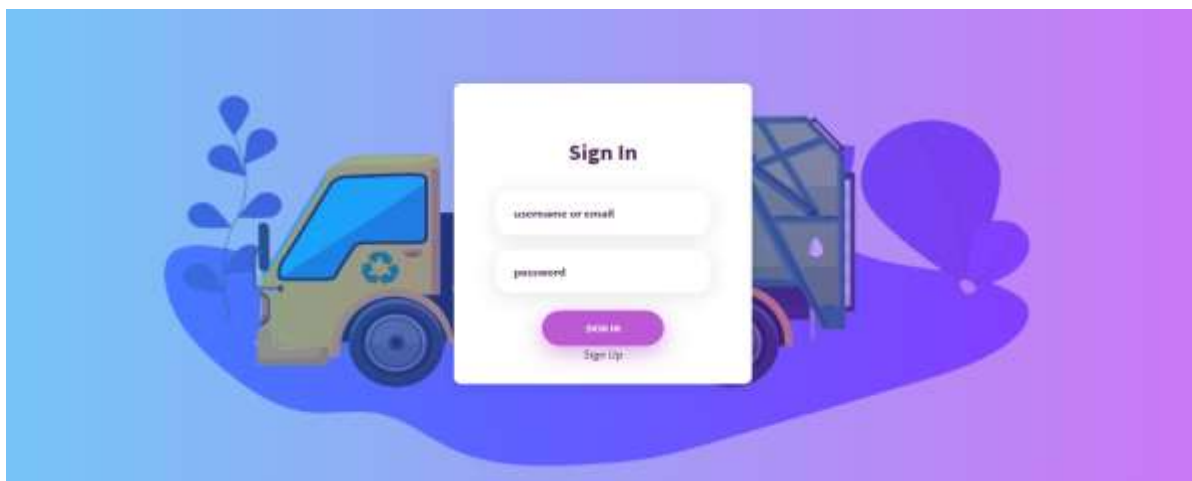


Fig. 3: Registration.php (Source: Implementation of a Web based waste disposal management system with payment integration (A case study of Mushin local government, Lagos State)

*Web-based Application of Waste Disposal Management System*



**Fig. 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))



**Fig. 5: Login.php** (Source: Implementation of a Web based waste disposal management system with payment integration (A case study of Mushin local government, Lagos State))

The screenshot shows a search interface with a search bar containing the value '4512' and a 'Search' button. Below the search bar is a table displaying search results. The table has 12 columns: Customer Name, Payment, Payment Ref, Amount Paid, Registration No., Transaction Date, Name on Card, Payment Option, Property Category, Price To Pay, Waste Disposal Status, and Customer Address. One result is shown for Adeola, with a payment of N2,000 made on 4/20/2020.

Customer Name	Payment	Payment Ref	Amount Paid	Registration No.	Transaction Date	Name on Card	Payment Option	Property Category	Price To Pay	Waste Disposal Status	Customer Address
Adeola	Paid	548355	N2,000	4512	4/20/2020	Adelola nathan	Online	Face me I Face House	N2,000	Removed	No. 13 Off Ije Road Anyigba

**Fig. 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))

Sample implementation output snapshot

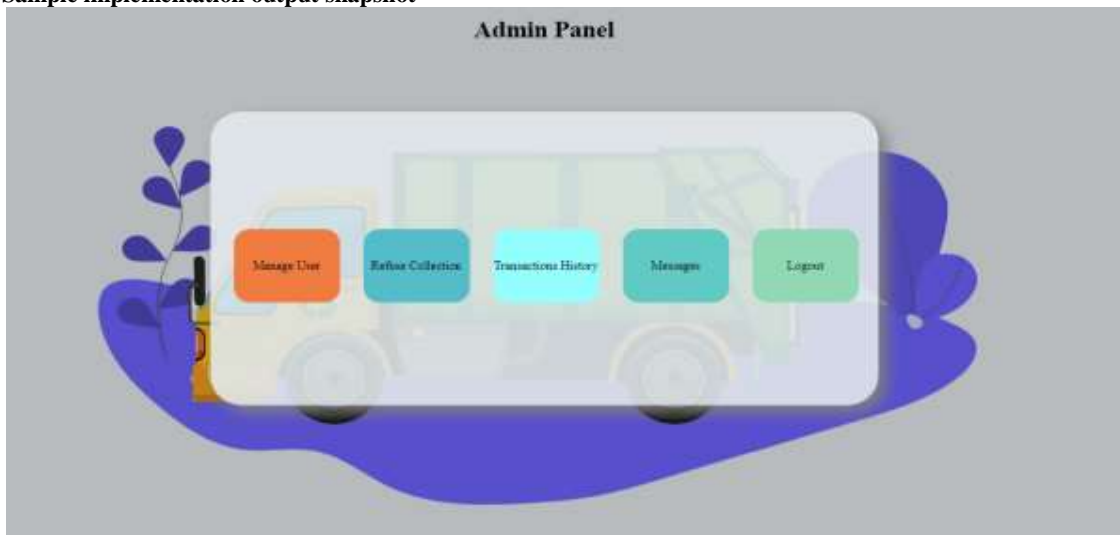


Fig. 7: Adminhome.php (Source: Implementation of a Web based waste disposal management system with payment integration (A case study of Mushin local government, Lagos State)

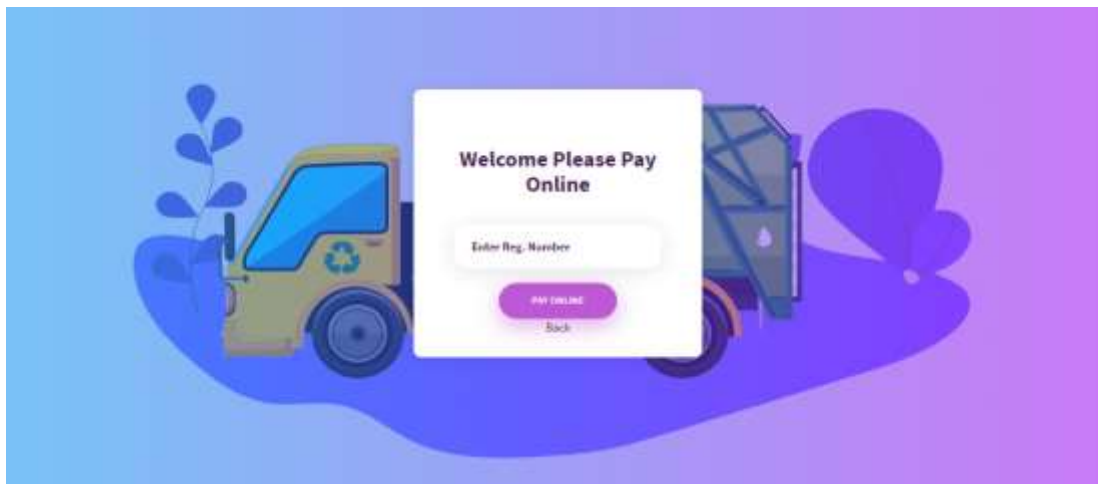


Fig. 8: Payonline.php (Source: Implementation of a Web based waste disposal management system with payment integration (A case study of Mushin local government, Lagos State)

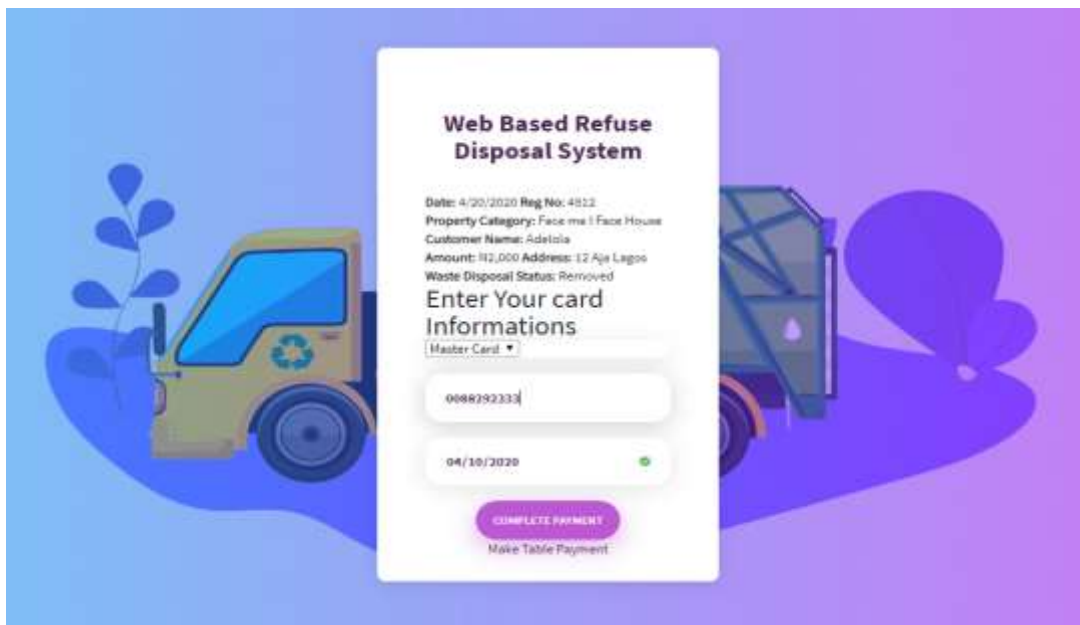


Fig. 9: Paymentpage.php (Source: Implementation of a Web based waste disposal management system)

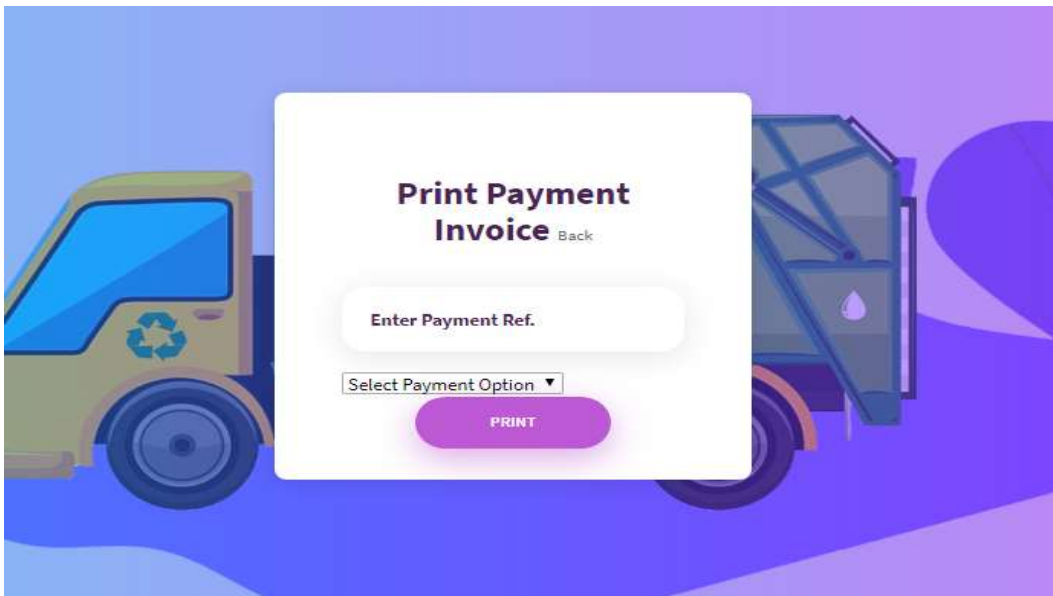


Fig. 10: Print.php (Source: Implementation of a Web Based Waste Disposal Management System (A Case Study of Mushin Local Government, Lagos State)



Fig. 11: Printresult.php (Source: Implementation of a Web based waste disposal management system (A case study of Mushin local government, Lagos State)

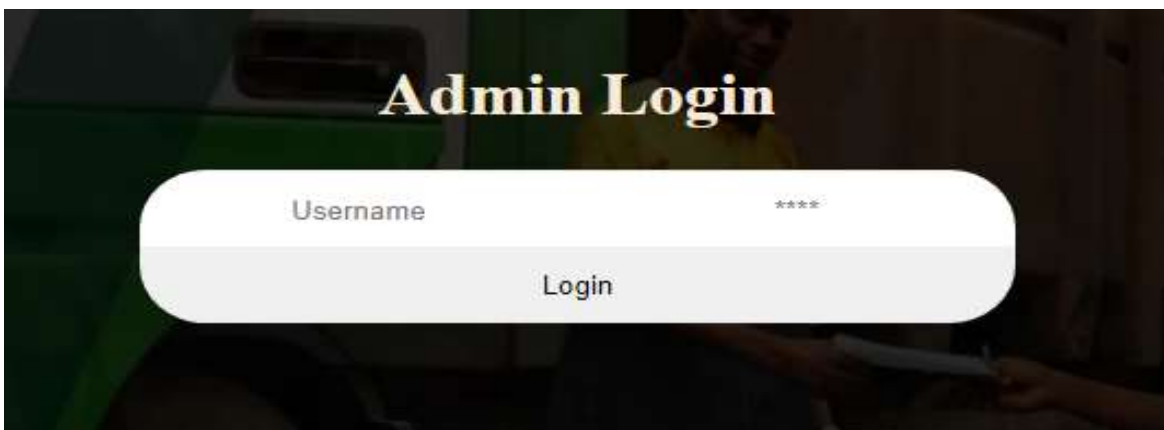
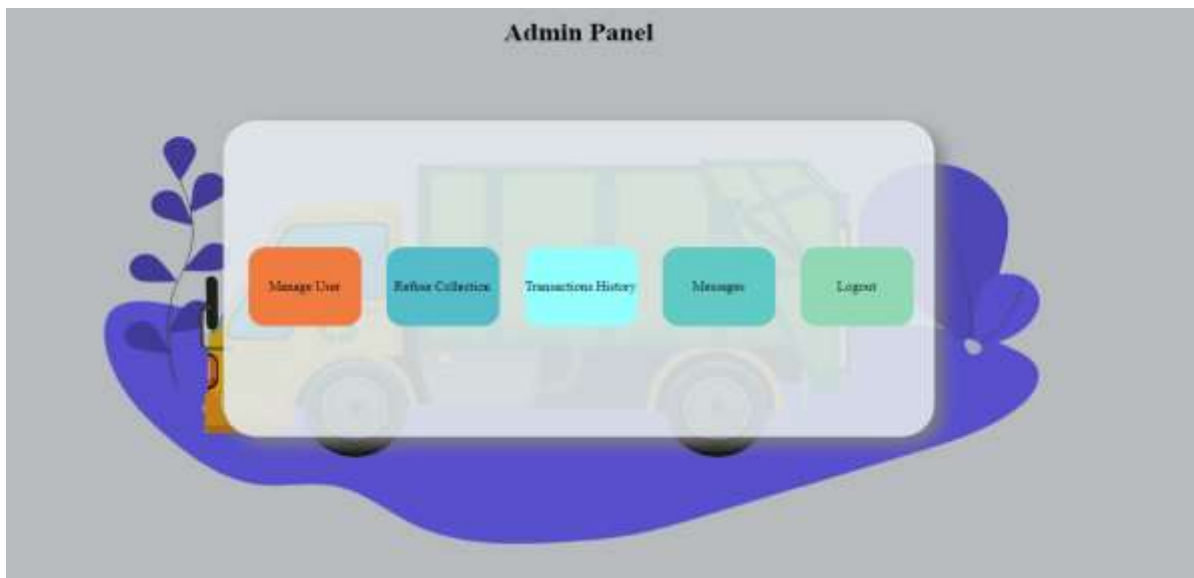


Fig. 12: Adminlog.php (Source: Implementation of a Web based waste disposal management system (A case study of Mushin local government, Lagos State)





**Fig. 13: Adminhome.php** (Source: Implementation of a WFeb based waste disposal management system (A case study of Mushin local government, Lagos State)

### 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 earlier. The software was evaluated using Xamp application which gives the output shown in the above figures for different class of users.

### Discussion and Conclusion

In conclusion, this research presents a solid waste management system for Mushin Local Government area of Lagos. This project has been able to achieve the set objectives. The current system was studied using site visitation and questionnaires administration. The result of the questionnaires was analyzed and the results were supported using various earlier works. 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 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. This research work emphasizes the effective and efficient ways evacuating environmental wastes in such a way that guarantee healthy living and maximizing revenue generation. It will also aid the prompt delivery of the services of the environmental unit of the local government areas in Nigeria Among other things the customer can do, they can view and monitor waste status collections. The database system is such that it fully integrates with the business workflow making generation of ad-hoc reports from the database archives possible.

### Conflict of Interest

Authors declare that there is no conflict of interest reported in this work.

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