Smart Bin: A Comprehensive Solution For Scrap Management Leveraging Machine Learning for Customer Segmentation

Revolutionizing Scrap Management: A Web-Based Platform for Efficient Scrap Management.

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***Abstract*— In recent years, environmental concerns have become increasingly important for many individuals and businesses. As a result, there has been a growing interest in recycling and upcycling, which can help reduce waste and conserve resources. This research paper presents a web application called "SmartBin" that addresses these concerns.**

"Smart Bin" is a web application where one can sell or donate scrap instead of just throwing them. There are different types of scraps in our day-to-day life like plastic, newspaper, carton, etc. which people throw anywhere and also if they want to sell it they have to go to "kabadiwala" which makes it a hectic task. So to ease this process we are going to make this web application where the user can select his location through pincode or his/her location and they can easily sell or donate their scrap material from their homes. The application also features a section for users to purchase recycled or upcycled products, making it a one-stop shop for environmentally conscious consumers. There will be two sections in the web app one for the admin and another for the user where the user can sell the scrap and another section will be there for buying the upcycled products with a payment gateway through which the payment can be done and also some other sections will be there like price list where the user can check the price of different scrap material and after checking the price if they agree to sell the scrap then they request a pickup for their scrap material from their doorstep and also this will help to reduce the amount of unusual scrap that is thrown in the environment. Some machine learning concepts will be used in this project, these are customer segmentation and the Product Recommendation system The Customer Segmentation part will be used to group customers based on similar characteristics, such as demographics, behavior, or purchasing history

Keywords—Machine Learning, Customer Segmentation, Product Recommendation

I. INTRODUCTION

This is an online scrap management system, which will be used for the buying of recycled/upcycled products and selling of scrap materials. It will solve the basic problems which occur with different industries as a huge amount of unused materials is thrown as waste which leads to environmental degradation and the same problem is with a society where scrap is just thrown as garbage. One of the key topics to reduce environmental impacts is represented by the recycling of waste/scraps derived from industrial productions and raw materials supply chain (pre-consumer waste)[1]. It is eco-friendly and helpful to the environment as we are encouraging the people to use the product that is made from the scrap materials which are basically considered useless after there use. When huge amount of scrap materials are generated then this cause more amount of wastage of resource. By utilizing scrap materials to create upcycled products, we can conserve resources since there is no need to use additional raw materials in the production process. Instead, we are repurposing old materials and transforming them into useful items once again.

The machine Learning feature which we are using in our we-app is customer segmentation which will be used to group customers based on similar characteristics, such as demographics, behavior, or purchasing history. Authorizing traditional ways and analysis methods are not ensuring the rate of reliability of the sales prediction. To produce more precise predictions and analysis, we use ML algorithm[2].

II. PROPOSED SYSTEM

A. Problem Statement

In today's modern world various type of scrap materials are generated after the use of the certain product. These scraps are generally thrown as considered as a waste product. In industry various amounts of the materials are produced as waste material and they remain unused. As this much amount of waste can lead to harm to the society and the environment also. These are some common problem due to scrap material in real world.

1. Environmental pollution: Incorrect disposal of scrap materials can lead to environmental pollution, including air, water, and soil pollution
2. Health hazards: Scrap materials, especially electronic waste, can contain hazardous substances such as lead, mercury, and cadmium that can cause health problems for both workers and the general public.
3. Resource depletion: The extraction of new raw materials to replace those obtained from scrap can lead to the depletion of natural resources.

4. Inefficient recycling systems: Inefficient recycling systems can result in scrap materials not being properly sorted, processed, and reused, leading to waste and environmental damage.

Overall, it is important to properly manage scrap materials to minimize these problems and promote sustainability.

B. *Proposed Solution*

Our proposed solution for this problem is a web-app where one can sell different scrap materials like books,plastics,mettalic scrap etc.The customer can check the price of the scrap material he/she wants to sell from our website and can send a pickup order for selling the scrap at ease of their home without any problem unlike the old traditional way where they need to carry the scrap to shop for selling it.Also the upcycled and recycled products can be bought by the user through our website.

By simply reusing the material instead of discarding them, we can reduce the number of waste materials and also conserve future natural resources[3].

C. *Stakeholders*

- Companies producing the scrap materials
- Companies recycling the scrap materials
- Labours working in these companies
- Society Peoples (in different ways)

III. Project Flow

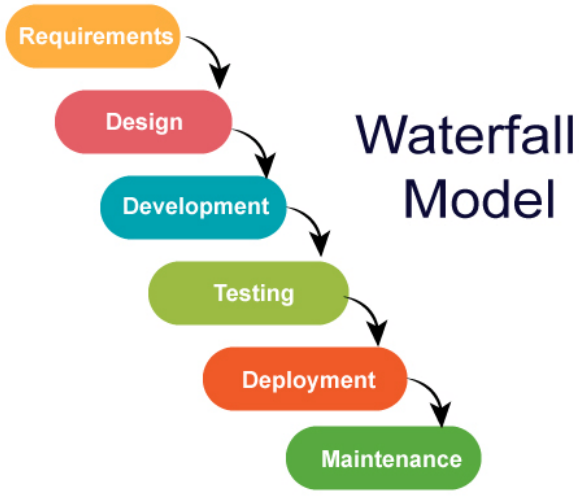

Figure 1:Waterfall Model

The system is developed using Waterfall model, as all the requirements resource process flow were already discussed .
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The Waterfall model is a sequential software development process, where development is seen as flowing steadily downwards through several phases. These phases typically include Requirements Gathering and Analysis, Design, Implementation, Testing, Deployment and Maintenance. Each phase must be completed before the next one begins and there is little or no overlap between the phases. The Waterfall model is best suited for projects where requirements are well understood and can be defined up front, and where there is a limited need for flexibility in the development process .

IV. Methodology

A. *Requirement Gathering*

We found that currently there is no such kind of application exist in the market so that's why we started conducting research on that problem statement. In very first step we tried to find out whether this problem really required a solution or not, after getting the positive response we started our requirement gathering process by following below steps

1. Understand the needs of the stakeholders: The first step is to understand the needs of the stakeholders, including customers, users, and business stakeholders. This helps to ensure that the software solution meets their expectations and requirements.
2. Define the scope of the project: The second step is to define the scope of the project, including what the software should do and what it should not do. This helps to ensure that the project stays focused and on track.
3. Collect requirements: The next step is to collect requirements from various sources, including stakeholders, existing systems, and market research. This helps to ensure that all requirements are captured and considered.
4. Analyze requirements: The collected requirements are then analyzed
5. to identify any duplicates, conflicts, or missing information. This helps to ensure that the requirements are complete, accurate, and consistent.
6. Document requirements: The final step is to document the requirements in a clear and concise manner. This helps to ensure that the requirements are well-understood for development process.

B. *Designing Phase*

Our design phase was broken in to six steps:

- System Analysis: Understanding the requirements and defining the scope of the project.
- Architecture Design: Determining the overall structure and organization of the software.
- Module Design: Breaking down the system into smaller, manageable components.
- Interface Design: Defining the interactions between components.
- Data Design: Defining the structure of data used in the system.
- Algorithm Design: Specifying the steps and logic to be followed in solving the problem.

Flow Diagram:

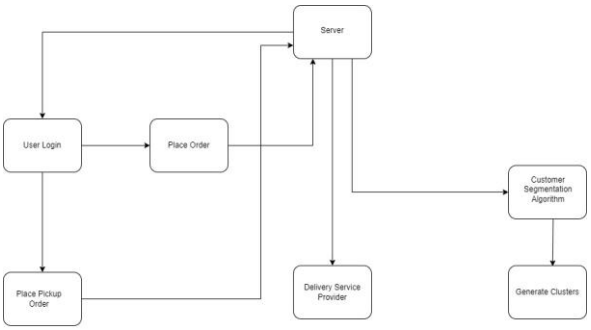

Figure 2:Flow Diagram

C. Development Phase

Technologies:

1) React.js
2) Node.js
3) Express.js
4) MongoDB
5) Mongoose
6) Machine Learning

1) React.js

Reactjs is an excellent addition to the projects that need component reusability, impressive user interactions, or crazy animations. That said, it's a robust UI library to build projects that cater to small, medium, and even large-scale organizations. That's why so many companies rely heavily on React for their long-term business goals. Considering React js pros and cons, it can be easily summed up in three words: non-risky, responsive and advanced. The main idea behind this particular library is: "to build large-scale applications with data that changes repeatedly over time" and it tackles the challenge well. It provides developers with the capability of working with a virtual browser (DOM) that is much faster and user-friendly, than the real one. Apart from that, it offers the easier creation of interactive UIs, JSX support, component-based structure and much more. The combination of the above-mentioned factors makes it a reasonable choice for both startups and enterprises[7].

2) Node.js

Node.js is a JavaScript runtime environment. It is built on Chrome's V8 JavaScript engine. It is a cross platform runtime environment originally developed in 2009 by Ryan Dahl for developing server-side applications. Using Node we can easily building scalable, fast, and lightweight applications. V8 and Node are mostly written in C and C++ focusing on low memory consumption and performance. It can be regarded as server-side JavaScript. It was created to address the issues platforms can have with the performance in network communication time dedicating excessive time processing web requests and responses. Node.js allows JavaScript to be used end to end, both on the client and on the server end. JavaScript has developed very well and has exceled to dominate server side scripting [8].

3) Express.js

We used Express as it is a Node.js framework. while building the application we studied that instead of creating loads of node modules and writing the code with NodeJS, NodeJS Request Flow Express made it simpler and easier to write the back-end code and implement it in a structured format. Express helped us in designing our web applications and APIs required in our project as it supports many middlewares which makes the code shorter and easier to write. Asynchronous programming and Single-threaded architecture are the biggest advantages of using Express in our application. For our application robust API Created a new folder to start our express project and the steps for it are, we had to add a command in the command prompt to initialize the package.json file. After that, we had to accept the default settings and continue. npm init is the command to start[9].

4) MongoDB

MongoDB is an open-source document database that provides high performance, high availability, and automatic scaling. A record in MongoDB is a document, which is a data structure composed of field and value pairs. MongoDB documents are similar to JSON objects. The values of fields may include other documents, arrays and arrays of documents[10].

After completing our design phase we started the development phase ,We started developing our web application as per the design specification and requirements. We developed the core functionalities of our web application like Selling Page, Product Purchase Page, Admin Dashboard where the Admin can make changes according to the requirements, Stripe Payment Integration etc.

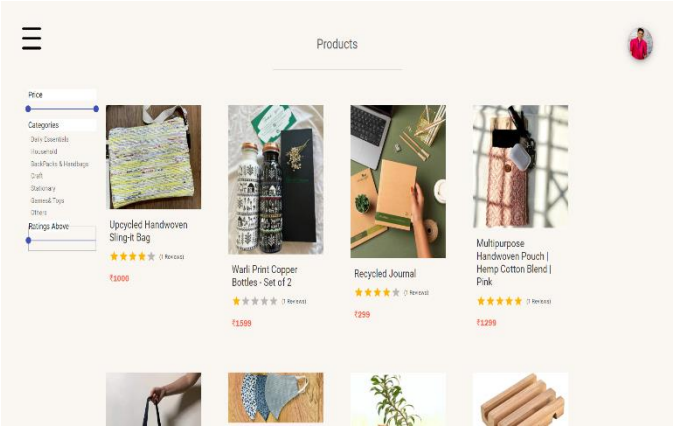

Figure 3:Product Page

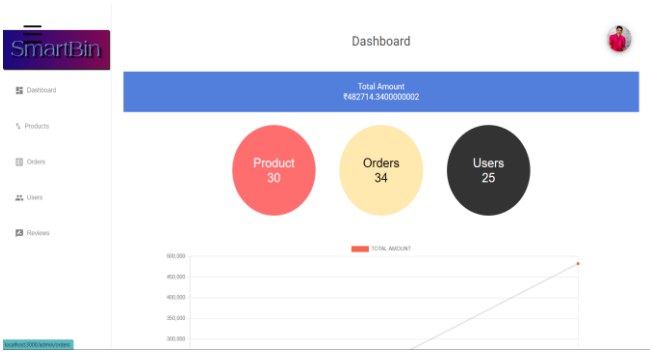

Figure 4:Admin Dashboard

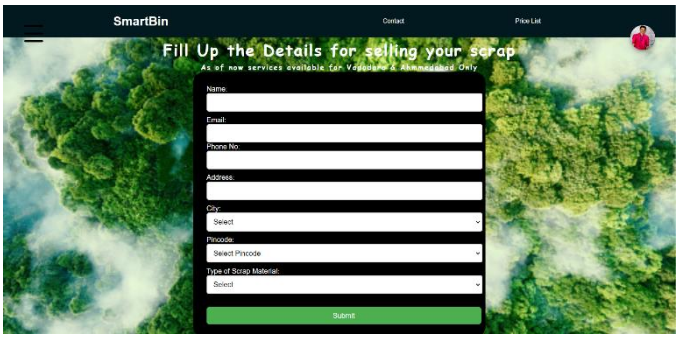

Figure 5:Selling Page

After development of the web application we started the development of the machine learning model that we are using in our project for customer segmentation process and clustering.

a. Customer segmentation:

Customer segmentation refers to a way of dividing according to different characteristics of consumer groups. This theory proposes to study and predict the future consumption trend of customers in the way of segmentation of customer information and consumption behaviour, as well as the profit market planning of enterprises[4].This allows companies to create targeted marketing strategies and offer personalized products and services that meet the specific needs of each segment. Customer segmentation is based on various factors, including:

The goal of customer segmentation is to identify the different groups within a customer base and understand their unique needs, behaviors, and motivations. This information can then be used to develop more effective marketing strategies and improve customer satisfaction and loyalty.

Through this process, we divided the customers into groups according to their spending score and location where the color of the bubble indicates different locations and the size of the bubble indicates their spending score.

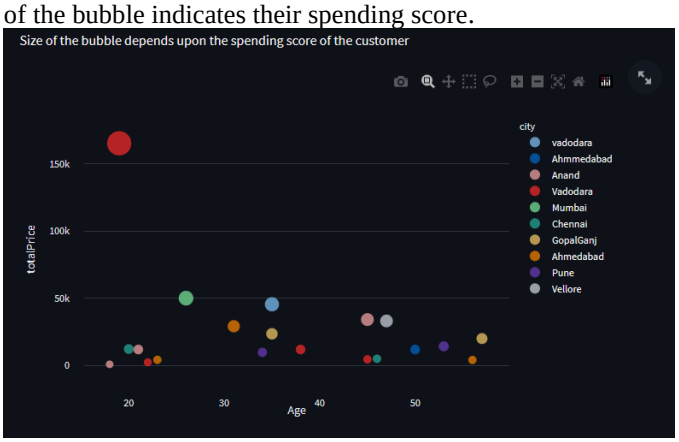

Figure 6:Segmenting Customers According to their Spending Score and Location

b. K-means Algorithm

The most well-known unsupervised partitioning clustering approach is K-Means Clustering. This clustering approach, commonly known as the centroid-based technique, divides data into non-hierarchical categories[5],[6].The algorithm works by iteratively assigning each data point to one of K pre-defined clusters, with the goal of minimizing the sum of the squared distances between each data point and its assigned cluster centroid (mean).

The basic steps of the K-Means algorithm are:

1. Initialization: Choose K initial centroids randomly or using some heuristic method.
2. Assignment: Assign each data point to the closest centroid based on the Euclidean distance.
3. Recalculation: Recalculate the mean of each cluster to get the new centroids.

Repeat steps 2 and 3 until convergence, i.e., until the centroids no longer change or a maximum number of iterations is reached.

After that we started collecting the data for our machine learning model to train it. after collecting the enough amount of data we started we started training our Machine learning model.

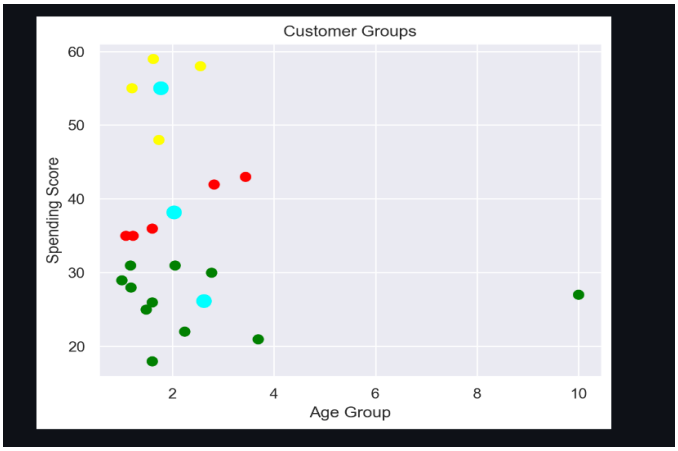

Figure 7:K-means Algorithm

D. Testing Phase

This process helped us to ensure that the developed product meets the requirements and works as intended.The main goals of testing was to identify and resolve any defects or bugs in the software, and to validate that the software meets the functional and non-functional requirements. Our testing phase typically includes the following activities:

i. Test Planning
ii. Test Design
iii. Test execution
iv. Test Result Analysis
v. Defect correction

V. FEATURES AND FUNCTIONALITIES

A. Functionality

- Persons need to first login or register to use the web
- The consumer's activity related to their purchase and sell order will be stored.
- This stored data will be used by the ml algorithms

And the processed data obtained as an output from the ml algorithms will be used for product enhancement and obtaining the customer demands

B. Features

- Using machine learning and the Javascript frameworks used for web applications. The development we had provides features such as
- Sign-in signup for the users so that we can trace the record of the user.
- Important information provided by the user at the time of registering will be stored in a hash form that provides additional security.
- Admin can anytime delete the user or can make admin to any other user.
- New product addition, delivery flow, and Stocks will be managed by the admin user.
- Customers and products are divided into groups in the form of the cluster by the customer segmentation features.
- Customers segmentation feature helps the admin to evaluate which product is performing on what basis and what will be the scope of the product in the future.
- Online Payment System through payment gateways

VI. IMPLEMENTATION CHALLENGES

As this type of applications are not available in the market in the current scenarios. There is not any source available to take the reference so all the development part was little bit complicated.

The main challenges faced by us due to that were

- Lack of expertise
- Unclear Requirements
- Dependencies
- Resistance to changes

a. Challenges due to choosing the machine learning

1. Data quality and quantity
2. Algorithm selection
3. Hyperparameter tuning
4. Model interoperability
5. Integration with existing systems
6. Computational resources
7. model maintenance and the updating

b. challenges faced while integrating the machine learning parts with the webpage

1. Technical complexity
2. Scalability
3. Data security and privacy
4. Performance

VII. CONCLUSION

This project focuses on the management of scrap materials and the recycled products made from it. The application will remove the traditional way of buying and selling scrap which help the stakeholders to save there time.

This will reduce the amount of scrap materials wasted due to improper management.

VIII. FUTURE WORK

In future when we get the more traffic on our website we have to increase our server capability to manage more number of get requests so it can serves large amount of users at the same time.

When we will get more and more number of users on our website we will get huge amount of the data that will helps our machine learning models to increase its capability we will be continuously upgrading our machine learning models to by training them with more numbers of dataset

In future we will also add the recommendation engines so that the products will be recommended to the customers on there past activities on the website or seeing there previous purchase history

We will be continuously working on the UI of the page to make it more and more simple and the user friendly

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