

Development of a Plastics and Paper Waste Management System for a University Community

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Abstract. In Nigeria, poor waste management practices are evident in many urban centers. This study considered a University community as the model to explore the use of digital solutions in proper waste management. This study developed a web-based waste management system for the collection of plastics and paper in a University community. The framework developed utilized the use case and system block diagram. In this study, HTML, CSS, MySQL and Java programming language was used in the design of the web-based system. The result of this study was presented using screenshots. The web-based system had an interface to show profiles of the users, waste pickup information, incentive platform, and the admin dashboard to monitor and approve pickups and incentives. Past studies have indicated the success of using incentives to build sustainable behavioural change towards efficient waste disposal. Therefore, this study was able to introduce the incentive platform which converts weight of paper and plastics waste to points then to rewards for the users. The web-based waste management system for the collection of plastics and paper can be deployed for University communities to help reduce the number of paper and plastics that end up in landfills. Also, by picking the paper and plastics waste from source helps to prevent bin contamination.

Keywords: Paper · Plastics · University · Waste management · Web-based system

1 Introduction

Municipal waste is a challenge in most urban cities. This also the assertion in the study by [1], where it stated that most Nigerian towns and cities are confronted with the significant problems of poor solid waste management. The high level of urbanization and rural-urban migration has inhibited the ability of the appropriate waste management agencies' capacity to deal with the high levels of solid waste. The studies by [1–3]

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reported that the waste management crisis is evident with the presence of mountain of refuse on major roads and streets in Lagos, Kano, Ibadan, Enugu, Onitsha to mention a few. The sudden increase in the solid waste and its weak disposal system is becoming alarming and becoming a health hazard to communities. Health hazards such as cholera, typhoid, dysentery and so on have been linked to inadequate solid waste management [4]. In [5] it was noted that this is compounded with the high volume of plastics waste that has littered streets, drainages, and public premises. As far back as 1986, the report by [6] noted that the high volume of solid waste experienced in major cities in Nigeria has been due to the incomplete removal of the central refuse dump. In addition to the problem of poor collection and disposal system is the population explosion in urban cities, nonchalant attitude towards adequate waste disposal, and lack of environmental awareness [7].

This assertion is also supported by [8], that the major contributing factors to poor waste management in Nigerian communities is its inadequate collection methods, unsatisfactory coverage and inappropriate disposal systems. One of the ways that have been used in collection of solid waste such as scrap metals, bottles, plastics from dumpsite is the use of informal labour waste collectors [2]. By collecting these specific solid waste, recycling and reuse of these solid wastes is encouraged.

Most importantly, [2] found out that as population increases in urban centres, most of the solid waste generated are non-biodegradable which necessitates the need to recycle and reuse. Lack of necessary waste management infrastructure particularly improper coordination of waste collection and disposal is taking a toll on major cities in Nigeria. This study proposes that with the use of web-based systems and other digital technologies it will improve the coordination and planning of waste management units in door-to-door collection of waste thereby enhancing health and wellbeing of communities. As [9] noted, proper waste management should take effect from inception to the final disposal.

This study considered a University community as the model to explore the use of digital solutions in proper waste management. The studies by [10] and [11] stated that educational institutions, even though regarded as small communities, can actively and significantly impact their surrounding urban communities. The study by [12] supported the notion of proper solid waste management systems in educational institutions in that it can train students on the best practices which can be replicated in their communities when they leave the school premises. With the understanding of the need to carry out appropriate waste management practices within universities and outside, this study developed a web-based waste management system for the collection of plastics and paper in a University community.

2 Literature Review

Proper waste management strategies are gaining traction from most educational institutions [13]. Notably, since they are the citadel of learning, they should be at the forefront of best practices to protect the environment. [14] stated that Universities have the responsibility of ensuring that communities imbibe sustainable plans and policies, mainly as it deals with the environment. This is why there is an increased focus on

institutions of higher learning on enhanced sustainability [15]. The study by [15] reported that Universities have a moral obligation towards fostering sustainability agendas due to its possession of academic staff and their comprehensive range engagement of various stakeholders in their community.

Studies by [12] and [16] opined that some are adopting the zero-waste policy. This involves a conscious and rigorous effort to recycle solid waste generated within the educational institution. The first step in this has been able to show the composition and characteristics of the solid waste generated within a community [11, 13]. The solid waste generated per location will differ due to the prevalent activities within the area [14]. This would also help identify the best and workable waste management strategy. A previous study carried out in the same location as this study showed that the waste generation rate was 0.3–0.4 kg/capita/day [14]. The composition of these wastes was organic waste and non-biodegradable, which were generated from halls of residence, residential premises, cafeterias, and other business and religious areas within the University community. The non-biodegradable solid waste is sorted at the dumpsite and sold off to waste scavengers [14].

Even though the University has dust bins specially marked to separate different types of solid waste, many students and staff still do not comply. [14] suggested the need to carry out intensive awareness programs that teach and foster best practices in solid waste management. In the area of recycling in a higher education institution, [15] noted that the significant barriers were lack of motivation to recycle, high levels of bin contamination, and lack of knowledge on recycling initiatives within the University. In Romania, [9] proposed an online platform for waste management of selected items within a university community. Their study examined the present waste management system used within the University community and the volume of waste generated per time. By using IT integrated with the existing waste management infrastructure, they were able to raise the level of waste collection and recycling. The online waste management system proposed by [9] aimed at increasing operational efficiencies and cutback waste generation from the source. However, only the system architecture was shown in this study without the actual online platform.

3 System Design and Implementation

This section showed the system requirement, design of the system and the step-by-step implementation of the web-based waste management system.

System Requirement:

1. Users should be able to register their profile and be able to indicate the need for the waste management unit to pick up paper and plastics waste from residential homes, offices and student hostels within the University community.
2. Waste Managers/administrators should have their own profile and be able to identify point for pick up for paper and plastics waste from residential homes, offices and student hostels within the University community.

3. Waste Managers/Administrator should be able to input the weight of either the paper or plastic waste in the system at the point of pick up from the residential homes, offices and student hostels.
4. The weight generated from each pick up location should be converted to points which would show on the Users' profile.
5. The points gathered on a User's profile should be able to amount to rewards on the user's page to encourage an incentive system for proper waste management.

The study developed a web-based system for plastics and paper waste management within a University community. In the system design, the study followed the patterns of the unified modeling language (UML) used in [18, 19]. The UML used user case diagrams and system-block diagram. The coding language included HTML for the interface, CSS, MySQL for the database, and Java programming language in the NetBeans IDE. In the use case diagram, shown in Fig. 1, it helped explain the actions/steps defining the interactions between the users and the system developed. Figure 1 indicates that there are two primary users- the user needing waste pickup and the administrator of the waste management platform. In this study, the users can be faculty, staff, and students within the University community. In Fig. 1, there are five primary interfaces the administrator can access, whereas the user can access six primary interfaces. In the UML diagram, the system block diagram in Fig. 2 showed the flow of the process in the web-based system.

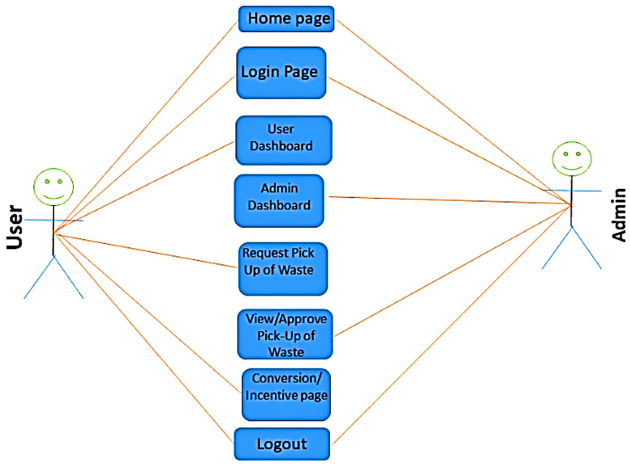

Fig. 1. Use case diagram of the plastics/paper waste management system. Source: Author's Design

The system block diagram showed the step by step activity pages the users can access via the URL of the web-based system. The URL of the waste management platform can be hosted as a link on the University community website. Users in need of a pickup of plastics and paper waste click on the URL and login to the platform. Figure 3 showed the homepage of the Plastics/Paper Waste Management System. Both

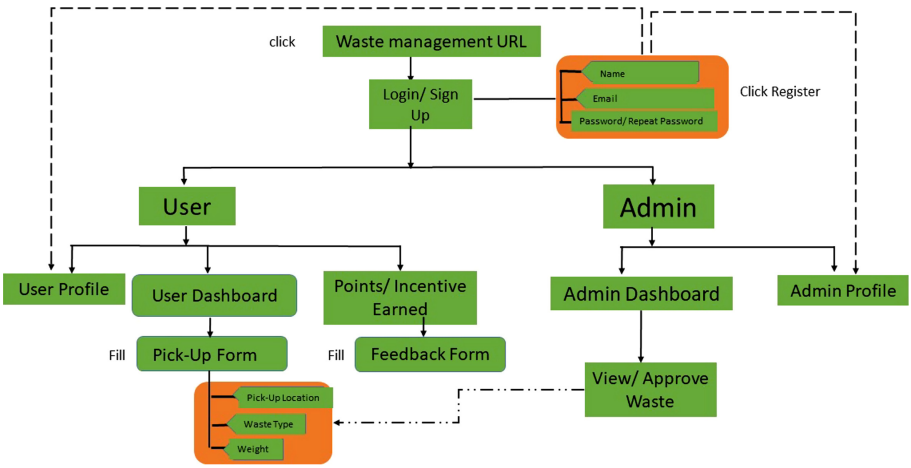

Fig. 2. System block diagram of the plastics/paper waste management system. Source: Author's Design

the users and admin supply their login details on the home page. Information about pickup times is displayed on the homepage in terms of the locations within the University community; hostels, residential homes, and offices. For new users, there is a sign-up page to create a profile on the Plastics/Paper Waste Management System, as shown in Fig. 4.



Fig. 3. Home page of the plastics/paper waste management system

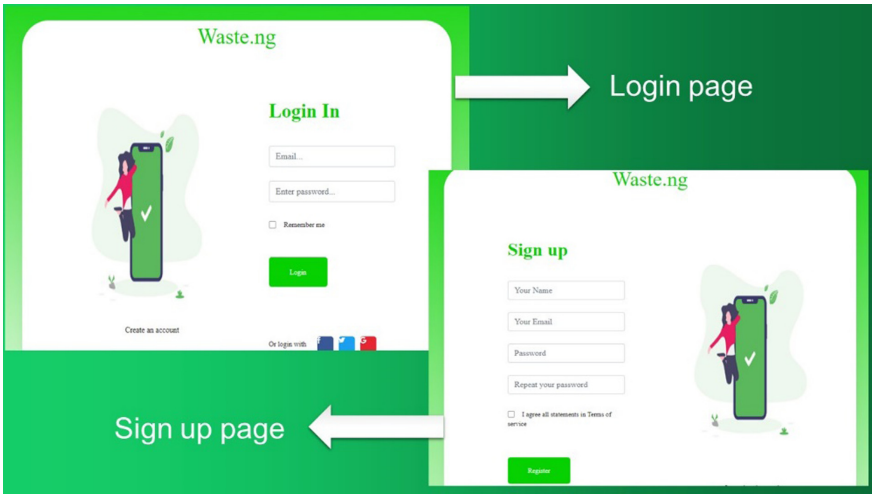

Fig. 4. Login page of the plastics/paper waste management system

Once each user has satisfactorily logged into the Plastics/Paper Waste Management System, a profile is created, which shows name and email, as shown in Fig. 5. The setting icon helps users to be able to supply other details associated with the user. Figure 6 showed the user dashboard of the Plastics/Paper Waste Management System. In the user dashboard, the total number of requests, location, number of times logged in, and points earned by the user is displayed. On the panel, there is also a recent pickup and request. Figure 7 showed the Pickup Form Page in Plastics/Paper Waste Management System. Users can fill the forms to indicate pickup location, waste type, and weight of waste. Figure 8 showed the Incentive Page of the Plastics/Paper Waste Management System. The study by [20] noted that ensuring waste reduction at landfills cannot be achieved solely based on a voluntary change in behavior by individuals; instead, they can be motivated using incentives. Figure 8 showed various incentives based on points that have been garnered. The score is generated from the weight of paper and plastics that have been put together for pick up over time. Incentives such as cash, toilet rolls, envelopes, and branded books are incorporated on the web-based platform. The incentive tool is in line with the previous study, such as the cash-for-trash program in Thailand [20].

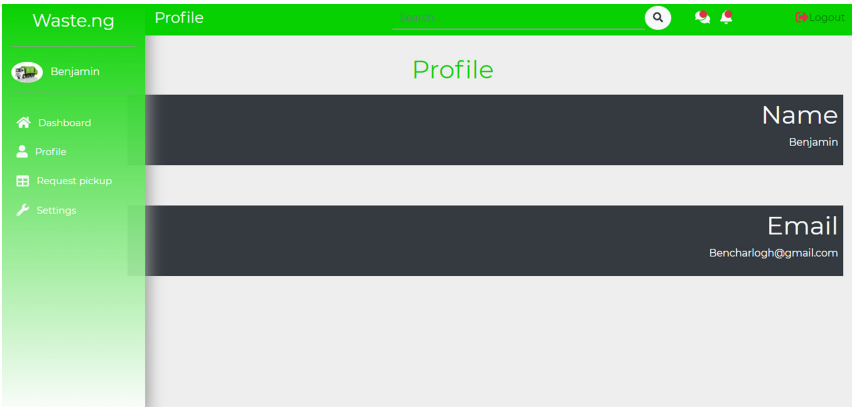

Fig. 5. User profile page of the plastics/paper waste management system

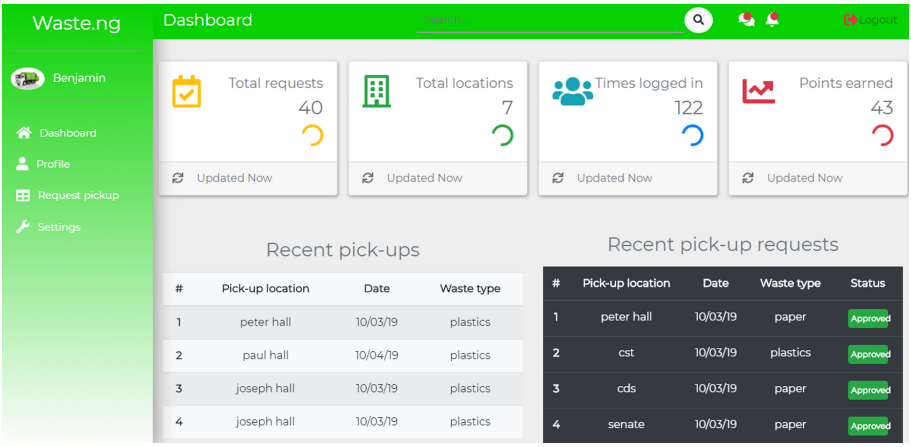

Fig. 6. User dashboard of the plastics/paper waste management system

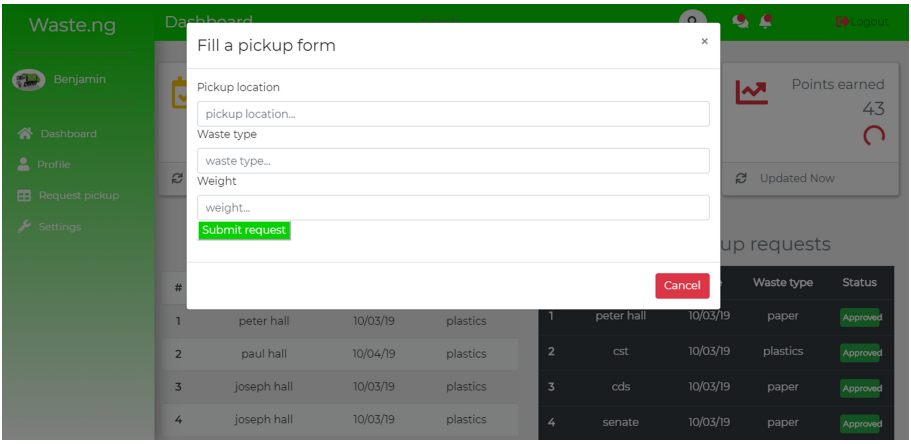

Fig. 7. Pick-up form page in plastics/paper waste management system

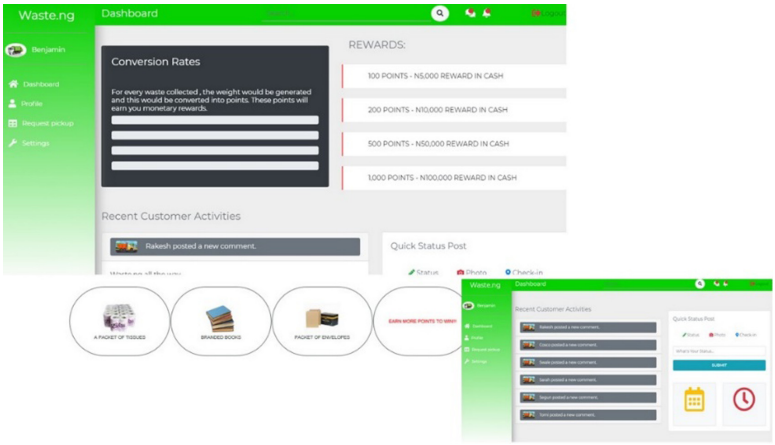

Fig. 8. Incentive page of the plastics/paper waste management system

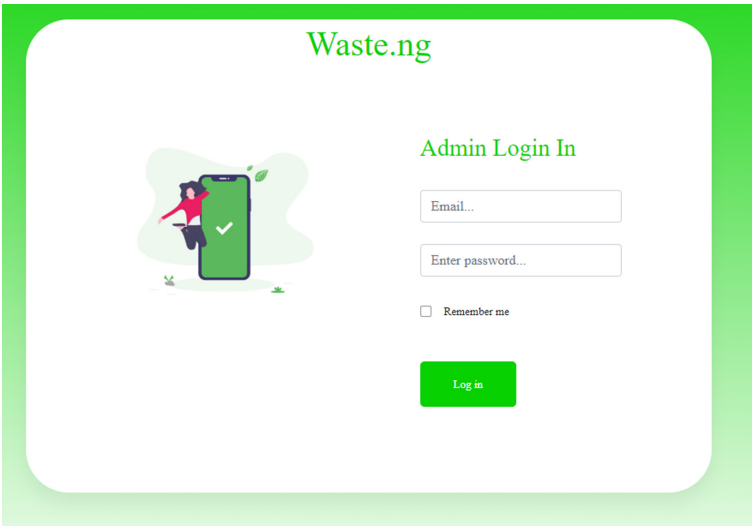

Fig. 9. Admin login page of the plastics/paper waste management system

Figure 9 showed the admin login page of the plastics/paper waste management system. In Fig. 9, the admin supplies the email and password to access the web-based platform. The action from Fig. 9 takes the admin into the admin panel of the plastics/paper waste management system, as shown in Fig. 10. Figure 11 showed the view page of the plastics/paper waste management system. Displayed on the admin dashboard is all the pickup requests. Figure 12 presented the approval page of the plastics/paper waste management system. In this section, the admin approves the

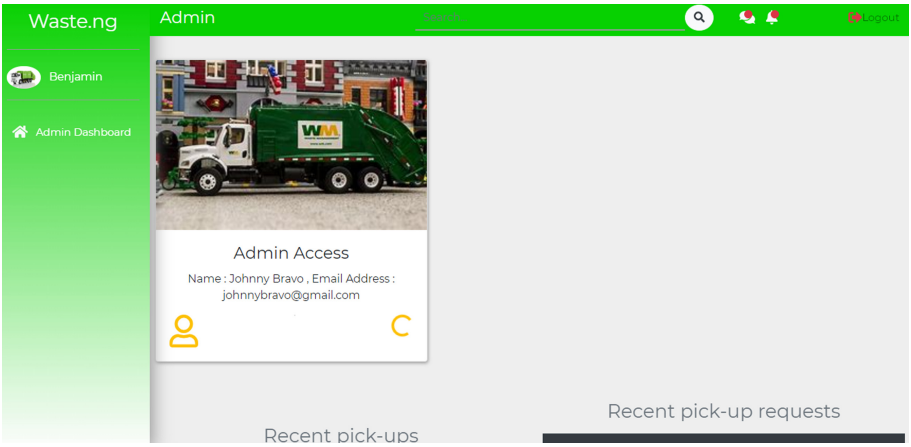

Fig. 10. Admin dashboard of the plastics/paper waste management system

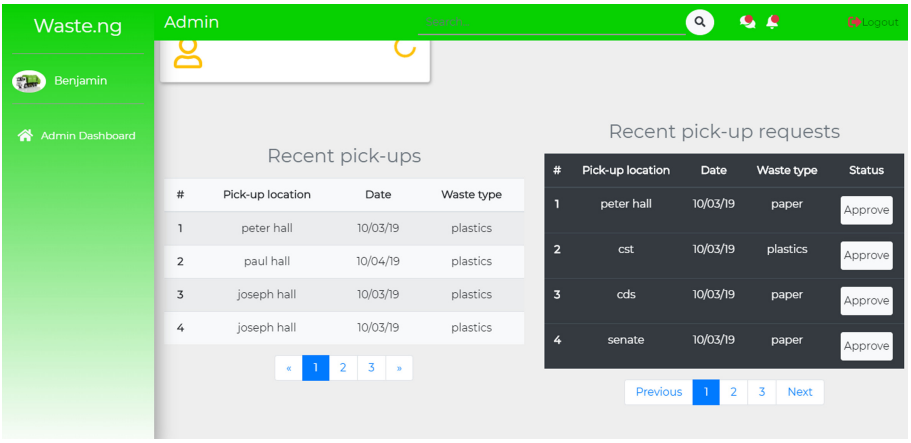

Fig. 11. View page of the plastics/paper waste management system

pickup and confirms the weight of the paper/plastics waste. Figure 13 highlighted the feedback page of the plastics/paper waste management system. Users of the platform can provide messages to improve the platform and state challenges experienced in the use of the platform.



Fig. 12. Approve page of the plastics/paper waste management system

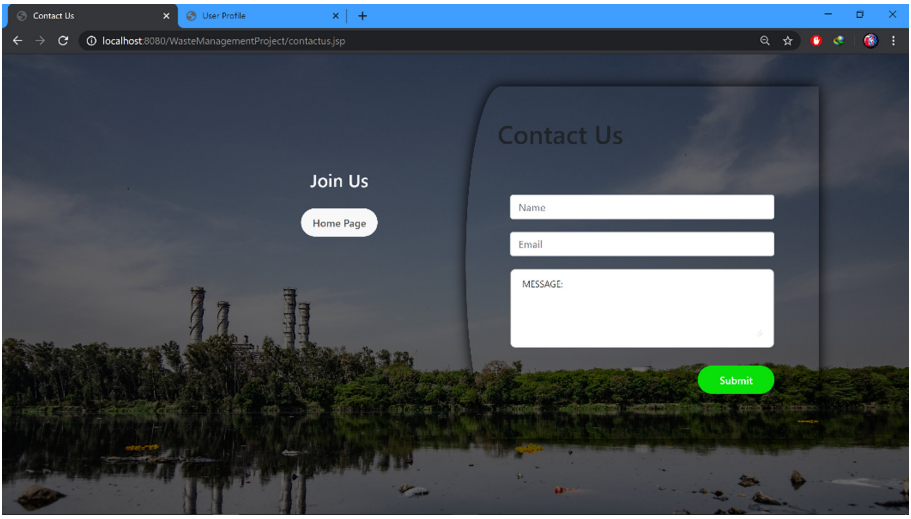

Fig. 13. Feedback page of the plastics/paper waste management system

4 Conclusion

This study developed a web-based waste management system for the collection of plastics and paper in a University community. The result presented were in screenshots. The web-based system had an interface to show profiles of the users, waste pickup information, incentive platform, and the admin dashboard to monitor and approve pickups and incentives. Past studies have indicated the success of using incentives to build sustainable behavioral change towards efficient waste disposal. Therefore, this study was able to introduce the incentive platform, which converts the weight of paper and plastics waste to points then to rewards for the users. The web-based waste management system for the collection of plastics and paper can be deployed for University communities to help reduce the number of paper and plastics that end up in landfills. Also, by picking the paper and plastics waste from source helps to prevent bin contamination. Areas of future studies should include the performance testing of a web-based management system in a controlled community. Also, the web-based waste management system can be extended for use in a State to understand the challenges and prospects in its use.

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