Lab 1 – Refill.Me Product Description

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1.   Introduction

Walk into any grocery store or supermarket and most of the products on the shelves will be in self-contained packaging materials. Most of these materials end up in landfills, and even products that end up in recycling centers are sometimes not eligible to be recycled or cost an astronomical amount of money to be reused. Society needs the ability to conduct sustainable shopping to reduce the burden of an overabundance of packing materials that end up in landfills.

Packaging waste accounts for approximately 82.2 million tons a year (EPA, 2022). "Modern food packaging is made from a variety of manufactured and synthetic materials, including ceramics, glass, metal, paper, paperboard, cardboard, wax, wood and, more and more plastics" (The Environmental Impact of Food Packaging, 2018). Much of this packing waste ends up in landfills where it sits until it decomposes, which can take hundreds of years to carry out. According to Hopewell (2009), "Approximately 50 per cent of plastics are used for single use, such as packaging, agricultural films and disposable consumer items…" (para. 3). This is not the right approach to being environmentally friendly.

Microplastic pollution is a significant problem. Most of the plastic and glass packaging containers are not biodegradable and will just sit in the landfills for eternity or until the material erodes enough until it becomes microplastics or micro glass, which then end up in the oceans, the soil, and have negative consequences towards the environment (Shen et al, 2020). The best solution to microplastics is to "control and prevent plastics from entering the environment" (Pinjing He et al., 2019). Paper packaging does not fare any better as it can only be reused a max of seven times before it is no longer recyclable (Sinai, 2017). This is due to paper being made up of fibers and after each reuse, these fibers become shorter and shorter making it effectively useless after the seventh time.

Creating packaging materials is not environmentally friendly. Each type of packaging material takes natural and manmade resources to produce. These resources include "energy, water, chemicals, petroleum, minerals, wood, and fibers". Many products also produce "greenhouse gasses, heavy metals, and particulates" (The Environmental Impact of Food Packaging, 2018, para. 14). For example, to make plastic, fossil fuels are used and to make aluminum, bauxite is used. There are an abundance of chemicals that are involved in creating plastic packaging that encounters food. Many of these chemicals are recognized by the EPA and through multiple international agencies as being hazardous to human health, can accumulate in the body, and disrupt the body's natural processes (Groh et al, 2019).

Recycling has shown to be an inadequate tool to combat waste. The current rate of recycling is failing. The recycling rates for glass is only 25%, paper is 68% and plastic is an abysmal 9% (EPA, 2022). According to the EPA, the current challenges facing recycling are that most Americans want to recycle but do not know what products are recyclable and this often leads to confusion. There is a growing demand for replacing single use plastic materials with reusable, compostable, or edible alternatives (Hoover, 2022). Shoppers want to reduce their environmental footprint and make a conscious choice in fighting climate change. According to the Consumer Brands Association, "the majority of Americans believe that the federal government should tackle plastic and packaging waste as its next "moon shot," and "If given the option to buy products with recyclable or compostable packaging, 47% of Americans opt for recyclable products as their first choice and 20% prefer compostable products". (Denis, 2021).

Refill.Me is the mobile software solution that is designed to enable shoppers to conduct package-free shopping. This will reduce the overall waste that ends up in landfills, reduce the burden of recycling, and prevent deleterious chemicals from entering foods and humans.

2.   Refill.Me Product Description

The Refill.Me is the proposed mobile software application that is designed to reduce and eliminate packaging waste by supplying relevant and timely information to shoppers and helping shoppers to conduct package-free shopping through an innovative application. Refill.Me is designed to help consumers to reduce or eliminate the amount of packaging materials they purchase, which therefore means a reduction in the amount of packaging material that ends up in landfills. When shoppers use the application, they will be able to shop in local stores, know what products are available in their area, know what containers to bring with them to conduct package-free shopping, be provided with up-to-date pricing data, and lastly, make the experience enjoyable.

Refill.me is also intended for stores that sell package-free products. Stores will gain valuable information on customers, other package-free stores in the area, and crowdsourced data. Crowdsourced data will include user experiences with package-free shopping, information on package-free stores and any other relevant information users need or want Refill.Me to know of. Refill.me can help package-free stores to track their inventories and the inventory and pricing data of other package stores in their area. Refill.me enables package-free stores to reach their target audience in a greater capacity through an innovative mobile application.

2.1.   Key Product Features and Capabilities

The main features for the shoppers will include a robust search function of local package-free stores in the user's area. It will also include a product search that will allow users to find products by a general icon. An example is if a user wants to search for nuts, they would click on the almond icon. This will display a variety of nuts available in their area, the store locations, and the associated cost. Refill.Me also enables users to search by barcode. A user can

scan the barcode of the product they are interested in through the use of their phone's camera, and it will display other products in their area that match that item and the prices. This will help the user to make choices on what is available to them and for the best price. Refill.Me will also allow users to search for products by their name. The application will then display the products that relate to the searched item in the user's area as well as the prices for these products.

Refill.Me also features a guide on containers. This is useful for novice or experienced package-free shoppers who may not know what to bring with them or find a new alternative container. The guide will encompass the variety of containers available, the best types of containers, and where these containers can be bought. The guide will also include containers that may already be available in most homes so as to avoid hinting that the user needs to purchase new containers.

Refill.Me will also enable shoppers to create in-app shopping lists and to have access to the smart container recommendation tool. The concept is based on the user's current in-app shopping list. As the user places items into the shopping list, Refill.Me will inform the user on the best containers to bring with them on their shopping trip. This is intended to help shoppers bring the most useful and correct number of required containers and improves the shopping experience by removing any confusion or ambiguity.

Another feature that will enhance the applications' repeated use is Reward.Me. Shoppers will receive reward points based on the amount of money spent on package-free items at participating stores. Shoppers can then redeem the points in the form of cash back or coupons on their future purchases. This system will be tracked through receipt uploading after purchases are made. The items that are considered package-free will be counted and the correct amount of reward points will be issued to the user.

Lastly, shoppers can play an active role in the package-free community by providing

valuable insights on their experiences through crowdsourcing. This can include sharing

information about other package-free stores, reporting changes in store hours, noting new

products not yet listed on the Refill.Me application, and any other relevant information. By

participating in this way, shoppers can help to reduce waste and contribute to the progress of the

package-free movement.

The main features for the store's owners will include the ability to add products and

pricing to their store dashboard. Refill.Me will allow shoppers to rate package-free stores based

on their shopping experience, the store's cleanliness, the amount of package-free items available,

and the cost of the items. This in turn will help other users to either avoid certain stores and/or to

promote certain stores. It is also intended to help store owners be aware of any potential issues

and correct any deficiencies they may be unaware of. Refill.Me will be tracking data across

multiple vectors to include: most popular searched items, the amount of people searching for

items in the store's area, how many shoppers are creating lists, and what items are being added to

those lists. Data will also include: how many shoppers conduct package-free shopping, how

many of the shoppers that do package-free shopping are also a part of the Reward.Me system, the

pricing of products from other stores, crowdsourced store ratings, and lastly crowdsourced store

reviews.

2.2.   Major Components (Hardware/Software)

The Major Functional Component Diagram, as shown below in Figure 1, illustrates a

high-level overview of the feature architecture and how the data will be transferred. The

Refill.Me application will be available on Android, iOS, and any PC or other devices with an

internet connection. We are expecting users to use the application while on the go and will be

anticipating them to shop with smartphones or tablets. While store owners will be able to access

the application through a smartphone, tablet, or any device with an internet connection.

Figure 1

Major Functional Component Diagram
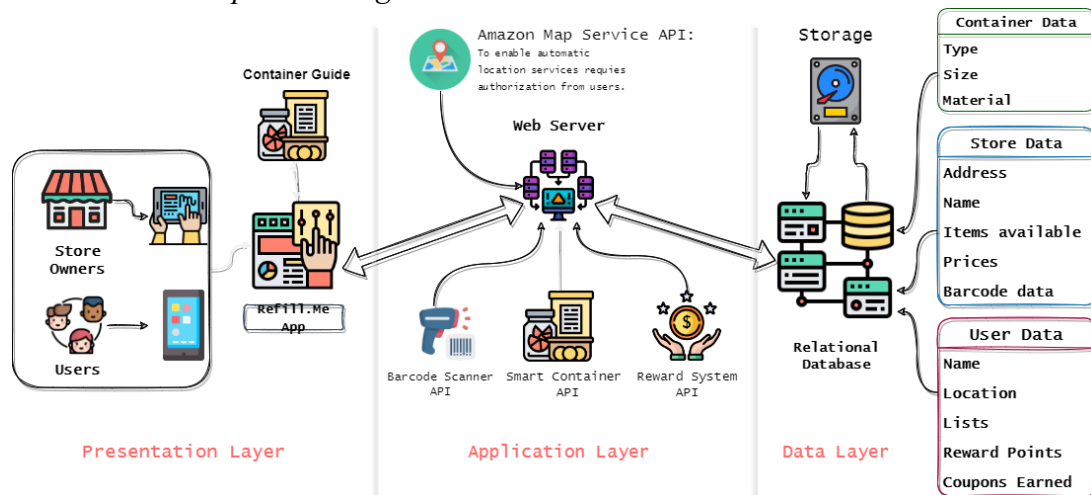
The Refill.Me application will be designed using a three-tier architecture system. The

presentation layer is where the users can interact with the application through an intuitive and

responsive interface. The application layer will include the web server, which will house the

business logic, several Application Programming Interfaces (API), and will communicate

between the user interface and the database. The server will be hosted by Amazon Web Services

(AWS). The APIs that will be used are a barcode scanner, receipt scanning, rewards systems,

mapping services, web scraping, and data analytics.

Several algorithms will include the searching features, container recommendations,

shopping lists, rewards systems, and data recordings. The multitude of the APIs and algorithms

will need to be connected continuously with the database in order to maintain integrity between

the user and server. The data layer will be a relational database for storing the store owner's and

user's data. The database will be hosted and supported by MySQL on Amazon Relational

Database Services (ARDS).

Refill.Me software will be stored in a GitHub repository for project management. It will also enable version control, issue tracking and reporting. Access to the repository will be restricted to authorized users only. Since the Refill.Me application will be utilizing a repository, programmers working on the code can utilize any Integrated Development Environment (IDE) of their choice. Refill.Me will utilize Trello for project management and for group collaboration, Discord and Zoom.

3.   Identification of a Case Study

A Refill.Me case study for users of the application is intended for eco-conscious grocery shoppers. They are shoppers who want to reduce their packaging waste consumption. They may be novice or expert package-free shoppers, but would like a way to find new stores, to search for products in their area, and/or to join a community of like-minded shoppers. Research indicates that eco conscious shoppers are mostly women (Kim, 2018). They also include age groups from Gen Z to Baby Boomers. In a 2021, Consumer Brands IPSOS poll surveyed a group of adults in the USA and found that approximately 80% of Generation Boomers, X, Millennials, and Z are concerned about packaging waste (IPSOS, 2021).

Eco-conscious shoppers come from diverse income levels. A package-free lifestyle does not mean it will cost more to achieve. As mentioned above, there are different generations of people that want to do something that helps the environment and combat climate change. The average income that bought ethical products was between $50,000 and $59,000, with a bigger jump when income hit the range of $125,000 and above (Kim, 2018). These ethical consumers are also highly educated. According to Laura Kim (2018), there is an increase in ethical consumption when there are more years spent in education. People who are more educated are more likely to be concerned about the environment and take steps to help. "Information about the

negative effects of consumerism on the environment have prompted environmentally minded consumers to take matters into their own hands by changing the ways they consume" (VanRemoortel, 2018).

A case study for store owners of Refill.Me includes retail stores that sell bulk items and packaged free products. These small business shops may lack the ability to reach a larger target audience. Refill.Me will enable shops to keep track of their inventories, keep track of their competitors' pricing, and gain useful data analytics of shoppers and real-time trends. Stores will be able to see what the most popular search items are, based on the current season, and will be able to better prepare their future inventories. Store owners want to connect with like-minded shoppers, but don't have a platform that directly supports this like Refill.Me does.

Package-free stores can be large grocery stores that have a bulk items section. These stores will include both packaged items and package-free items that are available for purchase. These stores are more prevalent than just package-free stores and this is an easier transition for novice package-free shoppers. Another type of package-free stores are Farmers' Markets. These markets are a collection of farms and agricultural communities. They are a community gathering place where local artisans, bakers, and other crafters display their goods or wares. Shoppers will need to bring their own containers to bring home their purchases. And then there are truly package-free stores. These stores have only bulk items and shoppers will need to bring their own containers and plan accordingly.

As more shoppers see the benefits of shopping package-free, the demand will quickly culminate in more packaged free products becoming available. This will in turn encourage more shops to open with the goal of promoting package-free products. The future of Refill.Me could include package-free delivery trucks, where users could place orders and receive the amount of

products they requested. All the users would need to do is show up with containers and collect their items. Future users of the service could include other grocery store applications.

4.   Refill.Me Prototype Description

Refill.Me is intended to help consumers conduct package-free shopping and to make the shopping experience as simplified as possible utilizing several in-app features. The intended purpose of the prototype is to express the real-world product (RWP) features in a streamlined prototype. Not every feature will be properly enabled in the prototype and will need to be omitted or shown with pre-generated data. As a proof of concept, the prototype will still look and feel as if it were the real product and will focus on the innovative goal of designing a mobile software application that will reduce the total amount of packaging materials that plagues the planet and the subsequent consequences.

4.1.   Prototype Architecture (Hardware/Software)

The Refill.Me prototype will be developed using a three-tier architecture system, similar to the RWP. This is shown below in Figure 2. The prototype includes a presentation layer, application layer, and data layer. Each of these components will be stored on a ODU Computer Science dedicated server. The application layer will be built using Django for the backend and will communicate with both the database and the presentation layer. The database will be built using MySQL on ARDS. While the presentation layer will be designed using React Native. The real-world application was planned with two hard coded applications, Android and iOS. Using React Native, the Refill.Me prototype can still be used on any device with an internet connection without loss of functionality across devices.

Figure 2

Prototype Major Functional Component Diagram
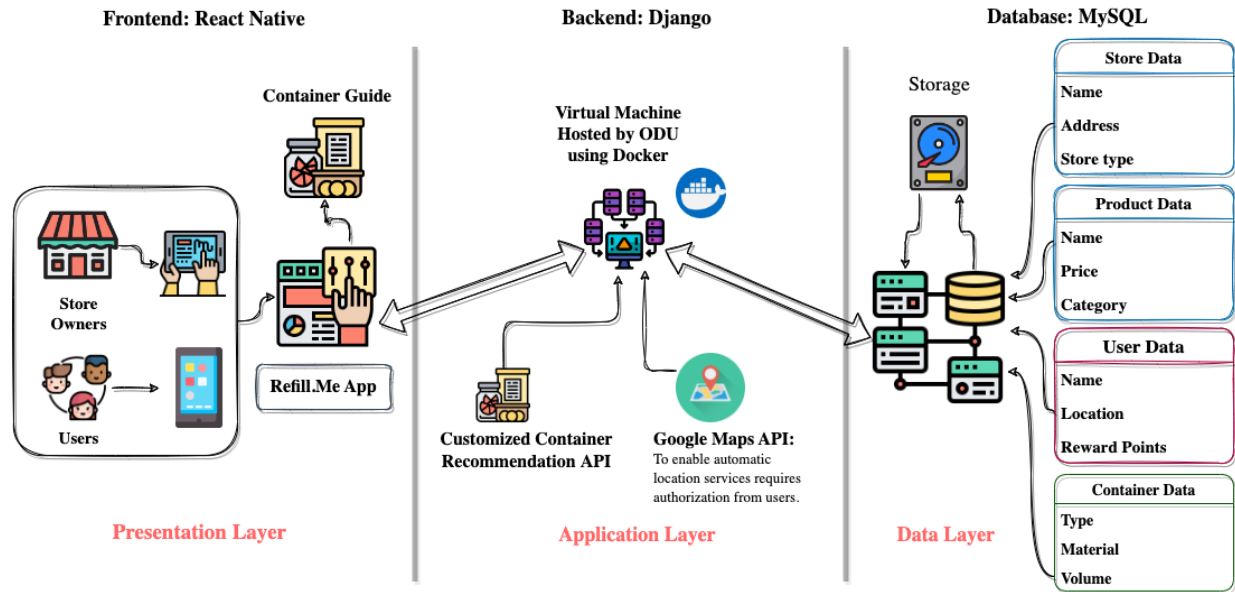
Much of the project development will remain the same as the RWP. The Refill.Me prototype will still be developed using GitHub for the repository and version control. GitHub also enables project management through Projects and enables features such as issue tracking and sprint goals. The Refill.Me group collaboration will remain the same with Discord for group discussions and Zoom for project meetings.

4.2.   Prototype Features and Capabilities

Most of the functionality and capabilities will be retained for the prototype application for Refill.Me. There will be a limited number of features that will be partially implemented as shown below in Table 1. The features listed show the RWP and the prototype and how it is being implemented. The limited functionality includes the search by icon. This section will be pre-generated data and will be partially implemented. The search by name will be omitted from the prototype altogether. The crowdsourcing store rating system will be implemented partially. This is due to stores being pre-generated data; this will be the same for the store owner users.

Table 1

Refill.Me RWP v. Prototype Features

Feature	RWP	Prototype
Account creation	Fully Implemented	Fully Implemented
Store Search	Fully Implemented	Fully Implemented
Product search		
By Icon	Fully Implemented	Partially Implemented
By Name	Fully Implemented	Omitted
By Barcode	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	Fully Implemented
Crowdsourcing		
Suggested Edits	Fully Implemented	Fully Implemented
Store Rating	Fully Implemented	Partially Implemented
Connect shoppers	Fully Implemented	Fully Implemented
Product/ Price Dashboard	Fully Implemented	Fully Implemented
Reward Point Conversion	Fully Implemented	Fully Implemented
Coupon Dashboard	Fully Implemented	Fully Implemented
Store Rating Dashboard	Fully Implemented	Partially Implemented
Store Information Dashboard	Fully Implemented	Fully Implemented

Although some features will not be fully implemented, the final prototype will still allow for a full display as if it were the RWP. A user will be able to log in to their profile, look up items that are available in their area (the data is pre generated and will not be actual products that are available for purchase), sign up for reward me, see stores in the area (also pre generated data), submit crowdsourcing information, read the container guide, create a list, view the container recommendation based on their lists, and submit crowdsourcing recommendations.

4.3.   Prototype Development Challenges

One of the main development challenges Refill.Me anticipates is the learning curve for many of the software products that will be utilized during the development process. These include the Django framework for the backend, the MySQL database configuration and deployment, and the React Native framework for the frontend development. Another technical challenge are the APIs that will serve to communicate between the different layers. These APIs ensure that proper data exchanges between the components are addressed and occurring as intended.

Another technical issue Refill.Me anticipates is the web server that is hosted by ODU. The server may cause issues with access rights of different software components that Refill.Me will be utilizing during the prototype build. As a result of these circumstances, it may be difficult to adhere to a rigorous sprint schedule and anticipate delays.

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.

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

Backend: a computer system or application that is not directly assessed by the users but rather responsible for storing and manipulation of 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 to avoid creating packaging waste.

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

Compostable: breaks down into organic matter and does not produce any chemicals during that process.

Container: tote bags, produce bags, glass or plastic jars, glass or plastic boxes, glass or plastic bottles 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.

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 gets 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.

Git Issue(s): a GitHub repository' feature that allows to track: issues, team-members' work and development process of an application.

Google Map: a map that provides detailed information about location-based products and services.

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, 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: a remote computer that stores web server software and website/application components.

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