SMART GROCERY SHOPPING APPLICATION

(SGSA)

CPIT 498 First Report

By

Elaf Aloufi	1911265
Layan Fakhurji	2110850
Manar Altaiary	1906775
Raneem Alshareef	1907696

Department of Information Technology
Faculty of Computing and Information Technology
King Abdulaziz University
Jeddah – Saudi Arabia

Fall 2022

DECLARATION by AUTHORS

"I/we certify that this work has not been accepted in substance for any degree and is not concurrently being submitted for any degree other than that of BS Information Technology being studied at King Abdulaziz University, Jeddah. I/we also declare that this work is the result of my/our own findings and investigations except where otherwise identified by references and that I/we have not plagiarized another's work".

[Signature]	[Signature]	[Signature]	[Signature]
			
[RANEEM]	[LAYAN]	[ELAF]	[MANAR]

DECLARATION by SUPERVISOR

I, the undersigned hereby certify that I have read this project report and finally approve it with recommendation that this report may be submitted by the authors above to the final year project evaluation committee for final evaluation and presentation, in partial fulfillment of the requirements for the degree of BS Information Technology at the Department of Information Technology, Faculty of Computing and Information Technology, King Abdulaziz University, Jeddah.

Abstract

Grocery shopping is one of the activities most of us find exhausting yet essential. Many people prefer to buy their groceries at a supermarket. However, a visit to the supermarket can be nerve-wracking and time-consuming.

Although supermarkets have improved tremendously over the years, technology can boost the supermarkets' future with simplicity and effectiveness. This project proposes the Smart Grocery Shopping Application SGSA, which aims to improve the in-store customers’ grocery shopping experience. The proposed application SGSA provides customers with in-store navigation, which helps save customers' time and organize the customer flow inside the supermarket. The SGSA offers several features all aims to enhance and revolutionize the in-store supermarket shopping experience.

Table of Contents

List of Figures

List of Tables

Chapter 1: Introduction

1.1 Problem Definition

Grocery shopping is one of the activities most of us find exhausting yet essential. Everyone must buy groceries, whether it is food, cleaning and laundry supplies, hygiene products, and other household items.

When we want to go grocery shopping, the first option that comes to our heads is the supermarket. Supermarkets provide almost all the customers' needs under one roof. However, a visit to the supermarket can be nerve-wracking and time-consuming. Customers face several problems during shopping. Such as, (1) They often waste a great amount of time by crossing all the supermarket aisles to collect their groceries; (2) Customers struggle to find a particular product within the supermarket because different supermarkets have different layouts. Even the same supermarket has multiple branches that have different ways of placing the products on the shelves and arranging the aisles; (3) Customers sometimes look for a product from a particular brand without knowing if that supermarket supplies it, so they try to find a staff member to help, which can also be frustrating. However, some supermarkets are understaffed and do not have enough employees -on the field- to help customers. Thus, customers waste their time wandering around the supermarket to look for a staff member that can direct them to the products they need.

Although supermarkets have improved tremendously over the years, technology can boost the supermarkets' future with simplicity and effectiveness. Therefore, we are developing the Smart Grocery Shopping Application (SGSA) to address the problems above as well as enhance the in-store supermarket shopping experience.

1.2 Project Scope

Since grocery shopping is one of the fundamental human activities performed regularly, the SGSA targets a large segment of society.

Using this application will revolutionize the in-store supermarket shopping experience, as it helps supermarkets to keep up with modern technological advancements.

The SGSA is created, developed, and tested on a Hyper Panda branch located in Jeddah, SA. More branches will be added in the future.

1.3 Aims and Objectives

Our main objective is to develop an application that improves the in-store customers' grocery shopping experience. The proposed application (SGSA) provides customers with in-store navigation map, which help save customers' time and organize the customer flow inside the supermarket.

The SGSA aims to:

- Give customers an option to write a new grocery list or modify a previous one (if any).
- Categorize grocery lists according to the supermarket aisles and the closest category to the customers to generate a route map that guides customers inside the store.
- Enable customers to check item availability and direct them to its location inside the supermarket.
- Develop a personalized shopping experience for each customer by suggesting items based on their previous lists.
- Provide an online space between customers of the same supermarket to share reviews and exchange recommendations.

1.4 Suggested Solution

To help customers save time and enjoy an easy and smooth in-store grocery shopping experience, we propose a solution called the Smart Grocery Shopping Application SGSA that helps customers to manage their grocery lists (Figure 1). The app provides different services: (1) Sorting the customer's list into categories based on the supermarket aisles (Figure 2) and then generating a route map to guide the customer inside the store, starting from the closest category to the customer (Figure 3). (2) Enabling the user to search for an item and navigate to its location (Figure 5, Figure 6). (3) Developing a personalized shopping experience for each customer by suggesting items based on their previous lists (Figure 7). (4) Providing an online space between customers of the same supermarket to share reviews and exchange recommendations (Figure 8).

Furthermore, all stakeholders can get benefits from using the SGSA. For instance, customers will enjoy a smooth shopping experience by following the in-store route determined for each customer based on their grocery list. Additionally, customers do not need to ask for assistance from the supermarket staff since they can search for products and navigate to their location inside the supermarket. This would ultimately increase customer satisfaction rate during shopping time. Furthermore, since the SGSA will store customers' grocery lists on the database, manufacturers would be able to analyze customers' lists to know the best-selling products and the customers' preferences. Analyzing the data collected by the SGSA would give manufacturers insights that can help them in making decisions, solving problems, and identifying future trends.

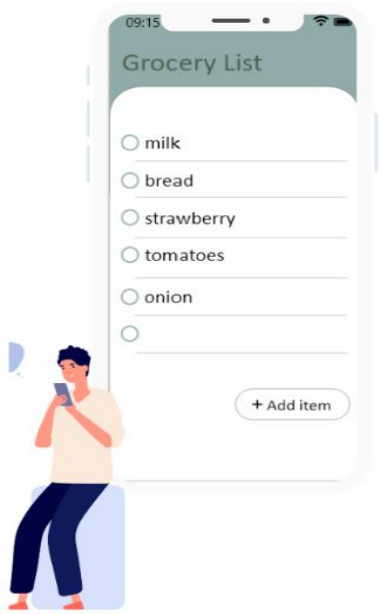

Figure 1: Create a grocery list

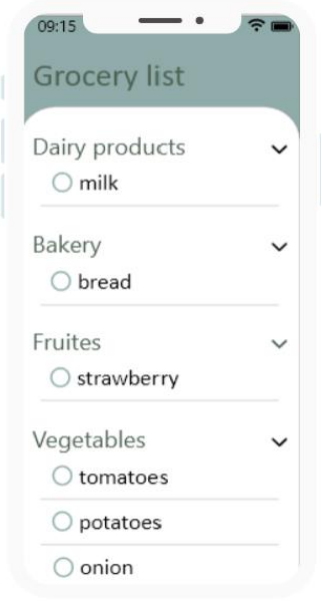

Figure 2: Sort items by category

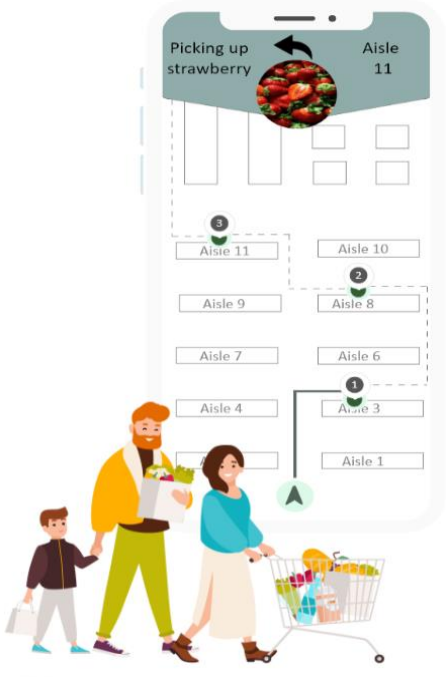

Figure 3: Generate a route map based on the item's location

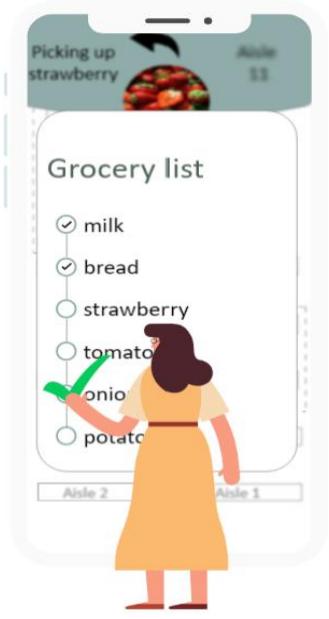

Figure 4: Check the collected items

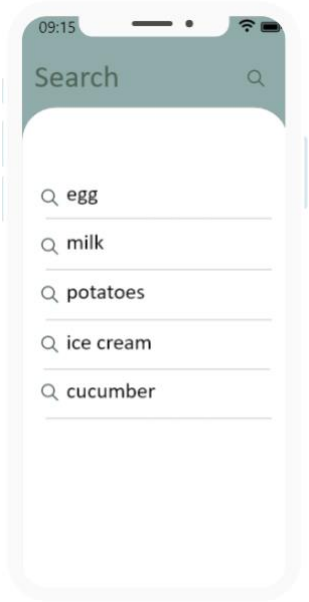

Figure 5: Search for a specific item

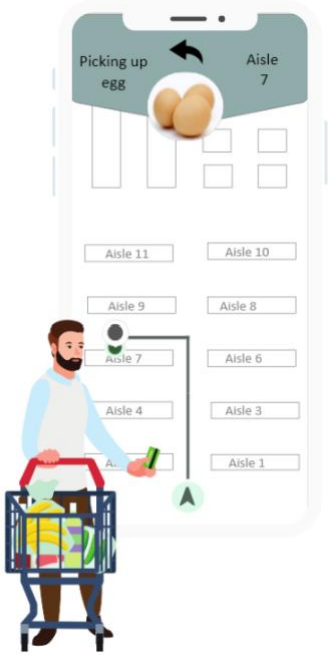

Figure 6: Navigate to the item location

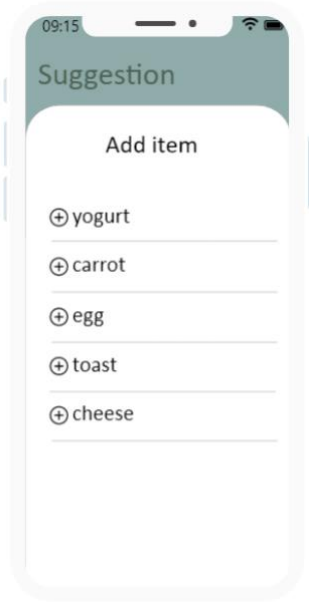

Figure 7: Shopping suggestions based on previous lists

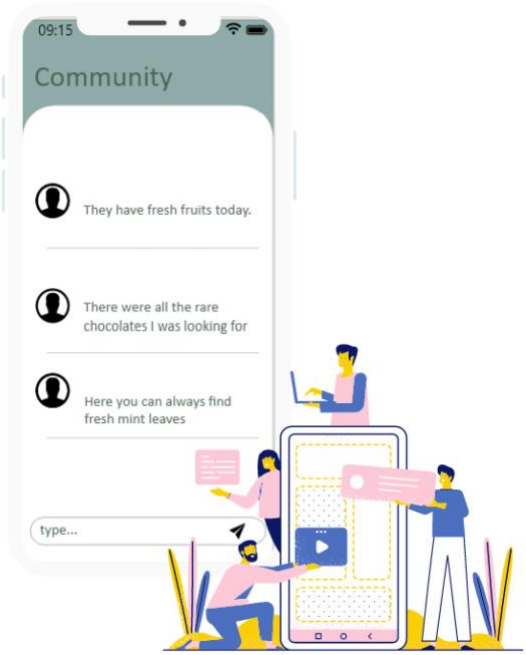

Figure 8: Share reviews

1.5 Methodology

A software development methodology is a framework used to structure, schedule, and manage the process of developing an information system. By choosing the appropriate methodology, a project can produce more accurate estimates, deliver more stable systems, create clear understanding of the work that lies ahead, and spots pitfalls earlier.

Since our project has a well-defined end scope and requirements, the Waterfall model is employed. Each phase of the project has specific deliverables and clear procedures that need to be followed to complete each phase before proceeding to the next one

.

The basic phases of the waterfall methodology:

1. Requirements Gathering & Analysis

   To evaluate the effectiveness of the SGSA services and explore more features, an online survey is shared between regular customers to collect their opinions and suggestions. Additionally, an online interview with a former IT employee in Hyper Panda is conducted to acquire a better understanding of the supermarket's layout. All required information is collected and analyzed to determine the SGSA software/hardware specifications.

2. System Design

   The SGSA design document has to be established, which includes the application interfaces prototype and the architecture diagrams of the application.

3. Implementation

   The development process to build the SGSA has to be started as outlined in both the analysis and the design phases.

4. Testing

   In this phase, the SGSA functionality has to be tested on Hyper Panda's supermarket layout.

5. Deployment

   In this phase, the SGSA has to be accessible to end users.

6. Maintenance

   Once the SGSA is deployed, feedback from end users has to be fetched to solve problems and bugs as they arise.

1.6 Designing Tools

This section lists the utilized tools. More tools might be added as the project proceeds through the development cycle.

- Google Forms

  To build an online survey and analyzing the results using clean response data with automatic summaries.

- Google Drive – Google Documents

  To collaborate on drafting our documents with real-time updates.

- Google Meets

  It is integrated with Google Workspace to conduct online meetings with a secure connection.

- Microsoft Word

  To create and collaborate on documents with built-in intelligent features.

- Microsoft Teams

  To conduct online meetings and edit files in real time.

- Draw.io

  A free platform to create and share diagrams integrated with several libraries of ready-to-use charts.

- Lucid

  An online design tool for creating charts and diagrams. -A backup tool if we encountered any limitations with Draw.io.

- Figma

  A cloud-based design tool that works on any platform and provides real-time updates for its embedded files. It is a user-friendly tool that facilitates developer handoffs and communication.

- Adobe XD

  A vector-based design tool for designing user interfaces (UI). -A backup tool if we encountered any limitations with Figma-.

- Canva

  A graphic design tool that simplifies digital design. It is also an inspiration source for design ideas.

- MySQL

  An open-source SQL database management system is used to add, access, and process data stored in a computer database.

- Visual Studio Code

  Source code editor to launch running apps with integrated debugging features.

- Android Studio

  An Integrated Development Environment (IDE) for Android app development that incorporates code editing and developer tools.

- Flutter framework, Dart language

  To create our application in an effective way the open-source Flutter framework has to be used in addition to the Dart programming language, which serves as the foundation for the Flutter SDK. Because of Flutter's code reusability, we can write one codebase and use it on Android, iOS, and the web.

- Python

  A high-level object-oriented programming language that supports modules and packages.

- PyCharm

  The Python IDE provides intelligent assistance such as smart code completion in addition to automated code refactoring.

- Beacon

  A small, wireless, and high-tech device that works based on Bluetooth Low Energy. It can transmit signals that other devices can receive.

Chapter 2: Background and Similar Applications

2.1 Project Background

Grocery shopping is an essential activity in our lives. The act of buying groceries will never go away, but how we buy groceries has certainly evolved over the years. The old grocery system involved customers calling or bringing their grocery lists. Then, stores would bag items for pick-up or delivery. However, Clarence Saunders revolutionized the industry when he opened the first self-service grocery store, the Piggly Wiggly, in 1916 in Memphis, Tennessee. By the 60s, shoppers became used to strolling through aisles and hand-selecting items themselves.[9]

Because they have advanced significantly, grocery stores are now referred to as supermarkets. They used to be small general stores, but now they are warehouses full of technological marvels.[4]

The following section overviews the history of **Grocery Lists** and how they evolved over the years.

2.1.1 Grocery Lists

Going to the supermarket without preparing a grocery list in advance is a waste of time. Customers will aimlessly shop without knowing what to buy or what is needed. Thankfully, the old grocery system proved that people started writing grocery lists before the 50s, which means that they realized the importance of grocery lists from the day they started grocery shopping.[9]

Consumers commonly shop for groceries with lists of items to purchase. The use of grocery lists represents a degree of pre-shopping planning, which reduces impulsive purchasing.[15]

The grocery list has transformed from a handwritten list to a digitized one. Studies showed that the paper shopping list is longer and includes more products than the digital shopping list. Furthermore, products on the paper shopping list are less hedonic than those on the digital shopping list.[7]

Modern consumers thrive on time and convenience. They are searching for solutions to optimize time and energy. Luckily, many applications were developed to manage grocery lists to meet the consistently evolving users' needs.

2.2 Summary of Similar Works

2.2.1 Applications

2.2.1.1 Application 1: *AnyList*[3]

AnyList is an application that creates grocery shopping lists, then intuitively organize them into categories and allows users to share them. Additionally, it collects and organizes recipes.

Figure 9: AnyList Application

AnyList Application Features:

- Grocery shopping lists

  It allows the user to create multiple lists to organize items and separate them into categories.

- Siri

  It allows the user to add items by voice with Siri and Reminders Import feature.

- Favorites

  It allows the user to store items as favorites to use them later.

- Recipes

  It allows the user to enter recipes to organize them into collections by type or occasion and share them with a trusted partner.

- Notifications

  Providing optional push notifications for any shared list modifications.

- Design

  It allows the user to badge the app icon optionally with the number of items remaining on the lists and choose a color for each list to help distinguish lists.

Features	*AnyList*	*SGSA*
Create grocery shopping lists	✓	✓
Sort the list into categories	✓	✓
Siri	✓	
Favorites	✓	
Storing food recipes	✓	
Notifications	✓	
Custom list design		✓
Generates a route map to guide the user inside the supermarket		✓
Search for an item and navigate to its location in the supermarket		✓
Develop a personalized shopping experience for each customer by suggesting items based on their previous lists	✓	✓
Create an online space between users of the same supermarket to share reviews and exchange recommendations.		✓

Table 1: Features of AnyList Application.

Relevance:

Both *AnyList* and *SGSA* are based on the idea of creating and managing grocery lists.

Differences:

- *AnyList* Application

  The application sorts grocery lists automatically by categories and stores food recipe ingredients. *AnyList's* objective is to provide stress-free shopping, cooking, and meal planning.

- SGSA

  The application sorts grocery lists by categories and generates a route map to guide the user inside the supermarket. The SGSA's objective is to improve the in-store grocery shopping experience.

2.2.1.2 Application 2: *Listonic*[10]

Listonic is an application that allows the user to write and share a synchronized list of items across all platforms and automatically sorts them based on their category.

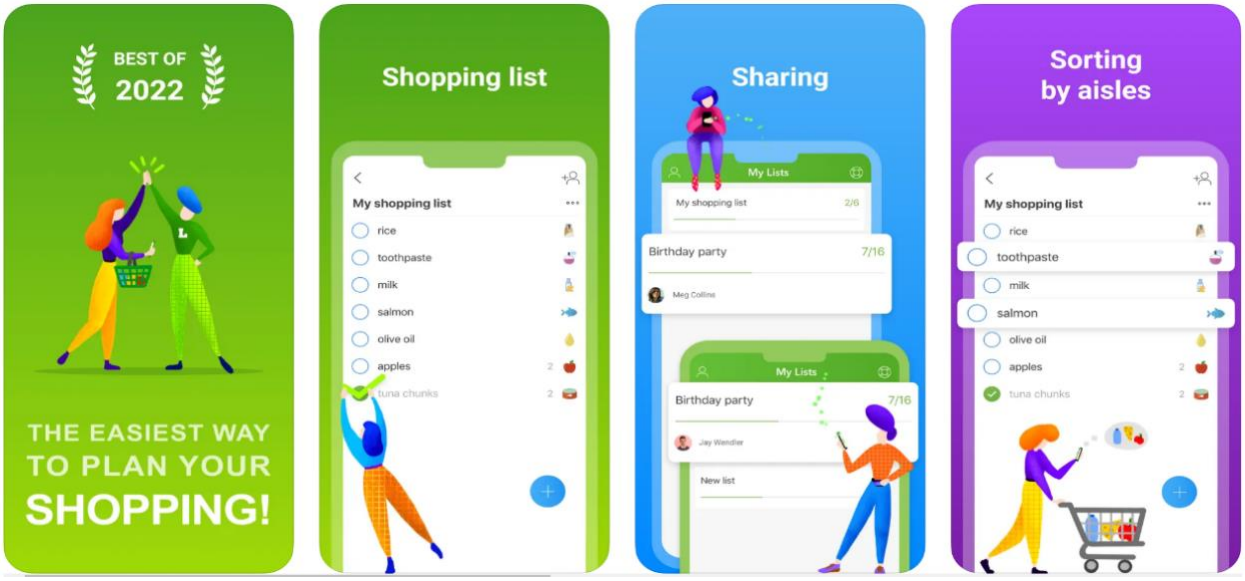

Figure 10: Listonic Application

Listonic Application Features:

- Smart and custom categories

  It allows the user to add list of items and automatically sort them by categories.

- Sync across all platforms

  It allows the user to share a synchronized lists with others across all platforms.

- Unlimited lists

  It allows the user to create and share various type of lists.

- Smart suggestions

  It provides an intelligent item prompter feature that suggests to the user the duplicated purchases based on the previous lists by understanding the users' shopping history.

- Control user’s budget

  It allows the user to control their spending by calculating the total price automatically once the item is added to the grocery list.

Features	*Listonic*	*SGSA*
Smart and custom categories	✓	✓
Sync across all platforms	✓	
Unlimited lists	✓	✓
Smart suggestions	✓	✓
Control user's budget	✓	
The app is linked to a supermarket database		✓
Generates a route map to guide the user inside the supermarket		✓
Search for an item and navigate to its location in the supermarket		✓
Create an online space between users of the same supermarket to share reviews and exchange recommendations.		✓

Table 2: Features of Listonic Application.

Relevance:

Both *Listonic* and *SGSA* are based on the idea of creating and managing grocery lists.

Differences:

- *Listonic* – Shopping List Application

  The application automatically sorts grocery lists based on categories resulting in saving the user's time and money.

- *SGSA*

  The application organizes the user's list into categories, then generates a route map to guide the user inside the supermarket resulting in saving the user's time and organizing the user flow inside the supermarket.

2.2.1.3 Application 3: *Grocery* – Smart Shopping List[5]

Grocery is a grocery shopping application that retains the list sorted while shopping using simple sorting algorithms with syncing support for iCloud and Reminders. It combines intelligent sorting, shopping histories, and recipe management.

Additionally, *Grocery* has an intelligent sorting feature that allows the users to minimize their steps and provides enjoyment every time the user crosses items off the list.

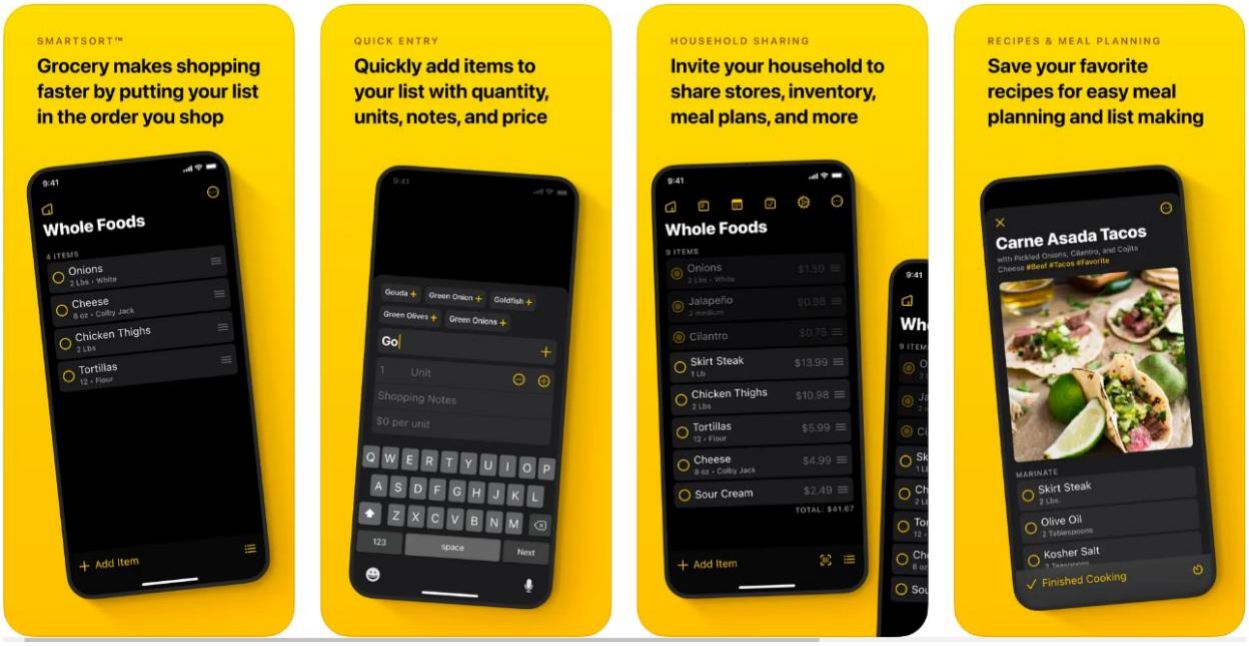

Figure 11: Grocery – Smart Shopping List Application

Grocery – Smart Shopping List Application Features:

- Smart Sorting

  The app automatically sorts the shopping list by two ways:

  - In the order in which the user crosses items off the list.
  - In the order specified by the user.

- Tracking the user's shopping list

  It analyses data from previous shopping trips to sort future lists.

- Pantry Tracking

  It allows the user to track items in the pantry and know when they expire.

- Reminder sharing

  It works with the reminder app to share lists with partners and stay synchronized once it is shared.

- Lightning Fast

  It provides a custom auto-complete with the user's list items and notes.

- Syncing

  It allows the user to share the shopping list with partners and it will be syncing in iCloud makes using Grocery across iOS devices seamless and easier.

- Siri

  It allows the user to add the shopping list items using Siri.

Features	*Grocery*	*SGSA*
Smart sorting	✓	✓
Sync across all platforms	✓	
Pantry Tracking	✓	
Smart suggestions	✓	✓
Lightning Fast	✓	
Reminder sharing	✓	
Siri	✓	
The app is linked to a supermarket database		✓
Generates a route map to guide the user inside the supermarket		✓
Search for an item and navigate to its location in the supermarket		✓
Create an online space between users of the same supermarket to share reviews and exchange recommendations.		✓

Table 3: Features of Grocery Application.

Relevance:

Both *Grocery* and *SGSA* are based on the idea of creating and managing grocery lists.

Differences:

- *Grocery* – Smart Shopping Application

  The application sorts the grocery list in the order in which the user crosses items off the list or in the order specified by the user to save the user's time.

- *SGSA*

  The application organizes the user's list into categories, then generates a route map to guide the user inside the supermarket resulting in saving the user's time and organizing the user flow inside the supermarket.

2.2.2 Comparative Study

2.2.2.1 Design and Development of SMART LIST: A Mobile App for Creating and Managing Grocery Lists.[11]

This paper described the design and development of a mobile app for creating and managing grocery lists. As a result, SMART LIST, a prototype of a mobile app for managing grocery lists, was developed and evaluated.

The study contributes towards an understanding of system requirements for such apps and could be a reference model for developers and researchers to improve the process for creating and managing grocery lists.

Advantages:

- Easy to use.
- Simple to learn. No written instructions are needed.
- The feature of setting a reminder for an item running out of stock.

Disadvantages:

- Limited features.

Features are summarized as follows:

Features	SMART LIST Application	*SGSA*
New user registration	✓	✓
Login to the system	✓	✓
Create a new shopping list	✓	✓
Modify a previous list	✓	✓
Add/ Remove items on the list	✓	✓
organize the list into categories		✓
Add a quantity of an item	✓	
The app is linked to a supermarket database		✓
Generates a route map to guide the user inside the supermarket		✓
Search for an item and navigate to its location in the supermarket		✓
Create a personalized shopping experience by suggesting items based on previous purchases		✓
Set a reminder for grocery items that are almost running out of stock	✓	
Develop a personalized shopping experience for each customer by suggesting items based on their previous lists		✓
Create an online space between users of the same supermarket to share reviews and exchange recommendations.		✓

Table 4: Features of SMART LIST Application.

Relevance:

Both SMART LIST and Smart Grocery Shopping apps are based on the idea of creating and managing grocery lists using modern smartphones.

Difference:

The SGSA is designed for a particular supermarket. It considers the supermarket aisles and the arrangement of products on each shelf to provide in-store navigation for users. In contrast, the SMART LIST app is designed to digitize, organize, and manage grocery lists.

Evaluation:

The study provided an overview of how to understand the system requirements and user interface of a mobile app for managing grocery lists. It is an excellent reference model to develop similar apps and enhance the capabilities in creating and managing grocery lists.

2.2.2.2 The Smart Shopping List: An Effective Mobile Solution for Grocery List Creation Process.[17]

This paper describes how people continue to utilize outdated techniques for grocery shopping, such as writing a list of what must be bought on paper or memorizing the items, which is not reliable and ultimately leads to time and financial loss.

The paper introduces the *Smart Shopping List*, an Android application that improves the grocery shopping experience. The Apriori algorithm was used in the application. Therefore, this paper is a valuable resource that enables us to study similar algorithms.

Advantages:

- Shares a list via SMS.
- Notifies the user of the nearest supermarket.

Disadvantages:

- Users cannot modify or reuse previous lists.
- The application works only on Android platforms.

Features are summarized as follows:

Features	***Smart Shopping List***	***SGSA***
Interactive shopping list that enables users to add/remove/cross items		✓
Notifies the user of the nearest supermarket in which they can find all their needs	✓	
Share the shopping list with others	✓	
Organize the list into categories		✓
Generates a route map to guide the user inside the supermarket		✓
Search for an item and navigate to its location in the supermarket		✓
Create a personalized shopping experience by suggesting items based on previous purchases		✓
Develop a personalized shopping experience for each customer by suggesting items based on their previous lists		✓
Create an online space between users of the same supermarket to share reviews and exchange recommendations		✓

Table 5: Features of Smart Shopping List Application

Relevance:

Both *SGSA* and Smart Shopping List users can create a grocery list and receive item suggestions.

Difference:

The *SGSA* is concerned with how much time users spend shopping for groceries. It provides a route map to make it easier for users to locate a specific item inside the store. On the other side, the *Smart Shopping List* creates an interactive grocery list and locates the nearest supermarket to the user.

Evaluation:

The paper encompasses a detailed explanation of how the application was implemented and the algorithms that were applied. By using a data mining algorithm, the paper declared that 82% of users benefited from the *Smart Shopping List* application.

Chapter 3: Analysis

This chapter describes the functional and non-functional requirements and their initial analysis using Use Case diagrams, in addition to mapping these requirements using the mapping matrix.

To relieve any confusion, the supermarket Customer is now referred to as the User of the application.

3.1 Functional Requirements

The method of Requirements Engineering defined in the Software Engineering book (chapter 4), 10th edition [14] is followed.

The functional requirements are divided into two parts, the user requirements (What the user can do) and the system requirements (How the system will make it happen).

User Requirements

R1: The user shall be able to create a new account.

R2: The user shall be able to login to the system.

R3: The user shall be able to write a grocery list.

R4: The user shall be able to modify a previous list (if any).

R5: The user shall be able to display the sorted grocery list.

R6: The user shall be able to navigate inside the store using a route map.

R7: The user shall be able to search for an item and navigate to its location inside the supermarket.

R8: The user shall be able to receive personalized shopping suggestions.

R9: The user shall be able to create posts in the online space between users of the same supermarket.

R10: The user shall be able to log out of the system.

System Requirements

R1.1: The system shall store the user information (username) in the database.

R2.1: The system shall enable the user to login to the application after verifying the username.

R3.1: The system shall provide a space where the user can write a grocery list.

R4.1: The system shall store all the user's grocery lists.

R4.2: The system shall allow the user to modify previous grocery lists.

R5.1: The system shall sort the user's grocery list into categories.

R5.2: The system shall allow the user to display the sorted list.

R6.1: The system shall organize the user's grocery list based on the supermarket's aisles.

R6.2: The system shall generate a route map based on the organized user's grocery list to provide in-store navigation.

R7.1: The system shall allow the user to search for an item.

R7.2: The system shall locate the item searched by the user.

R7.3: The system shall provide a navigation route to direct the user to the item location.

R8.1: The system shall store the user's previous grocery lists in the database.

R8.2: The system shall analyze the user's previous grocery lists.

R8.3: The system shall detect the user's most written items.

R8.4: The system shall display shopping suggestions to the user.

R9.1: The system shall create a space between users of the same supermarket.

R9.2: The system shall allow the user to create a post.

R10.1: The system shall allow the user to log out of the application.

3.2 Non-Functional Requirements

The non-functional requirements for the SGSA are:

1. **Usability**[13]

   Usability describes how well a user can use the system in a specific context to achieve a defined goal efficiently and satisfactorily.

   SGSA interfaces must be simple and user-friendly, especially because it targets a large segment of society, some of which are novice users. The usability of SGSA is measured by using the following factors:

   - Ease of learning

     The application must be easy to learn for both novices and users with experience in similar applications.

   - Ease of remembering

     The application must be easy to remember for casual users.

   - Understandability

     The user must understand the application functionality and services.

   - Subjective satisfaction

     The user must feel satisfied with the application.

2. **Maintainability**

"Maintainability states that software should be written in such a way that it can evolve to meet the changing needs of users." [14]

Since supermarkets are one of the most competitive and constantly growing sectors, the SGSA must be in a continuous state of evolution. The SGSA measures the flexibility of how the application can be modified -for fixing issues or adding new functionality- with a degree of ease. It also focuses on the refactorability of the code by using component-based software engineering.

3. Reliability[14]

Reliability is the probability that a system failure will occur when the system is in use within a specified operating environment.

There are three possible techniques to achieve reliability, which are fault avoidance, fault detection, and fault tolerance. In our case, SGSA will focus on fault tolerance, which is a runtime approach to dependability in which systems include mechanisms to continue in operation, even after a software fault has occurred and the system state is erroneous. Fault-tolerance mechanisms detect and correct this erroneous state so that the occurrence of a fault does not lead to a system failure.

By using dependable programming guidelines, the faults in the delivered application are reduced. Additionally, data about the SGSA operations is gathered to assess the reliability of the application. The data gathered include Rate Occurrence of Fault (ROCOF) or Time to Failure, which is the time or the number of transactions between system failures plus the total number of transactions. The data required include Rate Occurrence of Fault (ROCOF) or Time to Failure, which is the time or the number of transactions between system failures plus the total number of transactions.

Why security is excluded from the non-functional requirements:

The SGSA is a simple application. It only asks the user to enter a unique username to sign up. A unique username from the users is needed to:

- Store users' previous grocery lists to provide them with personalized shopping suggestions.
- Enable the users to participate in the space created between users of the same supermarket.

Therefore, security is not an important aspect to consider in the SGSA. Because the type of data the application collects about the users is public data, which has the lowest level of data classification. Since this type of data often gets shared and passed around, it is not considered an asset that requires a strong level of protection.

3.3 Stakeholders /Actors

Stakeholder:

- Project supervisor.
- Project team members.
- Users of the targeted supermarket.
- Employees of the targeted supermarket.
- Individuals who participated in the survey.

Actors:

- End users which are the supermarket’s customers.

3.4 Initial Design / Analysis

3.4.1 Use Case Diagram

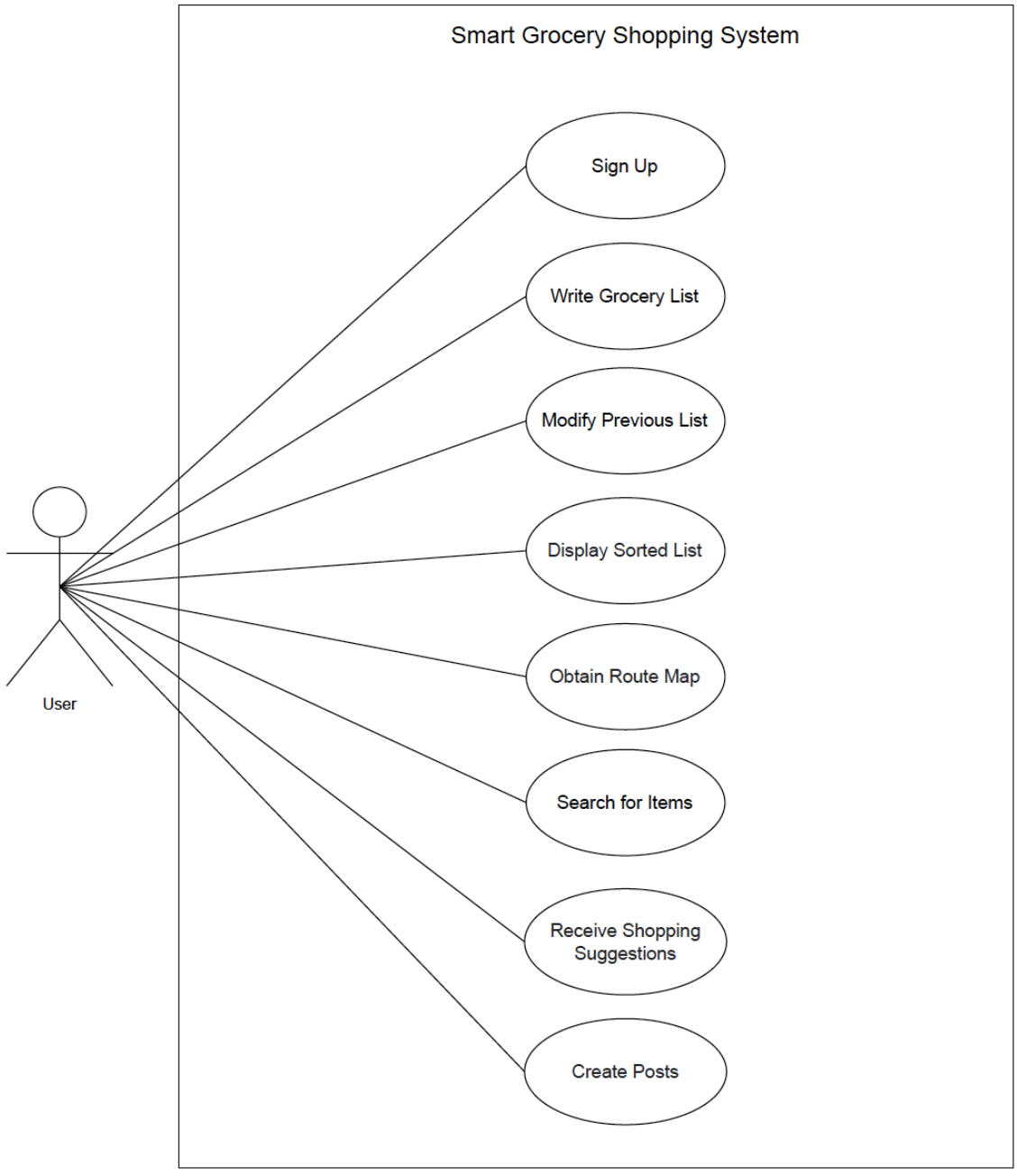

Figure 12: Use Case Diagram.

3.4.2 Elaborated Use Cases

Sign Up Use Case Description

Use Case Title	Sign Up
Actors	User
Description	The user enters a username to register in the application.
Data	A unique username.
Stimulus	The user chooses to create an account in the application.
Response	In a successful case, the user provides a unique username then he/she can access the application and use all its services. In case the user provides a username that already exists in the database, the application asks the user to try again with a different username.
Comments	The user must download the application to create an account.

Table 6: Sign Up Use Case Description.

Write Grocery List Use Case Description

Use Case Title	Write Grocery List
Actors	User
Description	The user can write a grocery list on the application.
Data	Grocery list items.
Stimulus	The user selects the Write a Grocery List option.
Response	In a successful case, the grocery list is stored in the database, and the user can proceed to display the sorted list. In case of a failure, the grocery list cannot be stored in the database, the application asks the user to wait a few moments or try again.
Comments	The user must be logged into the application.

Table 7: Write Grocery List Use Case Description.

Modify Previous List Use Case Description

Use Case Title	Modify Previous List
Actors	User
Description	The user can modify previous grocery lists (if any).
Data	User’s previous grocery list.
Stimulus	The user selects the Modify a Previous Grocery List option instead of the Write a Grocery List option.
Response	In a successful case, the modified grocery list is stored in the database, and the user can proceed to display the sorted list. In case of a failure, the modified grocery list cannot be stored in the database, the application asks the user to wait a few moments or try again.
Comments	The user must be logged into the application. The user must have a previous grocery list to be able to modify it.

Table 8: Modify Previous List Use Case Description.

Display Sorted List Use Case Description

Use Case Title	Display Sorted List
Actors	User
Description	After the user writes a grocery list, the application sorts the list based on the products' categories stored in the database.
Data	User's grocery list, products' categories.
Stimulus	The user selects the Display Sorted List option after writing a grocery list.
Response	In a successful case, the sorted list is displayed, and the user can proceed to generate the route map. In case of a failure, the sorted list cannot be displayed, and the user has to try again.
Comments	The user must be logged into the application. The user must write a grocery list.

Table 9: Display Sorted List Use Case Description

Obtain Route Map Use Case Description

Use Case Title	Obtain Route Map
Actors	User
Description	The user can obtain a route map generated by the application based on the user's grocery list to navigate the user inside the supermarket.
Data	User's grocery list, products' categories, and the layout of the supermarket aisles.
Stimulus	The user selects the Route Map option after writing a grocery list.
Response	In a successful case, the route map is generated based on the user's grocery list to navigate the user inside the supermarket. In case of a failure, the route map cannot be generated, and the user has to try again.
Comments	The user must be logged into the application. The user must write a grocery list.

Table 10: Obtain Route Map Use Case Description.

Search for Items Use Case Description

Use Case Title	Search for Items
Actors	User

Description	When the user searches for an item, the application locates the item inside the supermarket and navigate the user to its location.
Data	Item name, the layout of the supermarket aisles.
Stimulus	The user selects the Search option and write the item name.
Response	In a successful case, the application locates the searched item inside the supermarket and navigate the user to its location. In case of a failure, the item cannot be located, and the user has to try again.
Comments	The user must be logged into the application. The user must search for an item by its name.

Table 11: Search for Items Use Case Description.

Receive Shopping Suggestions Use Case Description

Use Case Title	Receive Shopping Suggestions
Actors	User
Description	Every time the user writes a grocery list on the application, the list is stored in the database and analyzed to detect the user's most written items in order to generate shopping suggestions for the user.

Data	User’s grocery list and the products’ categories.
Stimulus	Every time the user selects the Write or Modify a grocery list options.
Response	In a successful case, the application displays the shopping suggestions to the user. In case the user does not write the items the same way they were written before, the application asks the user to rewrite the items again.
Comments	The user must be logged into the application. The user must have previous grocery lists that have been analyzed to receive shopping suggestions.

Table 12: Receive Shopping Suggestions Use Case Description.

Create Posts Use Case Description

Use Case Title	Create Posts
Actors	User
Description	The user can create posts to share reviews in the space between the users of the same supermarket created by the application.
Data	Username
Stimulus	The user selects the Create Post option.

Response	In a successful case, the user's post is created and displayed on the space. In case of a failure, the user's post cannot be displayed on the space, and the application asks the user to try again.
Comments	The user must be logged into the application.

Table 13: Create Posts Use Case Description.

3.5 Mapping Requirements

	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
Sign Up	✓									
Write Grocery List			✓							
Modify Previous List				✓						
Display Sorted List					✓					
Obtain Route Map						✓				
Search for Items							✓			
Receive Shopping Suggestions								✓		
Create Posts									✓	

Table 14: Mapping Requirements.

The SGSA is not a security-oriented application -as described in the non-functional requirements section-. Therefore, R2 and R10 (login and log-out) are not considered use cases.

Chapter 4: System Modeling

4.1 Modeling Approach

Our modeling approach is Object-Oriented Programming (OOP). OOP maximizes code reusability and makes programs more efficient and easier to understand.

Since supermarkets are one of the most competitive and constantly evolving sectors, the SGSA must be in a continuous state of evolution. Therefore, using OOP as a modeling approach helps in adding new functionalities in the future to fulfill the continuously prospering users' needs.

4.2 Diagrams for Design Approach

4.2.1 Class Diagram

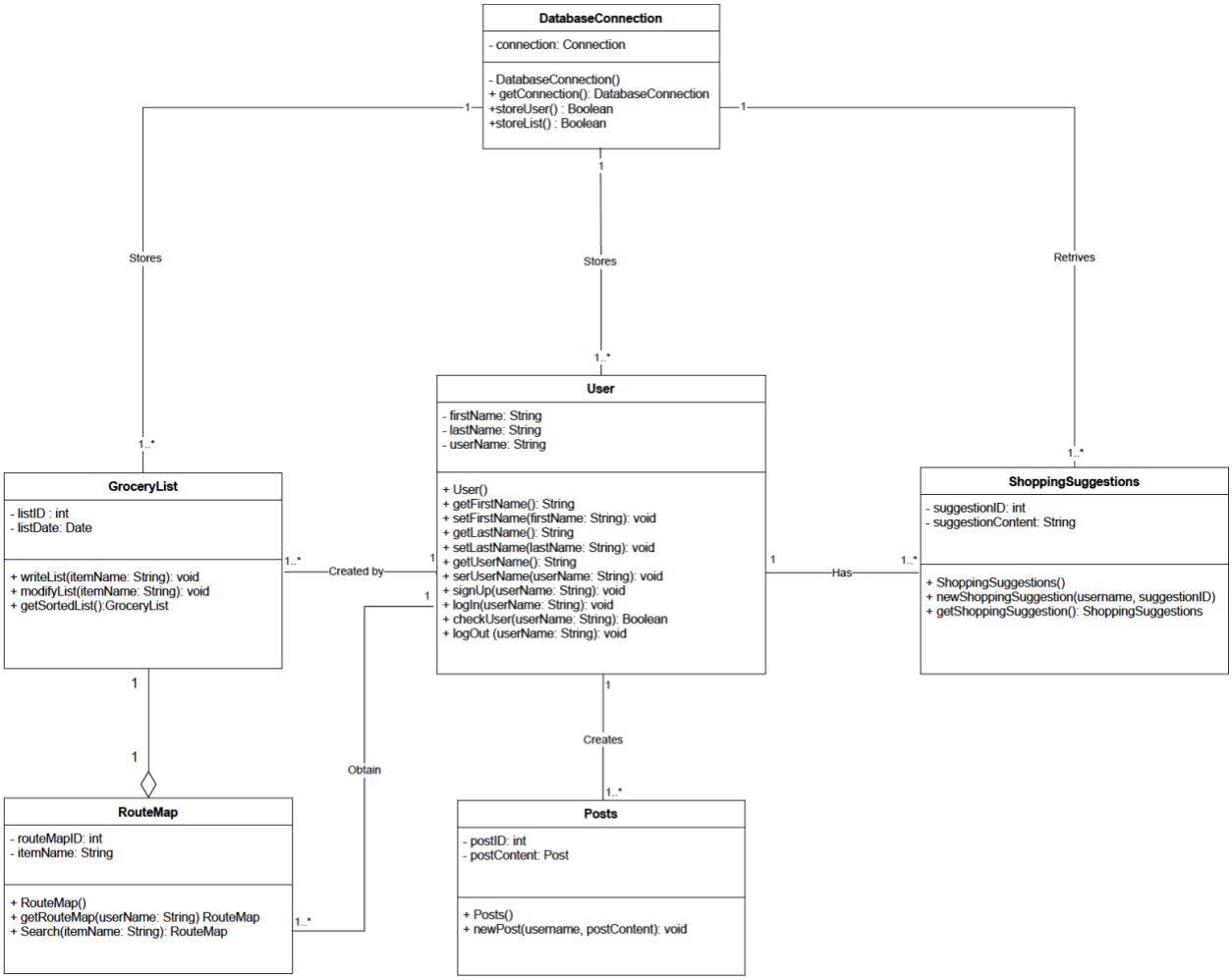

Figure 13: Class Diagram.

4.2.2 Sequence Diagrams

Sequence diagrams are provided only for the most important use cases, which are Obtain Route Map, Search for Items, and Receive Shopping Suggestions.

Obtain Route Map Sequence Diagram

The Obtain Route Map sequence diagram describes how the system provides the route map to the user.

The user creates a grocery list using the writeList() method, and the app stores it in the database using the storeList() method. Then, the sortList() method arranges the grocery list according to categories. The sorted list is displayed to the user then the user uses the getRouteMap() method to obtain the map.

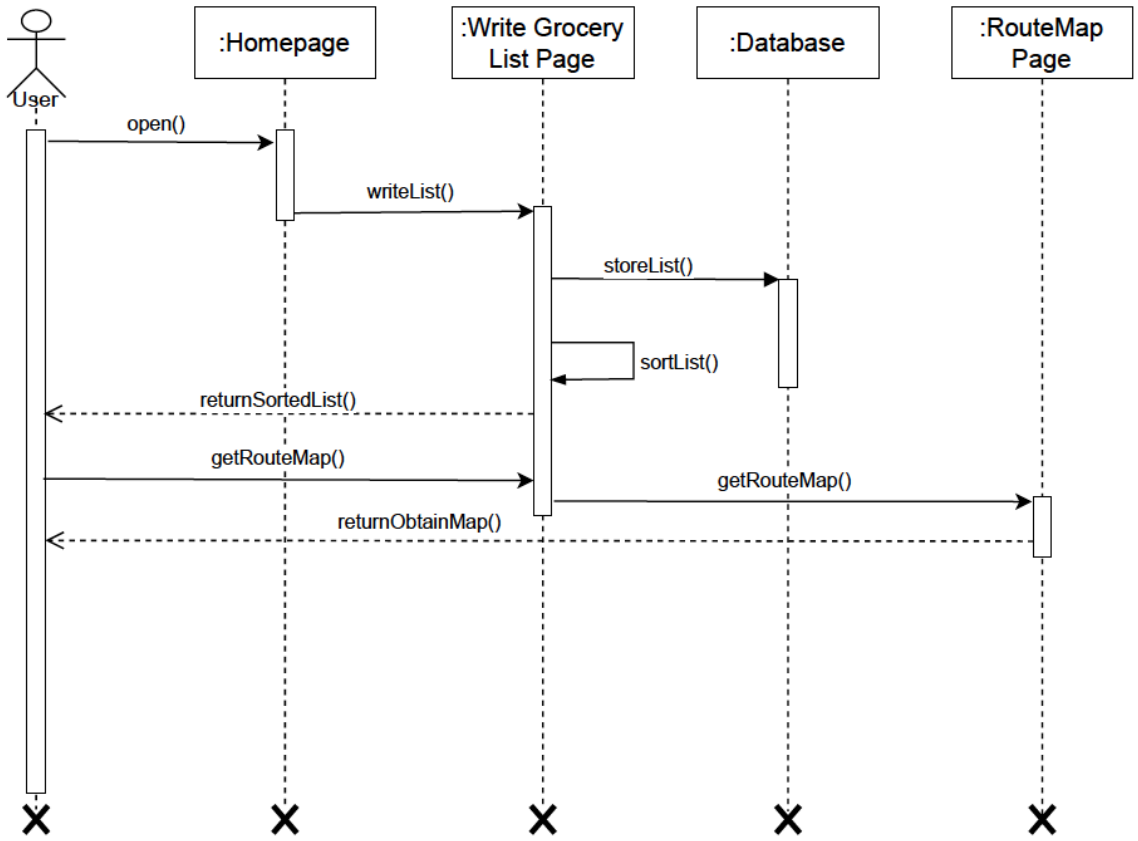

Figure 14: Obtain Route Map Sequence Diagram.

Search for Items Sequence Diagram

The Search for Items sequence diagram explains how a user can locate an item inside the supermarket and navigate to its location.

On the homepage, the user selects the search option and writes the item's name using the Search() method. Afterward, the system checks the item's location in the system database. If the item's location is found, the database returns the item's location and navigate the user to it. When the item's location is not found, a "Not Found Message" is returned to the user.

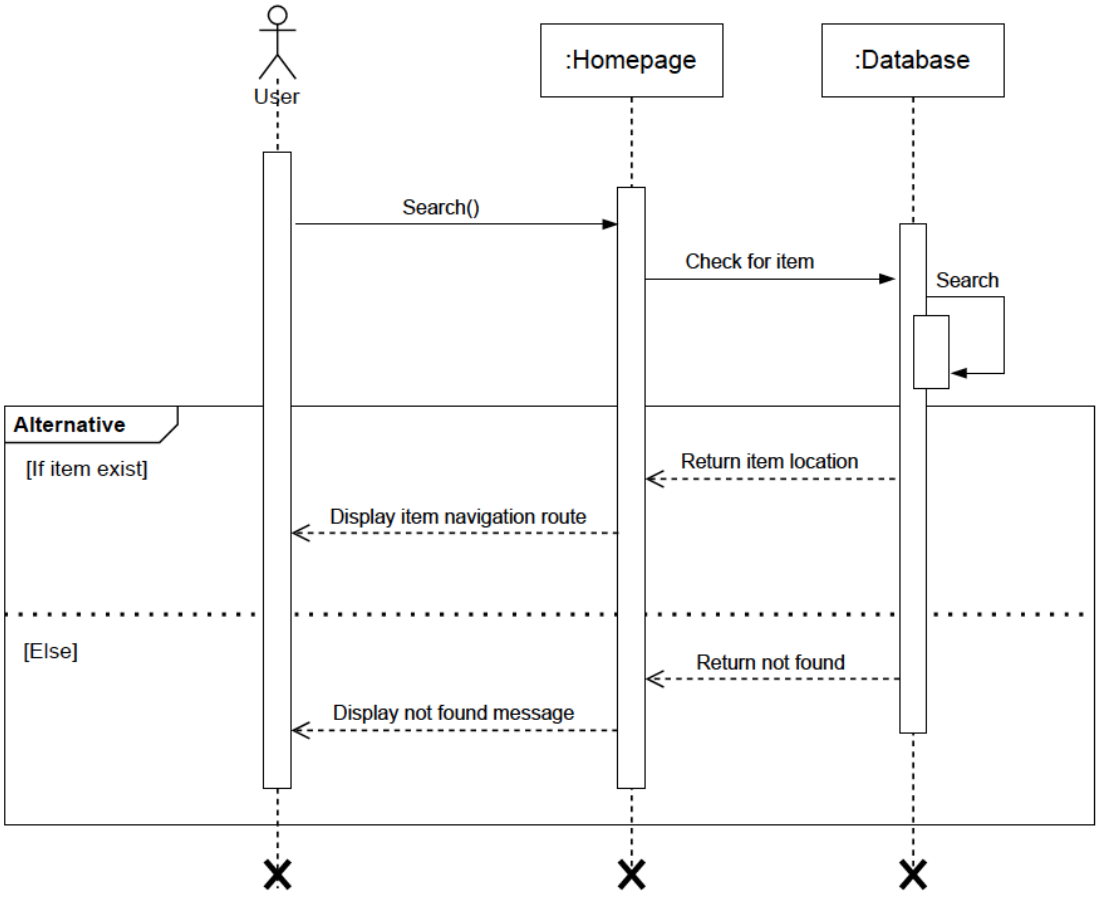

Figure 15: Search for Items Sequence Diagram.

Receive Shopping Suggestions Sequence Diagram

The Receive Shopping Suggestions sequence diagram describes how the user can receive shopping suggestions. The only way the system can offer the user a shopping suggestion is if it has stored the user's previous grocery lists in the database.

The user creates a grocery list using the writeList() method, and the app stores it in the database using the storeList() method. Then, the system analyzes the list to detect the more written items to provide the user with the names of these items as shopping suggestions.

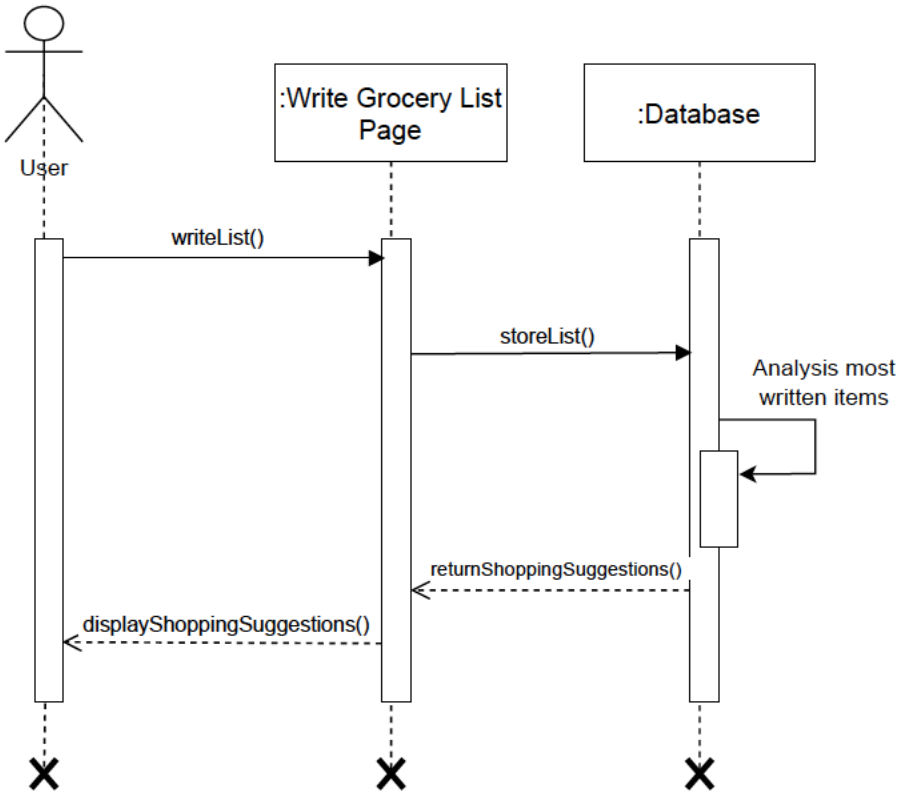

Figure 16: Receive Shopping Suggestions Sequence Diagram.

4.3 Data Model Design

4.2.1 ER Diagram

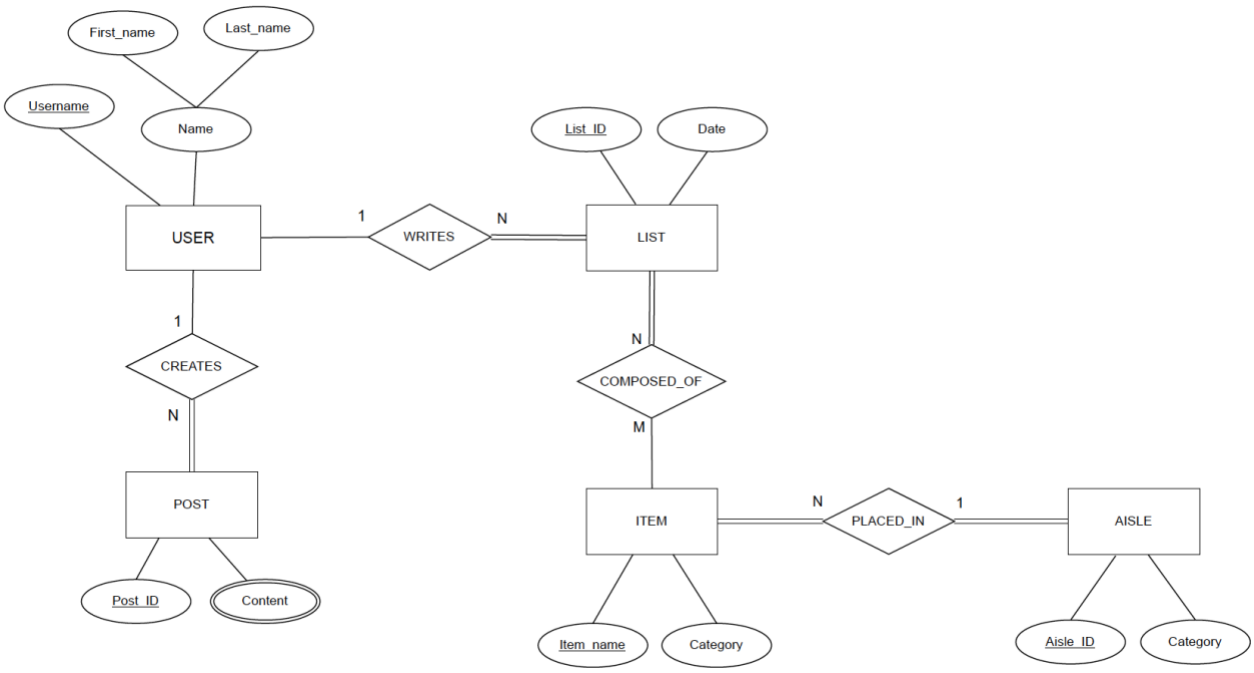

Figure 17: ER Diagram.

4.2.2 Relational Database Schema

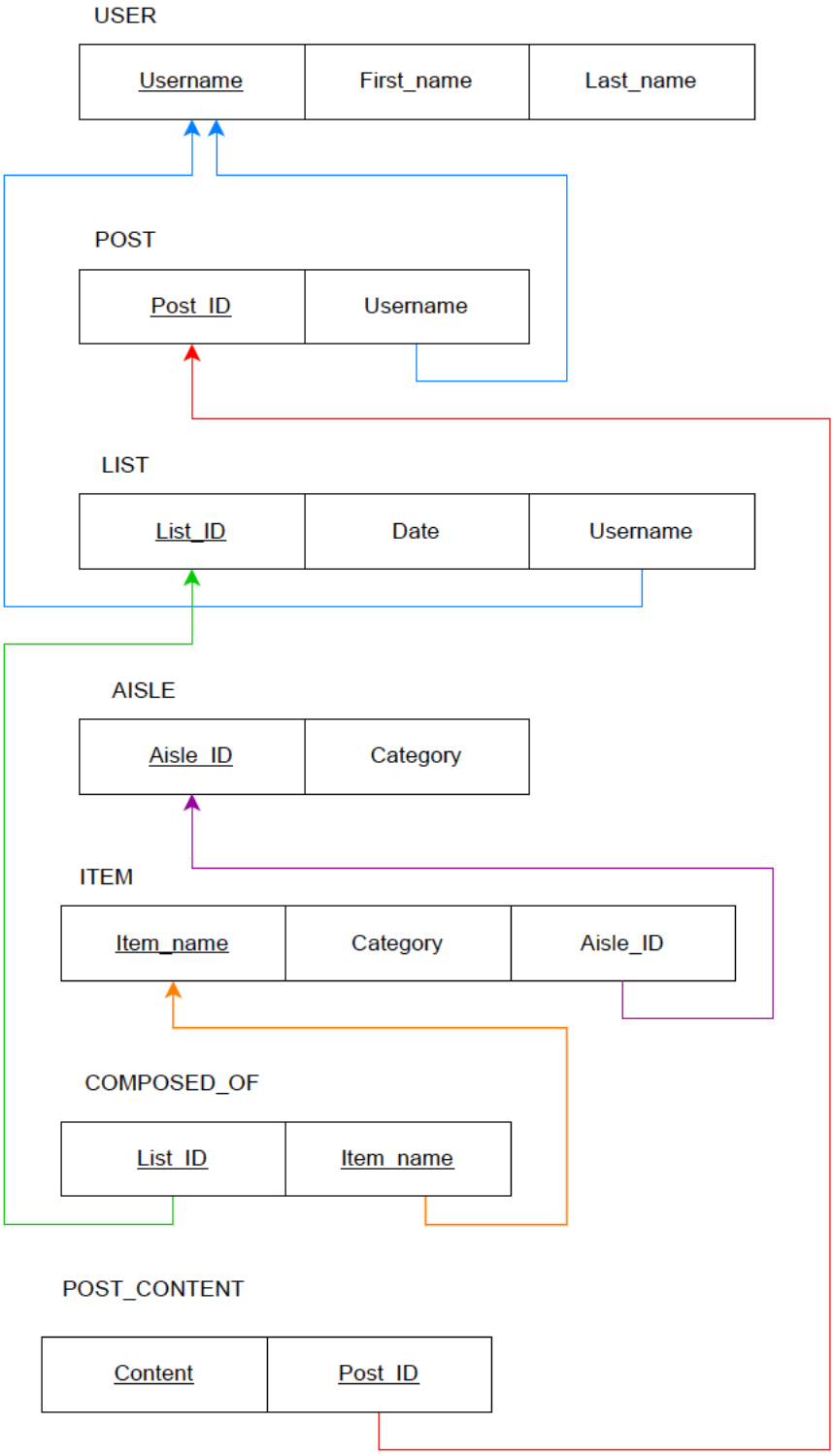

Figure 18: Relational Database Schema.

4.2.3 Normalized Database

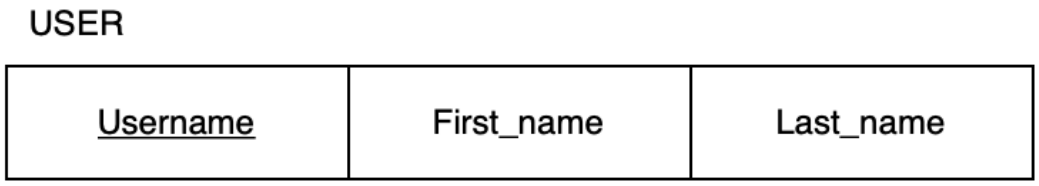

Figure 19: USER Relation.

1NF:

USER relation is in the first normal form because it does not have any multivalued or composite attributes.

USER [Username, First_name, Last_name]

2NF:

USER relation is in the second normal form because there are no partial dependencies.

USER [Username, First_name, Last_name]

3NF:

USER relation is in the third normal form because there are no transitive dependencies.

USER [Username, First_name, Last_name]

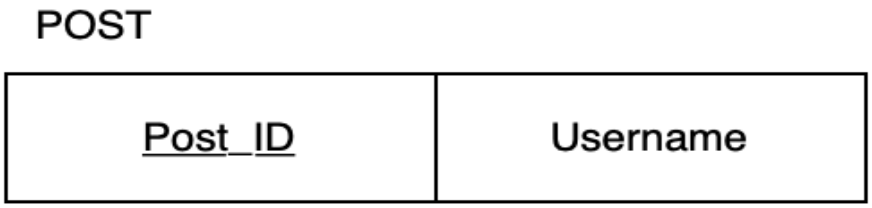

Figure 20: POST Relation.

1NF:

POST relation is in the first normal form because it does not have any multivalued or composite attributes.

POST [Post_ID, Username]

2NF:

POST relation is in the second normal form because there are no partial dependencies.

POST [Post_ID, Username]

3NF:

POST relation is in the third normal form because there are no transitive dependencies.

POST [Post_ID, Username]

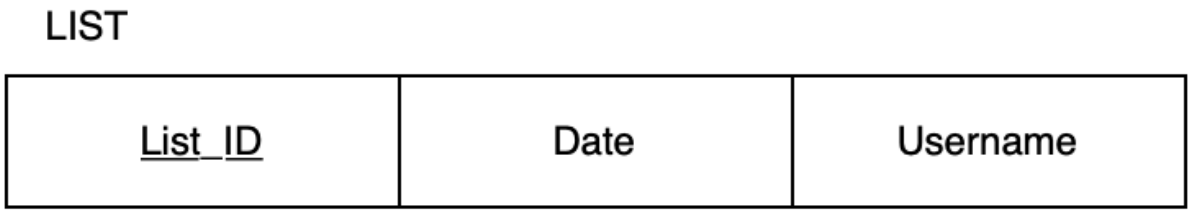

Figure 21: LIST Relation.

1NF:

LIST relation is in the first normal form because it does not have any multivalued or composite attributes.

LIST [List_ID, Date, Username]

2NF:

LIST relation is in the second normal form because there are no partial dependencies.

LIST [List_ID, Date, Username]

3NF:

LIST relation is in the third normal form because there are no transitive dependencies.

LIST [List_ID, Date, Username]

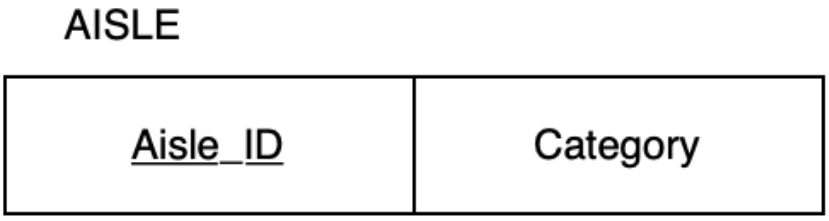

Figure 22: AISLE Relation.

1NF:

AISLE relation is in the first normal form because it does not have any multivalued or composite attributes.

AISLE [Aisle_ID, Category]

2NF:

AISLE relation is in the second normal form because there are no partial dependencies.

AISLE [Aisle_ID, Category]

3NF:

AISLE relation is in the third normal form because there are no transitive dependencies.

AISLE [Aisle_ID, Category]

ITEM

Item_name	Category	Aisle_ID

Figure 23: ITEM Relation.

1NF:

ITEM relation is in the first normal form because it does not have any multivalued or composite attributes.

ITEM [Item_name, Category, Aisle_ID]

2NF:

ITEM relation is in the second normal form because there are no partial dependencies.

ITEM [Item_name, Category, Aisle_ID]

3NF:

ITEM relation is in the third normal form because there are no transitive dependencies.

ITEM [Item_name, Category, Aisle_ID]

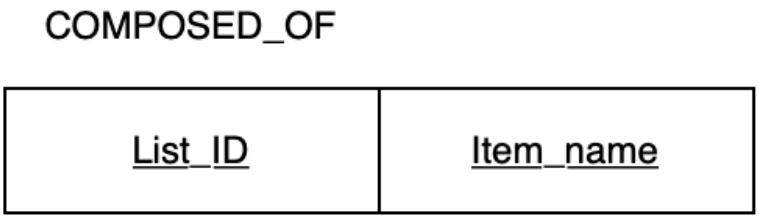

Figure 24: COMPOSED_OF Relation.

1NF:

COMPOSED_OF relation is in the first normal form because it does not have any multivalued or composite attributes.

COMPOSED_OF [List_ID, Item_name]

2NF:

COMPOSED_OF relation is in the first normal form because it does not have any multivalued or composite attributes.

COMPOSED_OF [List_ID, Item_name]

3NF:

COMPOSED_OF relation is in the third normal form because there are no transitive dependencies.

COMPOSED_OF [List_ID, Item_name]

POST_CONTENT

Content	Post_ID

Figure 25: POST_CONTENT Relation.

1NF:

POST_CONTENT relation is in the first normal form because it does not have any multivalued or composite attributes.

POST_CONTENT [Content, Post_ID]

2NF:

POST_CONTENT relation is in the first normal form because it does not have any multivalued or composite attributes.

POST_CONTENT [Content, Post_ID]

3NF:

POST_CONTENT relation is in the third normal form because there are no transitive dependencies.

POST_CONTENT [Content, Post_ID]

REFERENCES

[1] Asana, “Everything you need to know about waterfall project management • asana,” *Asana* [Online]. Available: https://asana.com/resources/waterfall-project-management-methodology. [Accessed: 19-Oct-2022].

[2] “Apply Apriori algorithm in Supermarket Layout Research.” [Online]. Available: https://www.researchgate.net/publication/350667281_Apply_Apriori_Algorithm_in_Supermarket_Layout_Research. [Accessed: 21-Oct-2022].

[3] A. Store, "AnyList: Grocery Shopping List," 2012. [Online]. Available: https://apps.apple.com/us/app/anylist-grocery-shopping-list/id522167641. [Accessed 16 10 2022].

[4] A. Ross, “America's first supermarket at 100: How it changed the world,” *Time*, 09-Sep-2016. [Online]. Available: https://time.com/4480303/supermarkets-history/. [Accessed: 22-Oct-2022].

[5] C. Stoll, “Grocery - Smart Shopping List,” *App Store*, 10-May-2017. [Online]. Available: https://apps.apple.com/us/app/grocery-smart-shopping-list/id1195676848. [Accessed: 19-Oct-2022].

[6] E. Felsenthal, “Front line workers tell their own stories in the new issue of Time,” *Time*, 09-Apr-2020. [Online]. Available: https://time.com/4480303/supermarkets-history/). [Accessed: 22-Oct-2022].

[7] “Hub: Write or type? how a paper versus a digital shopping list influences the way consumers plan and shop: 10.1086/698877,” *Sci*. [Online]. Available: https://sci-hub.hkvisa.net/10.1086/698877. [Accessed: 22-Oct-2022].

[8] “Indoor navigation with mobile augmented reality and Beacon Technology for wheelchair users,” IEEE Xplore. [Online]. Available: https://ieeexplore.ieee.org/abstract/document/7897199. [Accessed: 21-Oct-2022].

[9] K. Farrell, “How we wound up with supermarkets: A history of the grocery store,” *10Best*, 21-Apr-2020. [Online]. Available: https://www.10best.com/interests/food-culture/10-points-grocery-store-history-supermarkets-changed-how-we-shop/. [Accessed: 22-Oct-2022].

[10] Listonic, “Shopping list - listonic,” *App Store*, 15-Oct-2009. [Online]. Available: https://apps.apple.com/gb/app/shopping-list-listonic/id331302745. [Accessed: 19-Oct-2022].

[11] N. Katuk, “Design and development of smart list: A mobile app for creating and managing grocery lists,” *Baghdad Science Journal*, 15-Nov-2019. [Online]. Available: https://www.academia.edu/40941578/Design_and_Development_of_Smart_List_A_Mobile_App_for_Creating_and_Managing_Grocery_Lists. [Accessed: 21-Oct-2022].

[12] Non Function requirements.docx, “Non Function requirements.docx,” *Google Docs*, 2020.https://docs.google.com/document/d/1LC15HrUPxUwq7gJdYsCBb1hSqAajUCW9/edit (accessed Nov. 10, 2022).

[13] Sharp, H. (2019). *Interaction design: Beyond human-computer interaction, fifth edition*. Wiley & Sons Canada, Limited, John.

[14] Sommerville, I. (2019). *Software engineering, Tenth Edition*. Pearson Education.

[15] S. Spiggle, “>grocery shopping lists: What do consumers write?: ACR,” *ACR North American Advances*, 01-Jan-1987. [Online]. Available: https://www.acrwebsite.org/volumes/6695/volumes/v14/NA-14/full. [Accessed: 22-Oct-2022].

[16] S. Davu, “The benefits of adhering to a software development methodology,” *Segue Technologies*, 14-Aug-2017. [Online]. Available: https://www.seguetech.com/benefits-adhering-software-development-methodology-concepts/. [Accessed: 19-Oct-2022].

[17] “The Smart Shopping List: An effective mobile solution for grocery list ...” [Online]. Available:https://www.researchgate.net/publication/323713789_The_smart_shopping_list_An_effective_mobile_solution_for_grocery_list-creation_process. [Accessed: 22-Oct-2022].

[18] V. Sharma, “Supermarkets as an example – ‘Apriori algorithm,’” LinkedIn, 13-Apr-2020. [Online]. Available: https://www.linkedin.com/pulse/supermarkets-example-apriori-algorithm-vaibhav-sharma/. [Accessed: 21-Oct-2022].

Appendix A: Data Gathering

This section discusses the data-gathering techniques used and the findings from the collected data analysis.

A.1 Data Gathering Techniques & Discussion

A.1.1 In-Field Experiment

The main objective of the in-field experiment is to evaluate the effectiveness of the proposed solution. The in-field experiment was conducted in a specific Hyper Panda branch. We made sure to collect real data by choosing a supermarket branch that we do not normally visit, therefore, do not know its layout.

The experiment focused on calculating the time taken to collect a number of products using a pre-written grocery list containing 20 items.

On the first visit, the grocery list was written in disorder, and the items were unsorted by categories. It took an hour (60 minutes) to collect all the items on the list. On the second visit, the same grocery list was arranged and sorted by categories. This time, it took 35 minutes to collect all the items on the list.

As a result, we obtained solid proof that we are providing a solution for a real-world problem. This experiment helped us evaluate the effectiveness of the SGSA and reinforce our argument.

A.1.2 Interview

Interviewee	**Interviewer**
Mr. Hazem Alahmadi	Elaf Aloufi Layan Fakhurji Manar Altaiary Raneem Alshareef
Location/ medium: Online via Google Meet	**Appointment Date:** Start Time**:** 10:00 AM End Time: 11:30 AM
Objectives: Elaborate the idea of the project and permission to gain access to the supermarket's database	**Reminders:** Mr. Hazem Alahmadi is a former IT employee at Hyper Panda
Agenda: • Introducing the project team. • The project idea. • Questions regarding the Hyper Panda aisles layout. • Closing.	

Table 15: Interview Table1

Interviewee: Hazem Alahmadi	Date: 20 Sep 2022
Question 1: After hearing the project idea, is it possible that Hyper Panda could grant us access to the database of the supermarket to implement the project?	**Answer:** Maybe yes, based on your official statement from your college, I just need the top management approval to proceed with your request.
Question 2: Do supermarkets change the aisles arrangement frequently?	**Answer:** No, all items are arranged based on category. The only change is when some companies do not provide their items weekly.
Question 3: Approximately, how many aisles are there in the supermarket?	**Answer:** There are 11 basic aisles in the supermarket. Even if you want to go to a new supermarket branch, you will likely find the same number of aisles.
Question 4: Do you think that GPS service could be used to provide in-store navigation for users inside the supermarket?	**Answer:** No, GPS service is used on a wider range like outdoors. It does not work inside buildings.

Table 16: Interview Table2

Conclusions

The interview was enriching. We gained valuable information that would help us in our project. Furthermore, we realized that GPS services cannot be used indoors, so we must figure out another way to develop in-store navigation.

After the interview, Mr. Hazem provided the layout of the aisles in one of the Hyper Panda branches, but he requested that the name of the branch stays confidential.

A.1.3 Survey

Finding relevant data for any project helps determine the project scope and the main problems to be solved.

A survey is an effective approach to collect information from the public. It helps shape the project requirements and evaluate its effectiveness.

An online survey written in both Arabic and English was created. There were ten straightforward questions in the survey including closed-ended, open-ended, and multiple-choice questions with some questions requiring answers to previous questions. The following **Figures (26-37)** are a blank copy of the survey.

A.2 Blank Copy of the Survey

Smart Grocery Shopping Application

We are Information Technology students from the Faculty of Computing and Information Technology at King Abdulaziz University. we are developing an application to enhance the supermarket shopping experience by creating a route map that provides customers with in-store navigation, in addition to several features that ensure customer satisfaction.

Your cooperation in filling out this survey is highly appreciated and will help us evaluate the effectiveness of this application.

نحن طالبات تقنية المعلومات من كلية الحاسبات وتقنية المعلومات في جامعة الملك عبدالعزيز. نعمل على تطوير تطبيق لتحسين تجربة التسوق في السوبرماركت من خلال إنشاء خارطة طريق لتوجيه العملاء إلى الموقع المحدد لاحتياجاتهم داخل المتجر، بالإضافة إلى العديد من المميزات التي تضمن رضا العملاء.

نقدر تعاونكم في ملء هذا الاستبيان لمساعدتنا في تقييم فعالية التطبيق.

Next Clear form

Figure 26: Blank Copy of the Survey Description

How much time do you spend collecting your monthly groceries at the supermarket? *

كم من الوقت تقضيه في جمع مشترياتك الشهرية من السوبرماركت؟

- 1-3 hours / ١-٣ ساعات
- 2-4 hours / ٢-٤ ساعات
- 3-6 hours / ٣-٦ ساعات
- Other: _____

Figure 27: Blank Copy of the Survey- Question 1

Do you think you spend much of that time searching for a product in the supermarket? *

هل تعتقد أنك تقضي الكثير من ذلك الوقت في البحث عن منتج معين في السوبرماركت؟

- Yes / نعم
- No / لا
- Maybe / ربما

Figure 28: Blank Copy of the Survey- Question 2

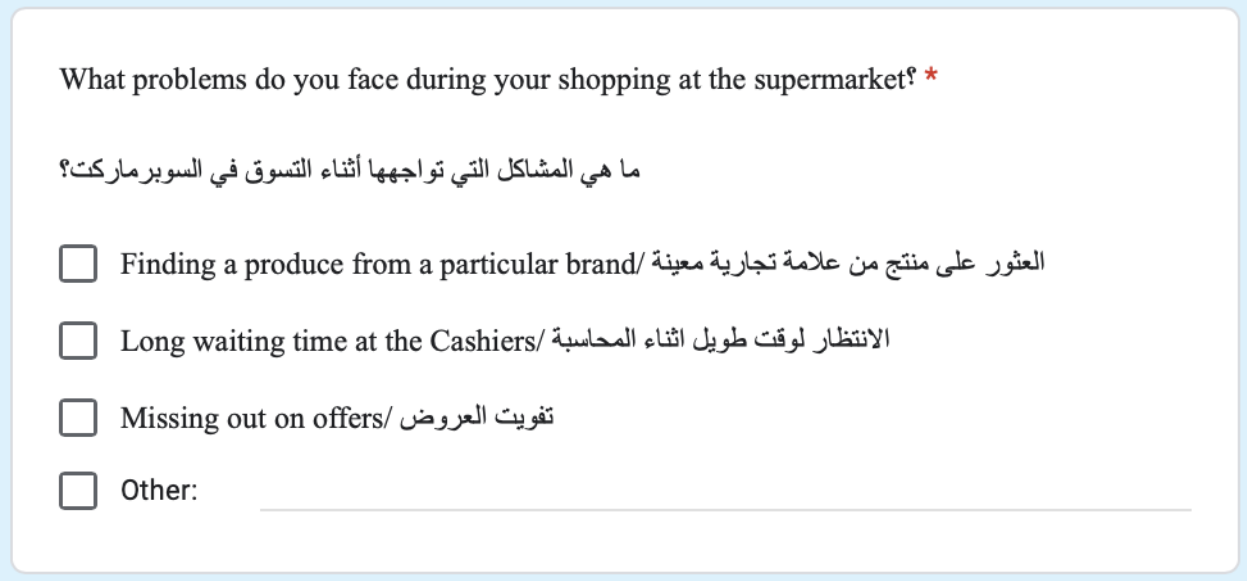

Figure 29: Blank Copy of the Survey- Question 3

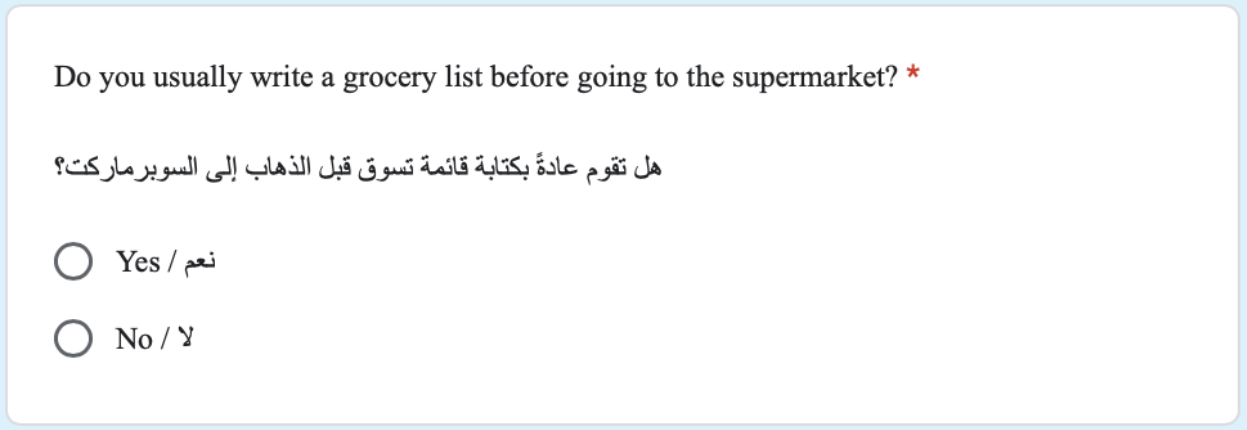

Figure 30: Blank Copy of the Survey- Question 4

If yes, what are the reasons?

إذا كانت الإجابة بنعم ، فما هي الأسباب؟

- [ ] Make shopping easier / لتسهيل عملية التسوق
- [ ] Help with meal planning / للمساعدة في التخطيط للوجبات
- [ ] Save money / لتوفير المال
- [ ] Save time / لتوفير الوقت
- [ ] Save energy / لتوفير الجهد
- [ ] Other: _____

Figure 31: Blank Copy of the Survey- Question 5

Which way is more effective, writing a Grocery Shopping List on paper or digitally? *

ما هي الطريقة الأكثر فعالية، كتابة قائمة التسوق على الورق أم رقميًا؟

- ( ) Paper / ورق
- ( ) Digitally / رقميًا

Figure 32: Blank Copy of the Survey- Question 6

If there is an application that arrange your grocery list items based on the aisles of your intended supermarket to provide you with the shortest path to collect all your groceries, would you like to use it? *

إذا كان هناك تطبيق يرتب عناصر قائمة تسوقك بناءً على ممرات السوبرماركت الذي ستذهب اليه لتزويدك بأقصر طريق لجمع جميع مشترياتك، هل سترغب في استخدامه؟

- ◯ Yes / نعم
- ◯ No / لا

Figure 33: Blank Copy of the Survey- Question 7

If yes, which of the following features would meet your requirements and make the Smart Grocery Shopping Application useful? (You can choose more than one option)

إذا كانت الإجابة بنعم ، أي الميزات التالية ستلبي متطلباتك وتجعل التطبيق مفيدًا؟ (يمكنك اختيار اكثر من خيار)

- ☐ A route map that guides you to a specific aisle that matches the items in your grocery list. / خريطة ترشدك إلى الممر الذي يحتوي على المنتجات الموجودة في قائمة تسوقك
- ☐ In-store navigation to help make finding items easier. / تسهيل العثورعلى منتج معين من خلال توجيهك الى موقعه داخل السوبرماركت
- ☐ Recommendation of items similar to your previous purchases. / اقتراح منتجات مماثلة لمشترياتك السابقة
- ☐ A space where customers can share reviews and exchange recommendations on a specific supermarket branch. / إنشاء مساحة تمكن العملاء من مشاركة وتبادل التوصيات لفرع سوبرماركت معين
- ☐ Other: _____

Figure 34: Blank Copy of the Survey- Question 8

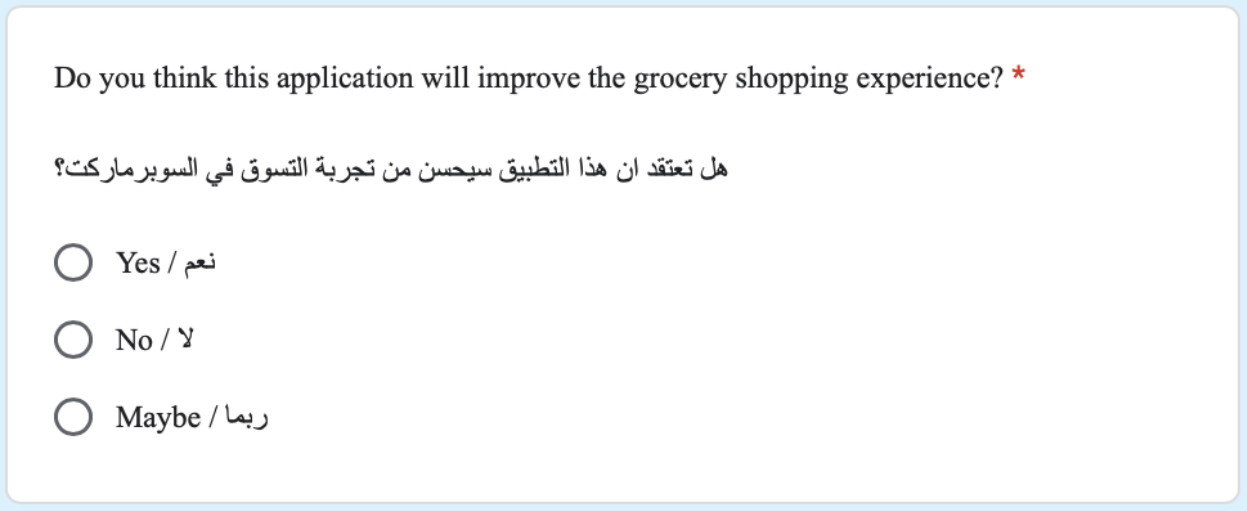

Figure 35: Blank Copy of the Survey- Question 9

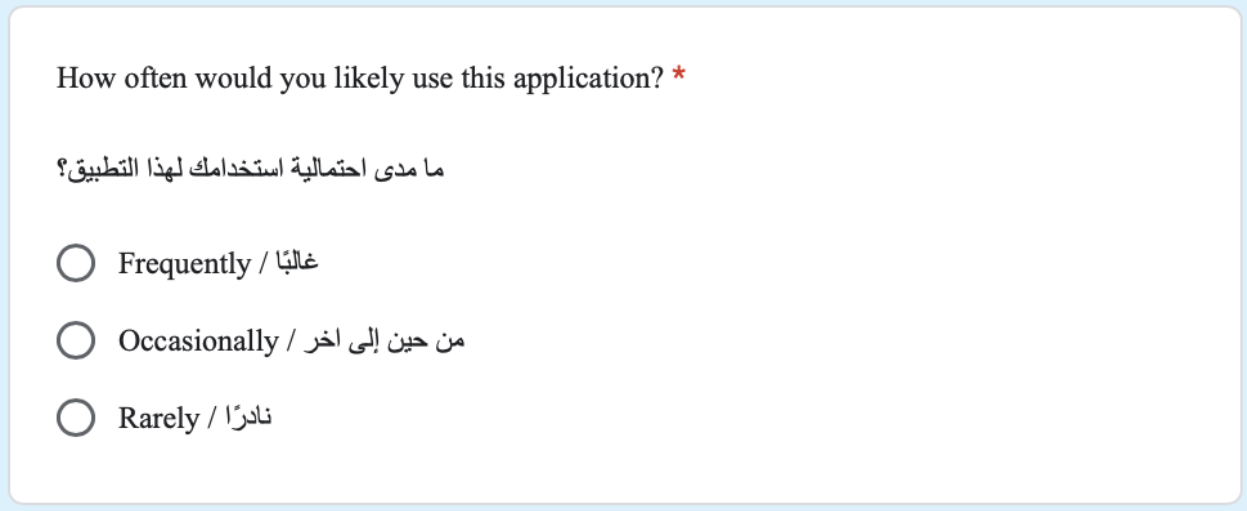

Figure 36: Blank Copy of the Survey- Question 10

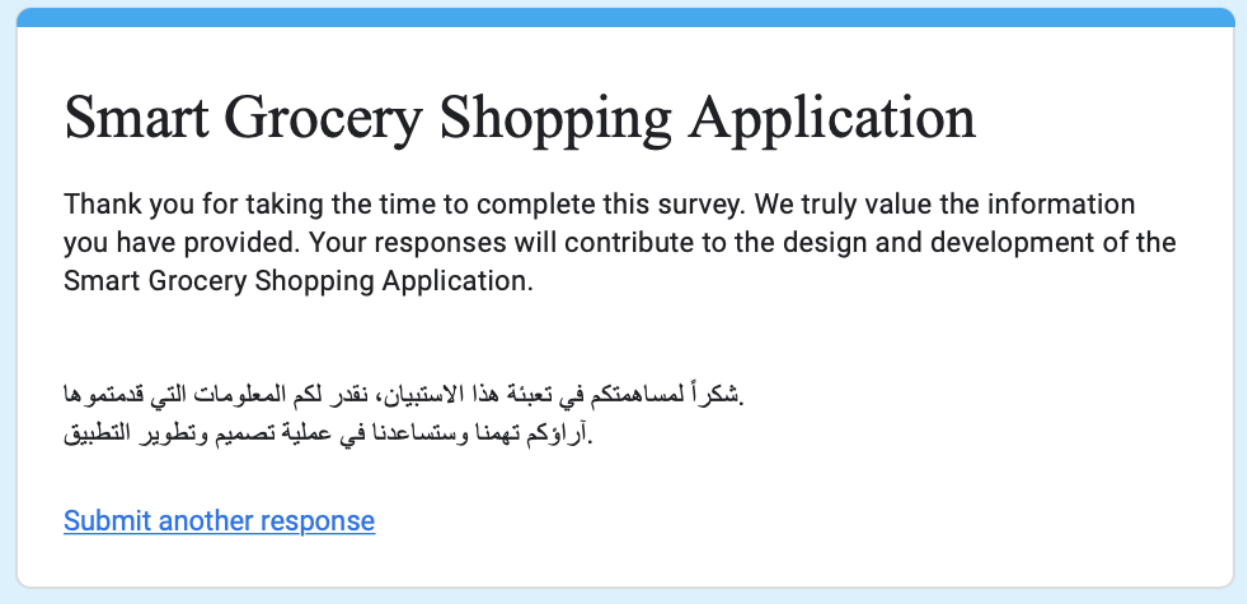

Figure 37: Blank Copy of the Survey Thank You Message

A.3 Survey Detailed Results

This section will present the detailed results of the 443 responses we received on the survey.

Question 1: In the following question, we noticed that 67.3% of the answers said they spent 1-3 hours collecting their usual groceries, which indicates a real problem. Collecting groceries should not be a time-consuming activity. The result assured us that the SGSA is needed.

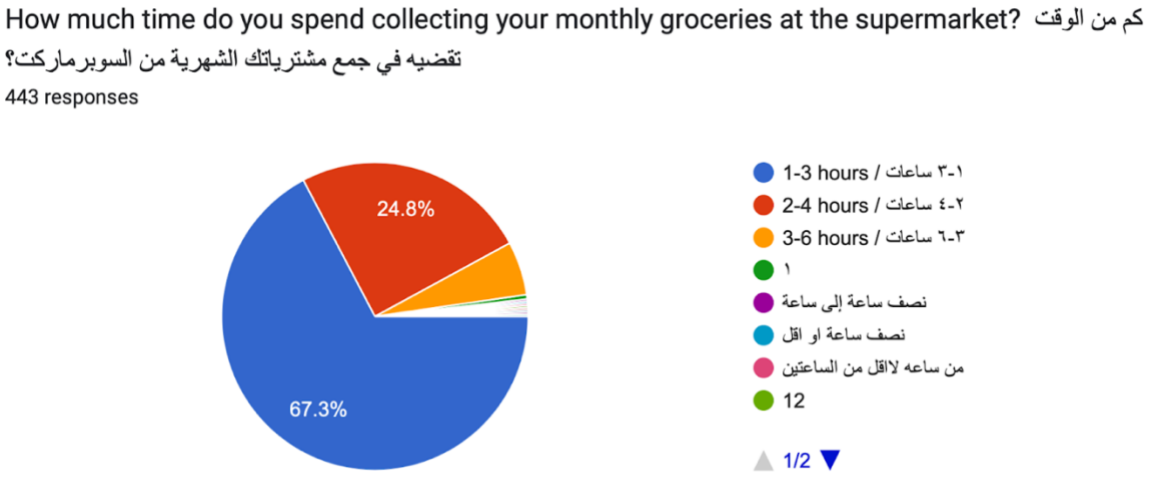

Figure 38: Survey Detailed Results- Question 1.1

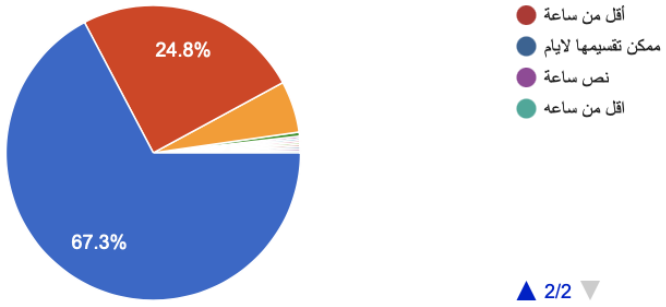

Figure 39: Survey Detailed Results- Question 1.2

Question 2: The following question shows that 52.8% of the answers said they spent much of their time in the supermarket searching for a product. As a result, the feature that enables the user to search for a product's location inside the supermarket appears to be useful in such cases.

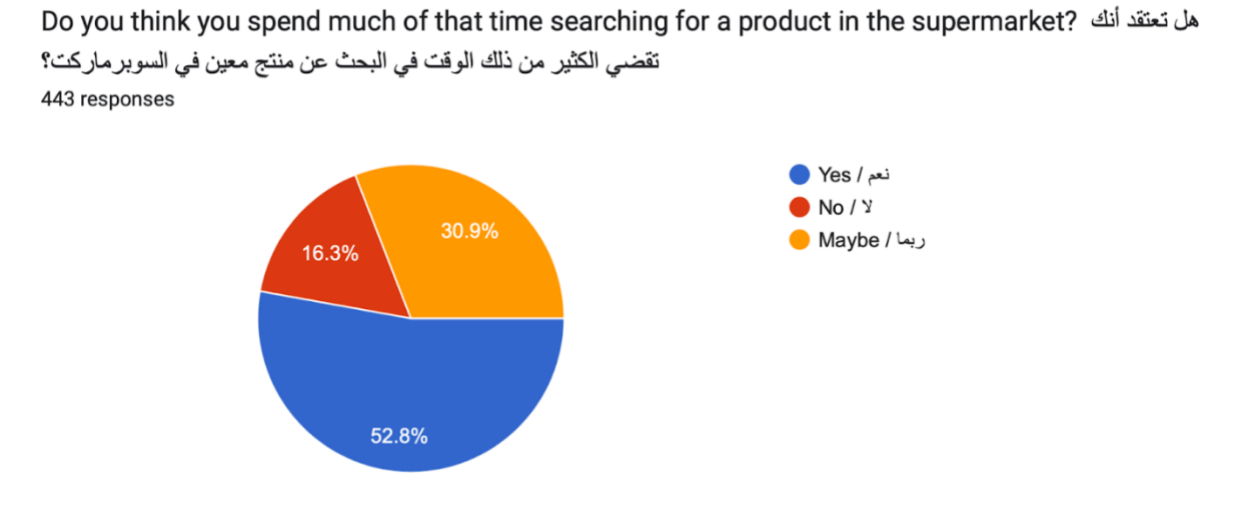

Figure 40: Survey Detailed Results- Question 2

Question 3: The following question shows that finding a product from a particular brand is one of the most encountered problems people face during their shopping at the supermarket.

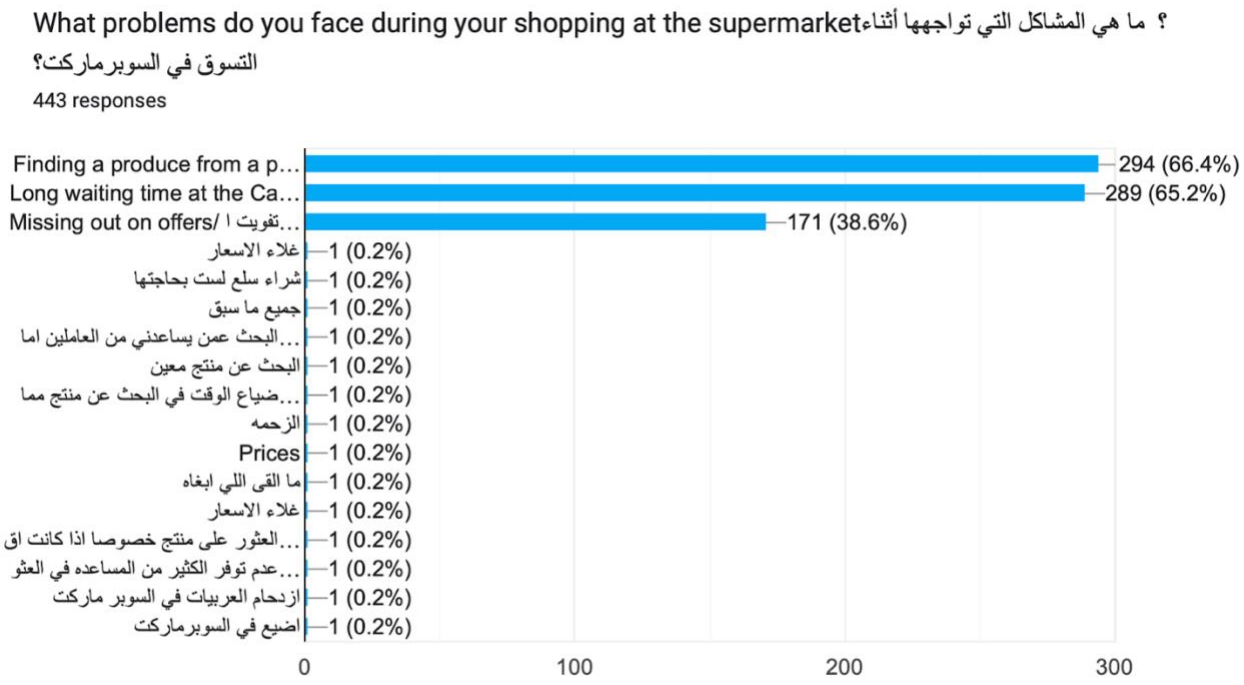

Figure 41: Survey Detailed Results- Question 3

Question 4: The following question shows that 77% of the answers said they write a grocery list before going to the supermarket, which ensures that new consumers strive on saving time and improving efficiency.

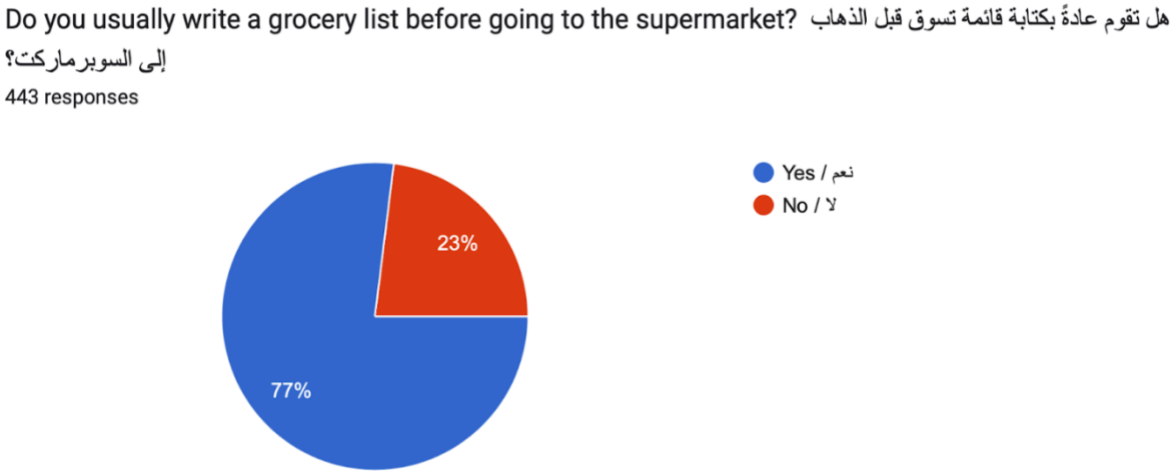

Figure 42: Survey Detailed Results- Question 4

Question 5: The following question reveals the reasons why people think writing a grocery list is important.

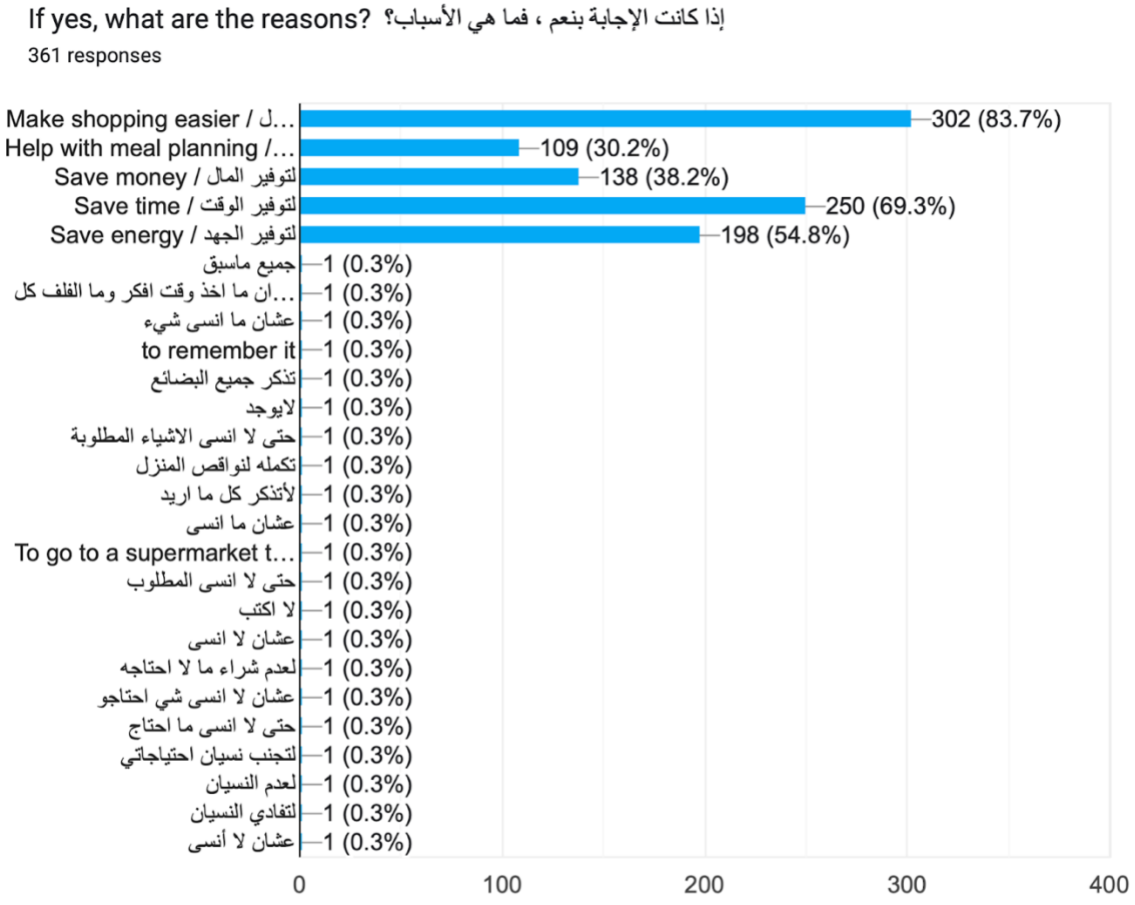

Figure 43: Survey Detailed Results- Question 5

Question 6: In the following question, we noticed that 72.9% of the answers said they prefer writing a grocery list digitally, which highly supports the SGSA because it is based on the idea of writing a digital grocery list.

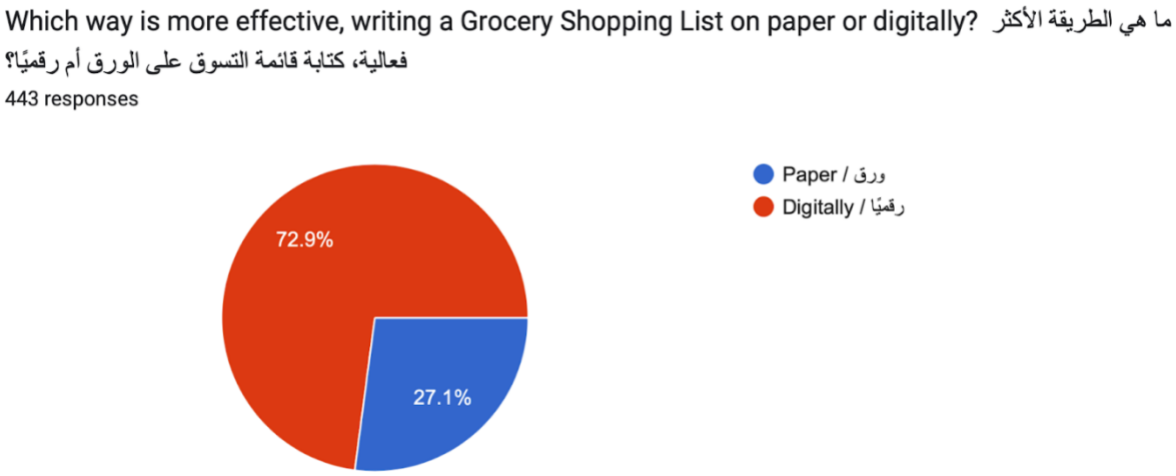

Figure 44: Survey Detailed Results- Question 6

Question 7: The following question shows that 92.8% of the answers said they would like to use the SGSA.

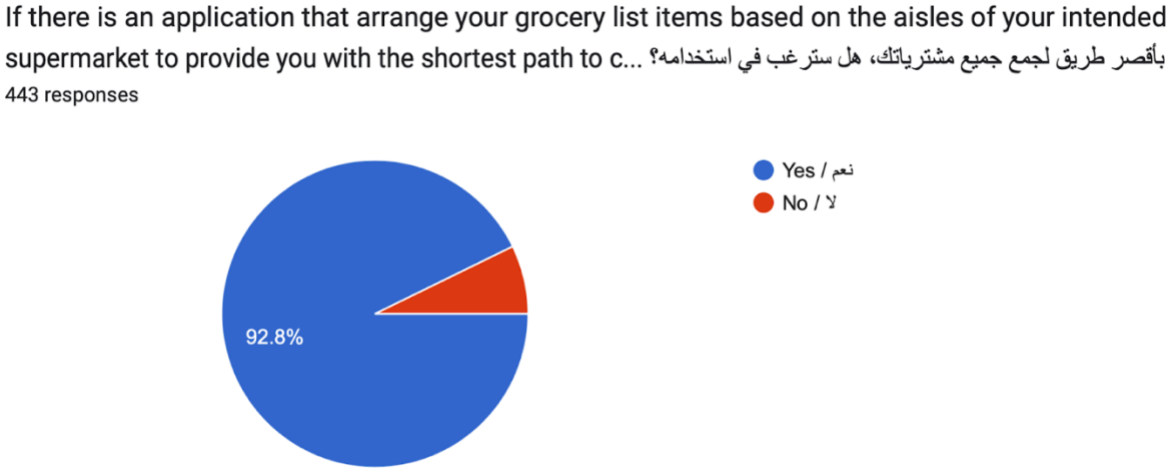

Figure 45: Survey Detailed Results- Question 7

Question 8: The following question shows the most liked features of the SGSA, we also had a number of useful suggestions that we plan on implementing in our future work.

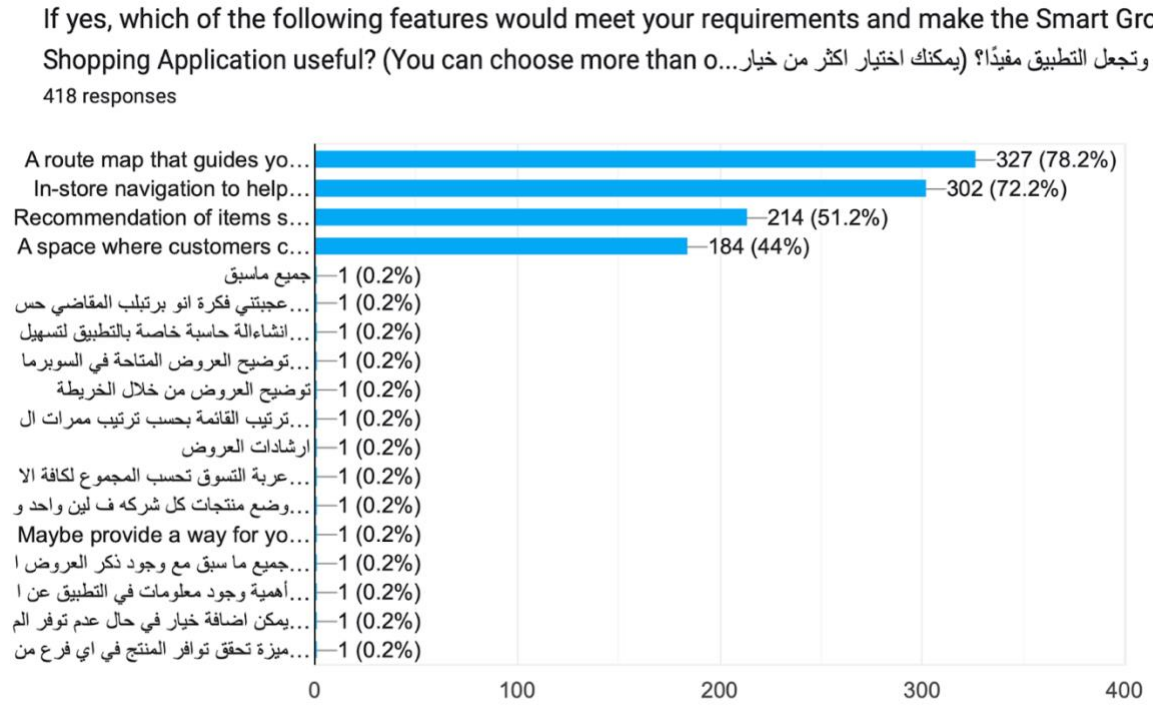

Figure 46: Survey Detailed Results- Question 8

Question 9: The following question shows that 84.4% of the answers said they think the SGSA will improve the grocery shopping experience.

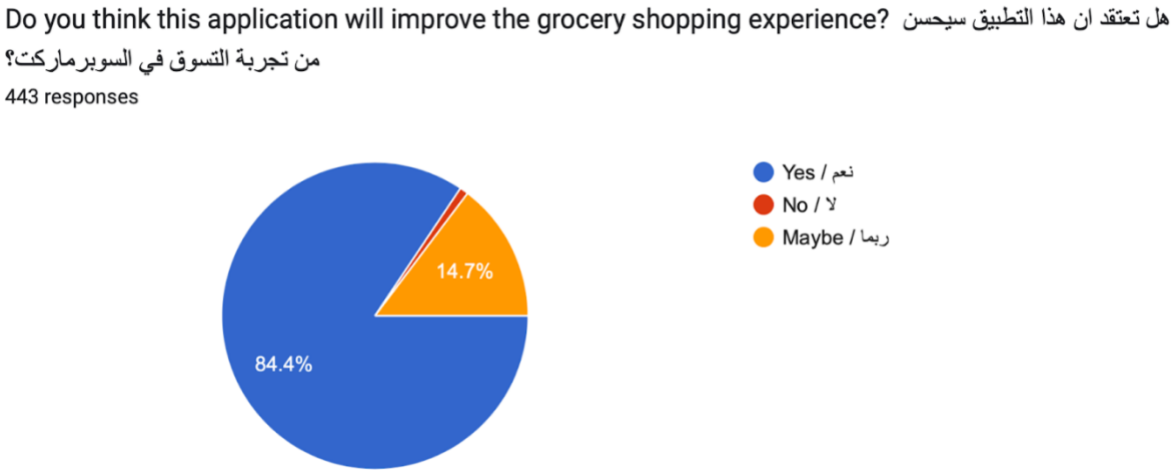

Figure 47: Survey Detailed Results- Question 9

Question 10: The following question shows that 64.8% would use the SGSA frequently, whereas 30.5% would use it occasionally.

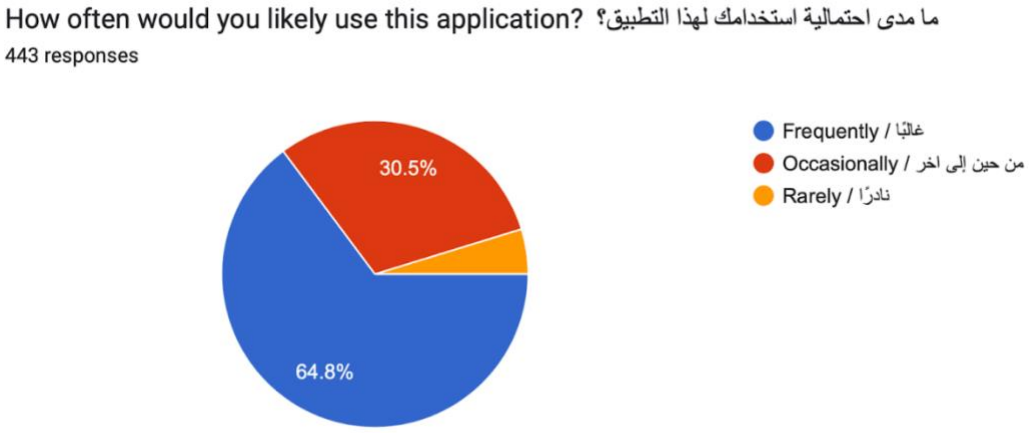

Figure 48: Survey Detailed Results- Question 10