Lab 1 – Refill.Me Product Description

Judit Chang

Old Dominion University

CS 411W: Professional Workforce Development II

Professor Sarah Hosni

March 8, 2023

Final Version

Table of Contents

List of Figures

List of Tables

1. Introduction

The huge amount of packaging waste generated every year as a result of mainstream grocery shopping is the main culprit of the omnipresent packaging waste problem that is harming the ecosystem, the health of humans, animals, and plants (Shen, 2020). The inefficient recycling system that is currently in use is another fundamental problem that contributes to the current situation. Contrary to common belief, the environmental problems regarding packaging waste are not unique to plastic, even though, it is in fact one of the most problematic packaging materials. Plastic heavily contributes to greenhouse gas emissions, to global warming, and to the microplastics problem (Shen, 2020). Also, many studies have proven that harmful chemicals leak from plastic, especially when it gets in contact with food (Groh, 2019). Still, paper because of its limited reusability, aluminum because of the nonrenewable bauxite needed for its production, and glass because of the fact that it does not biodegrade, all pose their own problems when it comes to their use as packaging materials (Sinai, 2017; Carvalho, 2022).

Even though recycling became very popular over the years, it is still not efficient enough to deal with the huge amounts of packaging waste that is created every year. In the USA alone, in 2018, packaging waste added up to 82.2 million tons of waste (EPA, *Containers and packaging: Product-Specific Data*, 2018). Regarding recycling rates in the USA, a huge percentage of plastic (91%) and glass (75%) is not being reused (EPA, *National Overview: Facts and Figures on Materials, Wastes and Recycling*, 2022). These numbers are worrying, and actually, according to a study, about 80% of Generation Boomers, Generation X, Millennials, and Generation Z are indeed concerned about packaging waste (Denis, 2021). As a result of the growing demand for more legislation, several countries have created a strict regulatory environment, and banned single-use plastic items like plastic shopping bags or takeout containers. Also, from 2021 to

2030, the market of reusable, compostable, and edible alternatives is expected to double (Zero Waste Packaging Market Size). Still, in order to effectively tackle the immense problems created by packaging waste, a growing number of shoppers want to completely opt out of packaging, and aim to adopt a low-waste lifestyle (VanRemoortel, 2018). Package-free shopping encourages people to bring their own containers, and it promotes refilling, and reusing bags, jars, boxes, and glasses. This waste-reduction practice allows eco-friendly shoppers to significantly decrease their environmental footprint.

Unfortunately, consumers who seek package-free options face many challenges. The lack of available information about package-free shopping, package-free stores, and loose products is a significant obstacle to those people who would like to help the environment and to take action. A central hub where information related to package-free shopping is easily accessible, accurate, and up-to-date is missing from the life of novice and experienced package-free shoppers. The mobile application, Refill.Me is designed to fill this void by providing an easy-to-use interface where information about package-free stores, products, and their prices are readily available. Also, information about containers that can be used for package-free shopping is an essential part of the app.

2. Refill.Me Product Description

Refill.Me connects package-free shoppers with nearby stores that have a bulk section, and it also provides shoppers with information about the practicalities of package-free shopping. It aims to help novice shoppers who are about to transition into package-free shopping, and also to help experienced package-free shoppers who would like to maintain their shopping habits.

Refill.Me's mission is to support local businesses, and to help build communities, while reducing packaging waste.

2.1. Key Product Features and Capabilities

Refill.Me accommodates shoppers' needs by providing a mobile phone view. Scanning the barcode of products for which shoppers would like to find package-free alternatives, uploading the photos of receipts to collect reward points, and using the shopping list are the most efficient when the app is used on a mobile phone. For store owners, the app is customized for tablet usage to provide flexibility while maintaining portability and convenience. Refill.Me supports store owners in their day-to-day work with the different views and tables that it provides.

One of the primary features for shoppers is the store search. To use this, shoppers either need to enable location services, or provide a ZIP code so that the app can suggest nearby stores. If there are any nearby supermarkets with a bulk section, package-free stores, or farmers' markets, they will be shown on the map. By clicking on a store, users can get more information, like opening hours, link to the store's website, etc.

The second most important feature is the product search that can be performed in three different ways. First, the search by icons option lists products represented by icons that are available package-free. Second, shoppers will also be able to scan a product's barcode for which they would like to find a package-free alternative. Lastly, users can also enter a product's name, and then search. These three options will give shoppers a thorough product listings with unit prices so that they will be able to make an informed decision. Information regarding the containers that can be used for package-free shopping is not easy to come by. To remedy this,

one of the main innovations of Refill.Me is to provide information about containers in the form of a simple listing, the Container Guide, and to give container recommendations for every product, and also based on the user's shopping list, for a specific grocery shopping that the shopper would like to do. With the reward program called Reward.Me shoppers can collect points and enjoy discounts or other benefits offered by the stores. To keep shoppers engaged, Refill.Me uses crowdsourcing to allow shoppers to suggest updates to the information provided by the app, like store, product, or price information.

The most important feature for store owners is the Product and Price dashboard, where they can add, edit, delete, sort, or filter products. The Reward Point Conversion dashboard is essential in communicating to the shoppers the amount of reward points needed for getting certain discounts or benefits. The Coupon dashboard helps to create and manage coupons that are provided to the shoppers in exchange for reward points. The Store Rating dashboard gives a good overview of ratings that were submitted by shoppers, and an opportunity to store owners to answer any questions or concerns that were addressed. Store owners will also have access to Store search and Product search so that they can validate whether the modifications they made will be displayed to the shoppers the way they wanted to.

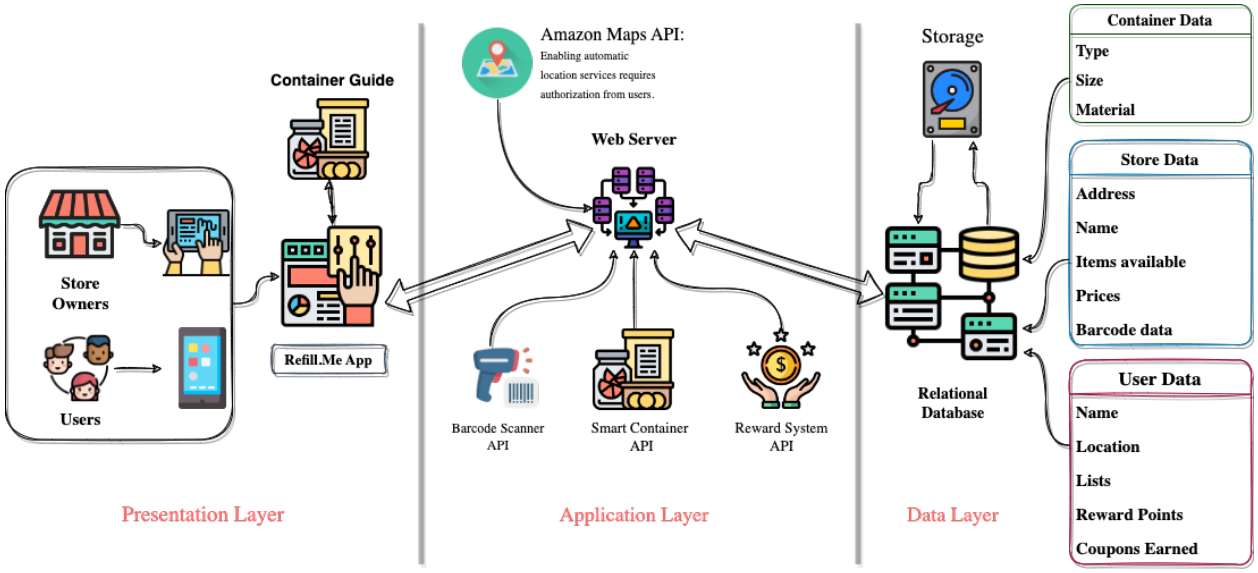
2.2. Major Components (Hardware/Software)

Refill.Me uses a three-tier architecture to organize the application into logical and physical computing tiers. Figure 1 illustrates the major functional component diagram of Refill.Me. The figure shows three layers: the presentation layer, the application layer, and the data layer. The application layer is all about the user interface that will be optimized for mobile phones for the shoppers, and for tablets for the store owners – both for Android and iOS. The

data flow is from the store owners who will provide the product and price, the reward point conversion, and coupon information to the users who can access it via Refill.Me.

Figure 1

Refill.Me Major Functional Component Diagram



The brain of the application, the web server, and the APIs reside in the application layer. It will enable the integration of various APIs. For mapping Amazon Maps API is used, for barcode scanning the Barcode Detection API, and for receipt uploading the open-source OCR (Optical Character Recognition) API, Tessaract. Furthermore, to create and deliver coupons, the Tremendous Gift API will be integrated, while for web scraping, the open source Scrapy will be used.

The data layer is where data that is associated with the application is stored and managed using a relational database. Amazon RDS for MySQL will provide the database that can be used to store data tables related to store, product, user, and reward information. Data analysis will be performed by Amazon Kinesis Data Analytics.

The React Native and Expo framework will provide the basis for developing a cross-platform solution. An Android, iOS, and a web application will be deployed based on the program written in HTML, CSS, and JavaScript. For database programming, SQL is used. The testing framework Jest provides the testing tools needed for our unit, integration, and system testing. The build is handled by Webpack and Node Package Manager.

The chosen IDE for development is Visual Studio Code. For version control and for continuous integration, GitHub will be used. For project management and group collaboration, Trello, GitHub Issues, Discord, and Zoom will be the main tools.

3. Identification of Case Study

Refill.Me's mobile phone version is designed for eco-conscious shoppers in the USA. This target group consists of mostly women between the ages of 18 and 65, who have diverse income levels, and are highly educated (Hoover, 2022; Kim, 2018; VanRemoortel, 2018). The user interface appeals to this market segment with a simple, easy-to-follow navigation bar, a quick menu, and a well-chosen color palette. On the other hand, the tablet version is laid out for store owners or vendors at farmer's markets who sell loose products, package-free.

The prototype case study will revolve around a Caucasian woman who is in her 30s, has a master's degree, high income, one child, and is passionate about the environment. Package-free shopping in general is targeted at consumers like the one in our case study, thus, Refill.Me has a high potential to become a major platform for these users to get practical information about package-free shopping, to search for stores and products, or to get familiar with containers that could be used for package-free shopping. Also, these shoppers will make use of the built-in shopping list, and will be excited to collect reward points in their favorite stores to get further benefits.

Regarding package-free stores, the case study will include the owners or employees of three different stores: those of a supermarket with a bulk section, those of a package-free store that specializes in loose products, and those of a booth at a farmers' market. These stores offer a moderate number of package-free items (approx. 100-120), while the vendor at the farmers' market approximately 30-40 items. The store owners or employees will use the app to communicate their products and prices to package-free shoppers, and to get search information in their area, which they can use for diversifying their store offerings.

In the future, once package-free shopping became more widespread, Refill.Me might be integrated into well-established grocery shopping apps. Currently, such an integration would not be beneficial because package-free shoppers' special needs cannot be addressed by just one or two filtering options, especially if the container features of Refill.Me are considered. Also, Refill.Me could be used by trucks selling package-free products for communicating their current location, and letting the users know about the products that they have in stock.

4. Refill.Me Prototype Description

The prototype of Refill.Me focuses on the most important aspects of the real-world product, namely, the store search, the product search, the shopping list, the functionalities related to the container recommendation, reward point collection, and the crowdsourcing feature of the application. Even though many grocery shopping apps have similar functionalities, the features that make Refill.Me unique and especially useful for package-free shoppers are the customized container recommendation, and the ability to directly connect with advocacy or petition websites. For store owners, the prototype includes a fully-implemented product and price dashboard and a reward point conversion dashboard. The features related to the store rating and to the search

information will be partially implemented. With the key functionalities completed, the prototype will be able to demonstrate the usefulness of the application.

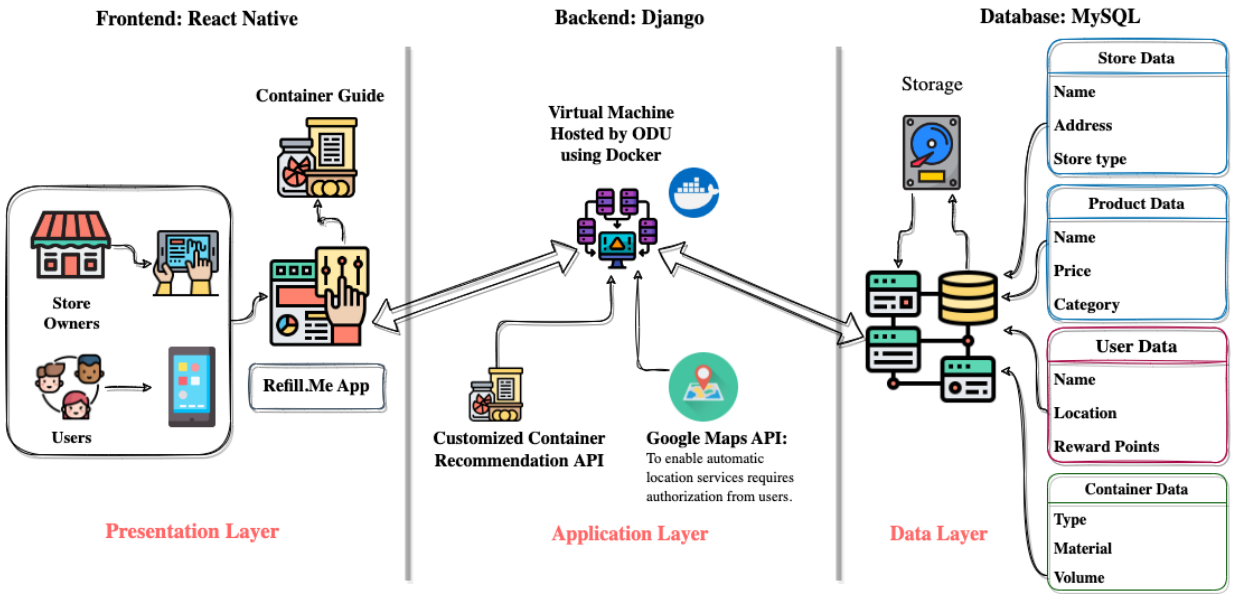
4.1. Prototype Architecture (Hardware/Software)

The prototype of Refill.Me will be developed following the three-tier architecture that includes the frontend, middleware, and the backend. Each tier will have a corresponding Docker container: one container for React Native, another one for Django, and one for the MySQL database that will have a Docker volume mounted to it. The Docker containers will run on the virtual machine provided by the Computer Science Department of ODU.

The Major Functional Component Diagram of the prototype is shown in Figure 2. It is updated to reflect the specifications of the prototype. The front end will use React Native to build a cross-platform application with an interactive user interface. On the back end, Django will be used to develop the server-side algorithms that will handle the different functionalities of the

Figure 2

Refill.Me Prototype Major Functional Component Diagram



app, and the collection and retrieval of data. A MySQL database running in a Docker container will be used to store the data related to stores, products, users, and containers for package-free shopping.

The prototype will be built using the programming languages HTML, CSS, JavaScript, Python, and SQL. For locating stores in the store search feature, the Amazon Maps API will be integrated into the application. Testing will be conducted using Pytest. GitHub will provide the environment for version control. The team will collaborate using GitHub Issues, Trello, Discord, and Zoom.

4.2. Prototype Features and Capabilities

To provide a product that is able to prove the usability and practicality of the application, the prototype will focus on the following functionalities: the store search, product search, the shopping list, the customized container recommendation, the reward point collection, and the crowdsourcing feature of the app. The static pages of the container guide and the advocacy and petition site will be completed at the very beginning of the development. Table 1 provides an overview of the features for shoppers that will be fully or partially implemented in the prototype, while Table 2 shows the features for store owners.

The prototype allows shoppers to find nearby package-free stores using a map, to see the product listing of a specific store, and to create a shopping list by choosing certain products and adjust their quantities. Information regarding containers will be available for the different products in the form of a general recommendation, while based on the items in their shopping list, shoppers can get customized container recommendations that specify the number and types of containers that they need for that particular shopping. The prototype will offer two ways for

Table 1

Refill.Me RWP vs Prototype: Features for Shoppers

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	Eliminated
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	Eliminated
Crowdsourcing		
Suggested edits for products and prices	Fully implemented	Fully implemented
Store rating	Fully implemented	Partially implemented
Connect shoppers to advocacy and petition sites	Fully implemented	Fully implemented

Table 2

Refill.Me RWP vs Prototype: Features for Store Owners

Feature	Real-World Product	Prototype
Product and Price Dashboard	Fully implemented	Fully implemented
Reward Point Conversion Dashboard	Fully implemented	Fully implemented
Coupon Dashboard	Fully implemented	Eliminated
Store Rating Dashboard	Fully implemented	Partially implemented
Search Information Dashboard	Fully implemented	Partially implemented

searching for package-free products. One option is to enter the name of the product into a search bar. In case Refill.Me returns no results for a specific product, shoppers will be provided with links to advocacy and petition sites that connect them with platforms where shoppers can express their wish for more package-free options. The second search option is to choose from a list of icons representing products that are usually available package-free. By showing product

categories that are generally available package-free, shoppers will encounter ‘no result’ messages less often compared to regular searching. Shoppers will be able to report new or closed stores, changes to products and prices using a suggested edit feature. The store rating feature will be available as a simple rating on a scale from 1 to 5, and will not contain open-ended questions.

Barcode scanning will not be part of the prototype because the great variety of barcodes would require significant amount of time and various resources for testing. Similarly, determining the product based on the barcode, and then further using this information to locate the stores that provide that product or similar products would require research that would be difficult to complete based on the time constraint of the project.

Store owners will be able to use a fully functioning product and price dashboard, where they can add, modify, delete, sort, and filter products that they offer. In the prototype, because of the complexity of web scraping, information about the products of different stores will not be gathered from the internet, but manually entered by the store owners. Also, information regarding new or closed stores will be reported by shoppers using the crowdsourcing feature of the app, and by the store owners who join the application.

The store rating dashboard and the search information dashboard will be partially implemented. These features will be developed containing only the most important aspects of these features, like the average rating for specific stores, and general search information data regarding product searches.

An API for creating, distributing, and retrieving coupons will not be part of the prototype. In the real-world product it is a prominent feature, however, in the prototype the focus will be on building out the functionality for collecting reward points. The store owners will be able to

specify the amount of reward points needed for certain products or services, and therefore shoppers will be able to use their reward points.

4.3. Prototype Development Challenges

The main challenge of the prototype development is the usage of new frameworks and technologies like React Native or Docker. To fully understand and to be able to use these new tools and to follow best practices will require a significant amount of time and practice. As a result, the sprint schedule determined at the beginning of the project might be difficult to follow, and will need several revisions during development.

The integration of the Google Maps API might also become a challenging task. The lack of experience with web application development might slow down the progress of the prototype development. The best mitigation strategy is to continuously reevaluate the progress of the development work, and adjust the criteria for the minimum viable product.

[This space intentionally left blank.]

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.

[This space intentionally left blank.]

6. References

Carvalho, J. S, et al. (2022). Consumers' knowledge, practices, and perceptions about conventional and sustainable food packaging, *Food Science and Technology*, https://www.scielo.br/j/cta/a/RcjxMbZXFTTtgfjrpCvjvtB/?format=pdf&lang=en

Denis, K. (2021, August 7). The Future Is Bright for American Recycling, *Consumer Brands Association*, https://consumerbrandsassociation.org/blog/the-future-is-bright-for-american-recycling/

Environmental Protection Agency (EPA). (2022, March 8). Containers and packaging: Product-Specific Data, *EPA*, https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/containers-and-packaging-product-specific#:~:text=Containers%20and%20packaging%20make%20up,beverages%2C%20medications%20and%20cosmetic%20products

Environmental Protection Agency (EPA). (2022, July 31). National Overview: Facts and Figures on Materials, Wastes and Recycling, *EPA* https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials#NationalPicture

Groh, K. J. et al. (2019, February 15). Overview of known plastic packaging-associated chemicals and their hazards, *Science of The Total Environment*, Volume 651, Part 2, https://www.sciencedirect.com/science/article/pii/S0048969718338828

Hoover, A. (2022, June 10). These influencers live trash-free in a garbage world, *Morning Brew*, https://www.morningbrew.com/daily/stories/2022/06/10/influencers-live-trash-free-in-a-garbage-world

Kim, L. Incentives, Demographics, and Biases of Ethical Consumption: Observation of Modern Ethical Consumers, *University of California,* https://www.econ.berkeley.edu/sites/default/files/Kim_Laura_F18%20Honors%20Thesis.pdf

Shen, M. et al. (2020). (Micro)plastic crisis: Un-ignorable contribution to global greenhouse gas emissions and climate change. Journal of Cleaner Production, 254(120138), 120138. https://doi.org/10.1016/j.jclepro.2020.120138

Sinai, M. (2017, June 27). How Many Times Can Recyclables Be Recycled?, *Recycle Nation*, https://recyclenation.com/2017/06/how-many-times-can-recyclables-be-recycled/

The Environmental Impact of Food Packaging. (2018, October 08). *FoodPrint,* https://foodprint.org/issues/the-environmental-impact-of-food-packaging/

VanRemoortel, A. (2018, May). Cultural Capital Among Zero Waste Consumers, *Wheaton College,* https://digitalrepository.wheatoncollege.edu/bitstream/handle/11040/24562/Anna_VanRemoortel_HonorsThesis.pdf?sequence=2&isAllowed=y

Zero Waste Packaging Market Size, Share, Report 2022-2030. *Precedence Research*, https://www.precedenceresearch.com/zero-waste-packaging-markethttps://www.precedenceresearch.com/zero-waste-packaging-market, https://www.precedenceresearch.com/zero-waste-packaging-markethttps://www.precedenceresearch.com/zero-waste-packaging-market