

Lab 1 – Refill.Me Product Description

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1. Introduction

Every year in the United States, packaging such as glass, paper, aluminum, and plastic produces an enormous amount of packaging waste. In 2018, packaging waste amounted to an astonishing 82.2 million tons, accounting for 28.1% of all waste generation that year (EPA, March 2022). The main problem with packaging is that it causes pollution and directly contributes to climate change. Producing plastic and aluminum releases a huge amount of greenhouse gases into the atmosphere. Non-renewable resources are also necessary to make these materials (Shen et al., 2020). For example, creating plastic requires fossil fuels, while making aluminum requires bauxite. (*The Environmental Impact of Food Packaging*, 2018). Another issue is that neither glass nor plastic biodegrades. These materials only break into smaller pieces of plastic and glass rather than eventually returning to nature's cycle (Carvalho et al., 2022). With plastic, this causes yet another issue with microplastics contaminating the environment and the food supply (Shen et al., 2020). Microplastics are not the only things contaminating food, though. Dangerous chemicals from plastic packaging are also leaking into food products (Groh et al., 2019). Due to these dangers, paper is thought to be a better solution to harmful packaging. However, paper packaging is also problematic because it is usually lined with plastic (*The Environmental Impact of Food Packaging*, 2018).

Recycling is increasingly becoming more popular as a way to try to mitigate the damage caused by packaging material building up in the environment. However, it is not the solution to reducing packaging waste. This is because a large amount of packaging is not recycled at all. For example, in 2018 only 9% of plastic, 25% of glass, and 68% of paper ended up recycled (EPA, July 2022). The numbers for paper seem encouraging, however, a big problem with paper packaging is that it can only be recycled up to seven times (Sinai, 2017). With more people

becoming aware of this problem, there is a growing demand for reusable, compostable, and edible goods. Every year, single-use plastics increasingly face bans in favor of reusable alternatives, and the market for better types of packaging is on track to double by 2030 (*Zero Waste Packaging Market Size, Share, Report 2022-2030*). Alongside this trend, up to 80% of Generation Z, Millennials, Generation X, and Boomers are very concerned about packaging waste (Denis, 2021). Within this growing movement exists a market for package-free shopping, where shoppers bring their own containers for the products that they buy.

These shoppers are concerned about the amount of packaging waste generated by mainstream grocery shopping and how it damages the ecosystem. They face obstacles such as difficulty searching for package-free stores or loose products in their area, and lack of information regarding the kinds of containers necessary for shopping package-free. Even when they do find package-free offerings, the information is often incomplete, such as no clear unit prices for products. Unfortunately, existing applications and websites about package free options are not up to date and have insufficient features for searching.

The solution to these issues is the application Refill.Me. Designed to fill the void in the market for package-free options, it makes package-free shopping more available to shoppers. Searching for package-free stores and products will be easier than ever. Unit prices for loose products will also be available so that there are no surprises regarding total prices. Refill.Me will also feature information about the necessary containers for package-free shopping. The shopping list feature will give convenient container recommendations as well. Points will also be awarded to shoppers based on completed package-free purchases, which can be redeemed for benefits such as coupons and discounts. These features will provide a useful information hub for both novice and experienced package-free shoppers.

2. Product Description

Refill.Me will be a mobile application designed to make package-free shopping more accessible for eco-conscious shoppers. With Refill.Me, package-free shoppers will be able to connect with package-free stores near them. It will also aid novice package-free shoppers in transitioning to package-free shopping, all while helping experienced package-free shoppers keep up their shopping habits. This will enable shoppers to support local businesses and reduce their packaging waste. Refill.Me will also provide practical information about package-free shopping, and present a useful platform for shoppers and store owners. It will also help store owners provide better offerings for their customers, keeping them engaged and motivated.

2.1 Key Product Features and Capabilities

Refill.Me provides many features for registered shoppers, such as searching for package-free stores. This will produce a list of all package free stores in the shopper's area. Shoppers can use this feature in two ways: either by entering in their zip code, or by enabling location services on their phone. They will also be able to search for loose products in three ways. One way is that they can search through icons and click on the one representing the product that they want to buy, such as nuts. A second way is that shoppers can scan an item's barcode to find package-free alternatives near them. And a third way is for them to type in the product's name in the search bar. These search features allow shoppers to find package-free stores and loose products easily. In addition, unit prices are provided so that shoppers know exactly what their total will amount to. The Container Guide provides information to novice package-free shoppers about containers such as jars, tote bags, produce bags, or other container types that are necessary. Shoppers will be able to create a shopping list of all the loose products they want to buy, after which the Container Recommendation feature will provide customized container recommendations (based

on the items in the list) so that shoppers will know exactly what containers they need to bring. Then, the Reward.Me feature will award points to shoppers who complete package-free purchases, which can be redeemed for coupons or discounts offered by the stores partnered with Refill.Me. Finally, shoppers will be able to crowdsource corrections and suggestions about desired products and prices directly in Refill.Me.

Refill.Me also provides useful features for store owners. The Product and Price dashboard allows store owners to add or remove products from their listings, and to update unit prices. Stores can also check that the information they entered displays correctly by searching for products. Store owners can search for products in the same ways that shoppers can: by icon, scanning a barcode, or searching by name. Similarly, owners have access to the store search feature as well to ensure that their store information is correct. The Reward Point Conversion dashboard allows store owners to add or remove awards. For example, owners can specify that 100 points can be redeemed for a 10% off coupon. The Coupon dashboard shows owners what coupons have been used by their customers. Store Analytics provides useful information such as products that shoppers are searching for and whether they were able to find these products. Store Owners also have access to their Store Rating, where they can read feedback from users and see how their customers rate their services.

Refill.Me's helpful features solve many of the current issues surrounding package-free shopping. The search features make finding package-free stores and loose products much easier than before. Unit prices are included in the product search so that no one is surprised at the total price. The Container Guide and the Container Recommendation features ensure that shoppers are familiar with the containers necessary for package-free shopping and will know what needs to be brought with them when going shopping. Store owners will be able to attract more shoppers

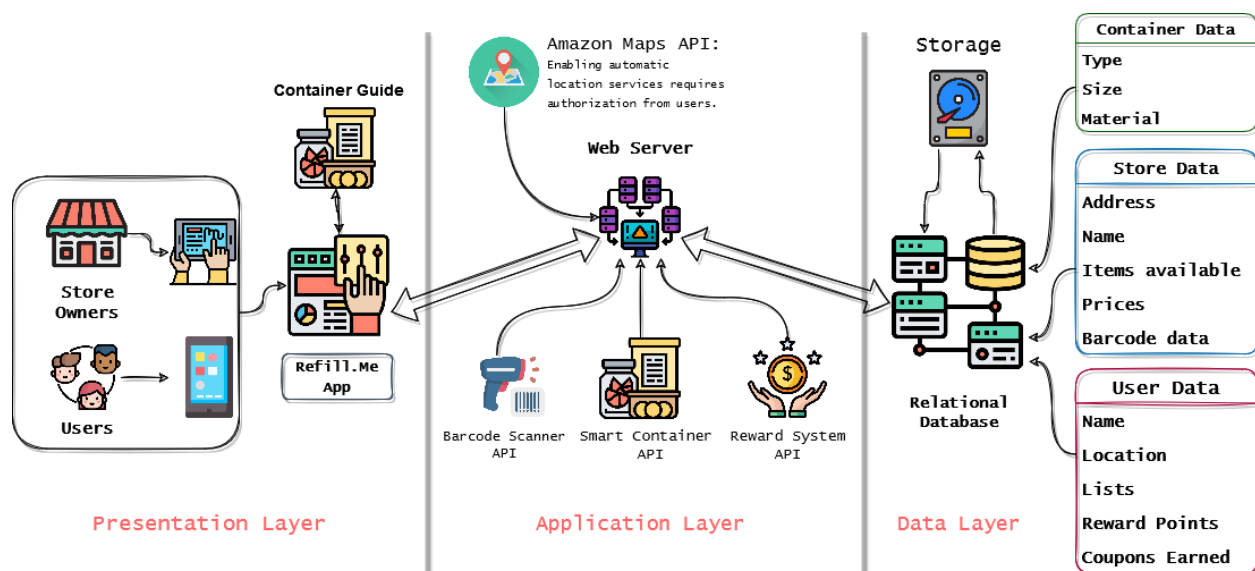
because information about their stores and package-free shopping is more accessible with Refill.Me.

2.2 Major Components (Hardware/Software)

Refill.Me's structure is three-tiered, as shown in Figure 1. These tiers are the presentation layer, the application layer, and the data layer.

Figure 1

Refill.Me Major Functional Component Diagram



The presentation layer is where users will interact with the application. For this, Refill.Me will be optimized for different hardware depending on the type of user. For store owners, Refill.Me will be optimized for tablets so that owners will have access to larger screens while maintaining portability. For shoppers, Refill.Me will be optimized for smartphones. The application layer will handle the web server as well as algorithms such as barcoding scanning and container recommendations. This layer will also handle API integration and linking APIs with the database. Lastly, the data layer will manage all of the data associated with Refill.Me in a

relational database. This database will include tables for stores, products, users, and rewards, while also including tables for data analytics—such as the kinds of products that shoppers are searching for.

The design of Refill.Me will be utilizing many software applications for the front end, back end, and testing purposes. For the front end, the React Native and Expo framework will be used with the languages CSS, HTML and JavaScript. The back end will be using MySQL for the database alongside AWS data management services, and the Jest framework and Gitlab CI/CD tools will be utilized for testing purposes. To provide many of the services Refill.Me promises, third-party software will be integrated, such as Amazon Maps and other APIs. Executing the project will also require third-party software. For example, project management will be tracked with Trello, while the code repository and version control will be handled through GitHub, and Zoom and Discord will provide the grounds for group collaboration. Visual Studio Code will be the IDE of choice, and Gitlab CI/CD will be used for continuous integration.

3. Identification of Case Study

Refill.Me is designed with eco-conscious shoppers in mind. These shoppers tend to be predominantly women who are very passionate and invested in climate change and mitigating the damage associated with it (Hoover, 2022). They come in wide variety of ages, from eighteen to sixty-five, and live mainly on the east or west coasts of the US. They also have diverse economic backgrounds, from low to high income levels, and are usually very educated (Kim, 2018). Refill.Me is also designed to benefit store owners who have stores offering loose products, such as supermarkets with bulk sections, package-free stores, and farmer's markets.

A small group of package-free shoppers and package-free store owners will act as the case study. The search features, container features, shopping list, and Reward.Me all benefit

shoppers' efforts to shop package-free. These enthusiastic shoppers will be a valuable source for feedback about the usefulness of Refill.Me's features. Store owners will be another important source for feedback. These owners that are part of the study will be able to communicate their products and prices to their customers, allowing them to increase their digital presence. They will also be able to access data about the products their customers are searching for, and they will be provided with useful feedback about the popularity of certain items.

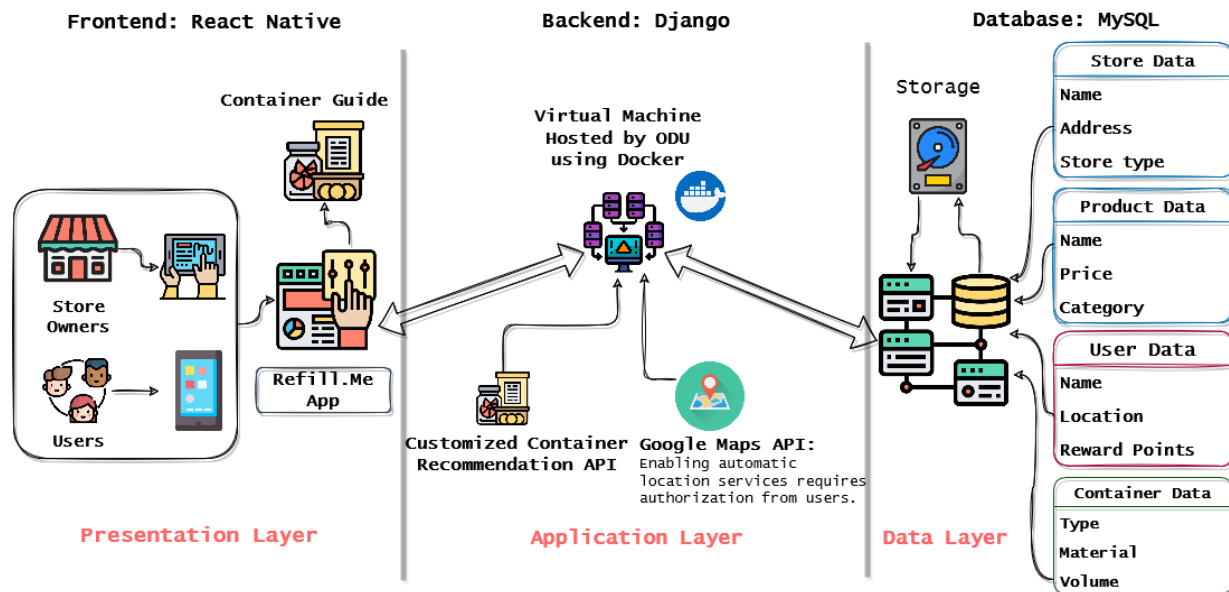
In the future, Refill.Me could be used like a regular grocery shopping application. The reason that shoppers cannot buy online with Refill.Me is that there would be no way to store those products for the shopper to pick up, since they need to bring their own containers. For shoppers to be able to buy through the application, trucks would need to be able to deliver the products straight to their door, where the shopper would be waiting with their containers. For now, there is not enough demand to warrant these trucks. However, this movement is growing and could come to compete with mainstream grocery shopping enough to increase demand for this kind of service.

4. Product Prototype Description

The goal of Refill.Me is to make package-free shopping more accessible and easier to understand for eco-conscious shoppers. The purpose for the prototype is to demonstrate the most important functionalities to show the capabilities of this concept for package-free shoppers and store owners. To prove these capabilities, the prototype will not include every feature of the real-world product. Some features will be partially implemented and show simulated data.

4.1 Prototype Architecture (Hardware/Software)

The prototype architecture will be similar to the real-world product, with a presentation layer, application layer, and data layer, as shown in Figure 2.

Figure 2*Refill.Me Prototype Major Functional Component Diagram*

The presentation layer will feature the frontend which will be developed with React Native using the languages HTML, CSS, JavaScript, and Python. The hardware required for this is a computer with internet access that has either Windows, Mac, or Linux operating systems for developing and testing. The application layer is where backend development with Django will take place, and Amazon Maps will provide location services. The data layer will feature the database, which will utilize MySQL to handle the prototype's data.

4.2 Prototype Features and Capabilities

The prototype will include many fully implemented features and a few partially implemented features for package-free shoppers. As shown in Table 1, most features for shoppers will be fully implemented such as account creation, searching for stores, the Container

Guide, the Container Recommendation, the shopping list, and connecting shoppers to advocacy and petition websites.

Table 1

Table of Comparison Between RWP and Prototype

Feature	Real World Product	Prototype
Account Creation	Fully Implemented	Fully Implemented
Store Search	Fully Implemented	Fully Implemented
Product Search		
Search By Icon	Fully Implemented	Partially Implemented
Scan product's barcode	Fully Implemented	
Enter product's name	Fully Implemented	Fully Implemented
Container Guide	Fully Implemented	Fully Implemented
Container Recommendation	Fully Implemented	Fully Implemented
Shopping List	Fully Implemented	Fully Implemented
Reward.Me		
Collect reward points	Fully Implemented	Fully Implemented
Receive coupons	Fully Implemented	
Crowdsourcing		
Suggested edits for products and prices	Fully Implemented	Fully Implemented
Store rating	Fully Implemented	Partially Implemented
Connect shoppers to advocacy & petition sites	Fully Implemented	Fully Implemented
Product and Price Dashboard	Fully Implemented	Fully Implemented
Reward Point Conversion Dashboard	Fully Implemented	Fully Implemented
Coupon Dashboard	Fully Implemented	
Store Rating Dashboard	Fully Implemented	Partially Implemented
Search Information Dashboard	Fully Implemented	Partially Implemented

For shoppers, partially implemented features will include searching for products, crowdsourcing, and Reward.Me. Searching for products will not include barcode scanning in the prototype, while searching for products by name will have full functionality and searching by icon will have partial implementation. For crowdsourcing, the prototype will have fully implemented suggested edits for products and prices from customers, and it will have a partially implemented store rating feature with simulated data. For the Reward.Me feature, collecting reward points will have full implementation—however, receiving coupons will be omitted.

Similarly, features for store owners, such as the Product and Price Dashboard and the Reward Point Conversion Dashboard will have full functionality while the Store Rating and Search Information Dashboards will have limited functionality with simulated information.

4.3 Prototype Development Challenges

The main challenge of developing the Refill.Me prototype is the developer's lack of experience. Namely, the developers have limited expertise in web application development and will need to become familiar with the necessary software before progressing. The developers also lack knowledge about database configuration and integration, requiring more research and experimentation with tools such as MySQL before building the database. Lastly, API integration is another challenge the team needs to overcome in developing the Refill.Me prototype.

5. Glossary

Amazon Relational Database Services (Amazon RDS): a web service to set up, maintain, and scale a relational database in the cloud.

Android: an open-source mobile phone operating system used on mobile devices such as smartphones and tablets.

Application Programming Interface (API): a set of rules for two different programs to communicate with each other.

Amazon Web Services (AWS): a cloud computing platform.

Amazon Maps API: a programming interface that allows developers to add mapping capabilities like interactive maps and custom overlays to android applications.

Application Layer: a layer where an application can effectively communicate with other applications on different computer systems and networks.

Backend: a computer system or application that is not directly accessed by the users but rather responsible for storing and manipulating data.

Bauxite: a naturally occurring mineral.

Biodegrade: to decompose and become incorporated back into the environment.

Bulk section: an aisle where products are available in dispensers or bins, and the shoppers can buy the exact amount they desire.

Bring Your Own Container (BYOC): an initiative to encourage shoppers to bring their own containers with them to the store in order to avoid creating packaging waste.

Cascading Style Sheets (CSS): a stylesheet language used to create the design (fonts, colors, borders, etc.) of webpages.

Compostable: breaking down into organic matter and not producing any harmful chemicals during that process.

Container: tote bag, produce bag, glass or plastic jar, glass or plastic box, glass or plastic bottle that can be used for package-free shopping.

Container Guide: a small lexicon providing an overview of different types of containers and the types of products that could be stored in them.

Container Recommendation Feature: a feature of Refill.Me that suggests specific containers for products based on the type of product such as liquid or solid.

Continuous Integration and Delivery (CI/CD): a method for automatically merging contributions and deploying new stable software to a production environment.

Customized Container Recommendation Feature: a feature of Refill.Me that suggests all needed containers for a particular shopping list based on the items added to the list by the shopper.

Crowdsourcing: a way to solicit user feedback using surveys (either paper based or online).

Database: an organized collection of structured information, typically stored electronically in a computer system.

Data Layer: a layer of the application/website which contains all of the data that is generated by users engaging with the application/website.

Django: a high-level Python web framework that enables rapid development of secure and maintainable websites.

Docker: a platform designed to help developers build, share, and run development processes.

EPA: United States Environmental Protection Agency.

Experienced package-free shopper: a shopper who has knowledge of package-free shopping.

Expo: an open source framework for creating mobile apps.

Farmers' market: a market where local farmers sell their products directly to consumers.

Frontend: a computer system of the website/application which is exposed to users for direct interaction.

GitHub: a hosting service for version control and development of software.

GitHub Issues: a GitHub repository feature that tracks issues, team-members' work, and development process of an application.

Google Maps: a web mapping platform and application that provides street maps, satellite imagery, and real-time traffic information.

Greenhouse gas emissions: gasses (such as carbon dioxide and methane) predominantly emitted through human activities that trap heat in the earth's atmosphere, and thus directly contribute to climate change.

Hyper Text Markup Language (HTML): a programming language used to create websites.

Integrated Development Environment (IDE): an advanced code editor with syntax highlighting, built-in debugger, and compiler.

iOS: a closed source mobile operating system used in iPhones and iPads from Apple Inc.

Javascript: a high-level client-side scripting language to implement functionality on websites.

Loose product: product sold without any packaging.

Mainstream grocery shopping: grocery shopping that does not follow sustainable practices, thus, it entails buying packaged items, using plastic, and not considering environmental aspects.

Microplastics: tiny plastic particles that are less than five millimeters long and are created when larger plastic pieces break down.

MySQL: a relational database that uses SQL as its database language.

Node Package Manager (npm): a software-sharing repository for software and packages that are used for software development, especially software written in Javascript.

Novice package-free shopper: a shopper who has no experience with, and thus, no knowledge of package-free shopping.

Optical Character Recognition (OCR): a software that recognizes and converts text from images to machine-readable format.

Package-free: without any packaging materials such as plastic, paper, cardboard, aluminum, or glass.

Package-free store (in the context of Refill.Me): a supermarket with a bulk section, a store exclusively selling loose products, and a vendor at farmers' markets.

Package-free shopper: a shopper who prefers to buy loose products by filling them into their own containers.

Package-free shopping: shopping using one's own containers, thus, shopping without creating packaging waste.

Package Manager: a set of software tools that automates the installation, updating, configuration, and deletion of programs in a systematic way.

Packaging: material used to protect a product from any damage during transportation or storage.

Presentation Layer: a layer where functions like data conversion, data encryption and decryption as well as data translation take place.

Produce bag: a reusable bag, usually with a window and tare weight label, that is used for buying fruits/vegetables.

Python: a high-level programming language that supports multiple programming paradigms, including structured, and functional programming.

React Native: a framework that allows for the building of native mobile apps using the programming language React.

Relational Database: a type of database that stores and provides access to data points that are related to one another.

Rest Framework(s): an application programming interface that conforms to the constraints of REST architecture.

Single-use: designed to be used only once, and then to be discarded.

Structured Query Language (SQL): a widely used database language used for inserting, querying, and retrieving data from relational databases.

Tare weight: the weight of an empty container that should not be included when the price of the product is calculated.

Tote bag: a large bag, often made of cotton, used to carry many items.

Virtual Machine (VM): a digital version of a physical computer.

Visual Studio Code (VS Code): a source-code editor that can be used with a variety of programming languages.

Webpack: a software tool that bundles Javascript files to be used in a web browser.

Web Server: computer software and hardware that stores content for a website such as images, videos, and other data, and it operates on HTTP and other protocols to deliver the files for a website to clients who request it.

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