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Designing a flutter-based community recipe mobile application

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ABSTRACT

This study focuses on developing a cross-platform mobile application for community-based recipe sharing, addressing the increasing role of mobile technology in daily life. Although recipe apps are globally popular, their adoption in Malaysia remains limited. The proposed application aims to fill this gap by providing users an interactive platform to explore, share, and try new recipes within a cooking-focused community. Key features include personalized recipe suggestions, and an intuitive, easy-to-use interface designed for all devices, enhancing user engagement and promoting community interaction. A background study is conducted to understand the existing landscape and user needs. It is followed by a design phase, which will lay the groundwork for addressing the identified challenges. Based on the insights gained from the background study and design outline, a mobile application is developed, aligning with the analyzed requirements and system design. This paper reports on the design and usability evaluation of this study. Based on the design guidelines, it has been found that this application could provide an intuitive and seamless user experience. Future works include the integration of smart kitchen features and personalized machine learning for better user experience.

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1. INTRODUCTION

The rapid advancement of technology has significantly changed how mobile applications work. Our mobile devices now serve as versatile tools that enable us to complete tasks quickly and accurately. In the realm of education, recipe applications have undergone a significant transformation. They have transitioned from traditional recipe books to digital platforms accessible via smartphones and the internet, transforming how people access cooking information. These applications have completely revolutionized how individuals discover, create, and share culinary knowledge, providing home cooks and food enthusiasts worldwide with a more dynamic and accessible platform.

The realization of the problem emerged while observing the experiences of many home-cooking people looking for a trustworthy online platform for recipe exploration. Despite the abundance of mobile applications available, there remains a noticeable gap in the market for recipe applications that fostered community interaction and engagement. Home-cooking lovers often face difficulties using different applications separately such as Pinterest, TikTok, and Facebook Group to discover recipes. There was not a single place where they could share experiences, learn from others, and find new cooking ideas together. Furthermore, considering the current economic situation, the effects of inflation and corresponding high cost of living [1].

Notably, despite these financial challenges, Malaysians have continued to increase their expenditure on restaurant services compared to the period before the COVID-19 pandemic. From here, technology can hold the potential to influence people's behaviours positively by encouraging them to opt for home-cooked meals instead of regularly dining out. The proposed application is designed for individuals interested in preparing food at home, particularly targeting home cooks, food enthusiasts, and those passionate about exploring, creating, and sharing recipes. The platform promotes interaction and recipe discovery with a user-friendly interface that encourages collaborative engagement within an active cooking community. Embracing a wide range of users, the application serves as a platform for sharing recipes and mutual learning. As a mobile app, it enhanced responsiveness, offline access, push notifications, better integration with device features, improved performance, and a consistent user experience across devices. Additionally, endless features like dynamic font size, grocery lists, and other interactive tools, making it comprehensive choice for home cooks compared to web applications.

2. THE COMPREHENSIVE THEORETICAL BASIS

2.1. Background study

Research has highlighted the intricate challenges that parents encounter as they attempt to balance caregiving with paid employment. In their quest to provide healthy meals for their families, parents struggle with various obstacles: time constraints, financial issues and the persistent need for convenient (yet nutritious) food options. This study not only acknowledges these difficulties but also explores how mobile applications can serve as a viable solution because they assist parents in planning, purchasing and preparing family meals as found in [1]. However, these digital tools may not alleviate all burdens. Although they offer support, the underlying complexities of family life remain.

The research investigates the role of smartphones and applications in tackling issues related to health, sustainability and waste, particularly in the context of grocery shopping apps [2]. It reveals that numerous existing applications fail to incorporate behavioural models, which are crucial for motivating and influencing consumer behaviour. The analysis reviews a selection of grocery shopping applications, evaluating their congruence with modern behavioural models through a methodology that consolidates various theoretical frameworks to classify app functionalities. The findings underscore both strengths and weaknesses in promoting the desired behaviours. This study stresses the significance of harmonizing app features with behavioural models to effectively foster healthy and sustainable grocery shopping behaviours that is recommended in [3].

This research highlights the potential of technology-driven interventions such as mobile applications to foster healthier eating habits within families. The emphasis on utilizing a mobile app for recipes and promoting cooking resonates with the broader trend of harnessing digital technology to improve dietary behaviors. However, despite its targeted approach, these findings contribute to the expanding body of evidence that supports the integration of digital tools in encouraging healthier eating practices among families. Provides insightful observations into the eating habits of adults; it particularly focuses on the prevalence and implications of dining out [4]. It reveals that a significant number of adults often opt to eat away from home, a trend that is associated with poorer dietary choices (and) higher sodium intake. Additionally, the research delves into the types of foods typically selected when eating out and examines how various socio-demographic factors-such as occupation and location-affect these practices. Because of this, it is clear that understanding these influences is crucial in addressing the challenges of promoting healthier eating habits.

These findings (although specific in their context) possess wider implications, particularly in the creation of tools and platforms designed to foster healthier eating habits, such as a community recipe application. By integrating research-driven insights, these applications have the potential to become more effective in meeting the dietary needs and behaviors of their user base. This study serves as a reminder of the significance of comprehending real-world eating patterns and preferences, which is essential for devising solutions that promote healthier lifestyle choices. In another study, the feasibility and development of a mobile application within Swiss households were assessed, specifically examining its influence on children's dietary behavior and food acceptability during cooking with limited parental support [5]. Aligned with the broader literature that emphasizes the positive impact of involving children in meal preparation, previous studies indicate that active participation in cooking not only improves food preferences but also increases the willingness to try new foods and enhances nutritional knowledge. However, there remain challenges in implementation, because understanding these dynamics is crucial for effective intervention strategies.

Recent investigations into mobile applications harness technology to promote healthier eating habits among families. A study conducted by Haddad *et al.* [6] explored the implementation of user-centered design in food and nutrition apps, highlighting how these platforms can aid families in meal planning and

preparation by aligning features with users' behavioral needs. They posited that successful food-related mobile applications must incorporate user-centered designs to more effectively address the challenges parents face when preparing nutritious meals. Yousaf and Palaniappan [7] scrutinized a community-based recipe-sharing app, focusing on user engagement and community building. Their research revealed that recipe-sharing mobile applications must meet both individual and communal needs; this requires leveraging features that motivate users to actively participate in food-related discussions and share their culinary experiences. However, achieving this balance can be complex, because it demands an understanding of diverse user preferences. Although the potential for these apps is substantial, their design must remain adaptable to the evolving demands of users. This observation corresponds with the wider trend of leveraging digital tools to enhance healthy eating habits via collaborative, community-driven platforms; however, the implementation of these features must be executed with care. Although mobile applications possess significant potential, numerous challenges persist in guaranteeing that they genuinely address the varied needs of families.

Smartphones have increasingly become essential personal assistants due to their widespread integration into our daily lives, which initially relegated them to simple communication tools as higlighted in the literature review [8]. Mobile applications designed for culinary exploration have emerged in response to users' evolving needs, encompassing both connectivity and assistance with their gastronomic endeavors. This trend is highlighted in the literature review, which underscores the pivotal role of smartphones in the culinary domain [9]. Furthermore, [10] demonstrated how the combination of Flutter and Firebase in mobile applications can enhance user interaction, streamline data management and improve scalability. However, this also emphasizes the significance of cross-platform technologies in modern app development. Their research suggests that these frameworks can greatly increase the efficiency and effectiveness of community-based mobile applications, making them better suited to user demands in recipe-sharing platforms. Although challenges remain, the innovation potential is vast.

Further explored how recipe applications can enhance user engagement by addressing challenges like the need for straightforward recipes, nutritional insights and personalized recommendations [11]. This is particularly significant because they take into account users' dietary preferences. Offered valuable insights into the rapid advancement of mobile applications created with Flutter [12]. They notably highlighted its performance advantages and the ability to develop high-quality, user-friendly applications. However, this framework proves to be a crucial asset for the development of community-oriented applications [13], [14]. Furthermore, assessed user experiences related to food-oriented mobile applications, emphasizing the essential role of usability, design and engagement [15], [16]. They argued that applications prioritizing these elements tend to be more successful in fostering healthier dietary habits. Although this aligns with the primary objective of community recipe apps, which aim to promote collaborative and health-conscious cooking practices, it also indicates that user engagement remains a vital factor in the success of such applications.

2.2. Existing recipe mobile applications

Existing recipe-related mobile applications are analyzed to determine suitable features and content before developing an application of this application. These apps are searched from Google Play Store and App Store for both Android and iOS-based applications.

1) Kuali: Kuali [17] is an application that collects thousands of recipes contributed by chefs and cooks in Malaysia, which offers a diverse collection of recipes sorted by categories and a wide-ranging search feature to help users find their ideal recipe.

2) Tasty: Tasty [18] is a mobile application featuring a user-friendly cooking application featuring a wide range of easy-to-follow recipes with video guides. It's perfect for both novice and experienced cooks, offering personalized recipe recommendations, shopping lists, and dietary filters to enhance user cooking experience.

3) Mealime: Mealime [19] is a mobile application that simplifies meal planning for busy singles, couples, and families by offering highly customizable meal plans and recipes that cater to unique tastes and lifestyles. This platform seamlessly integrates these recipes into a convenient grocery list, with the added option of having the items delivered, providing meal kit convenience at grocery store prices.

4) Comparison of Existing Applications: Surveying the existing food applications involved in observing standout features that differentiated each from competitors and similarities. This examination highlighted gaps within these applications and revealed the essential features necessary for the application to gain a competitive advantage. Table 1 shows the features of existing applications.

After reviewing competitors, it became apparent that they shared many common features, including browsing and user profiles, and managing recipes, as highlighted in the comparison. It is crucial for this application to identify and to stand out by offering unique functionalities distinct from those of competitors.

Table 1. Comparison of existing applications

Features	Kuali: Malaysia recipes and more	Mealime	Tasty	Proposed system
User community	No	No	Yes	Yes
Browse recipes	Yes	Yes	Yes	Yes
Create recipes	No	No	No	Yes
Cookbook	No	No	No	Yes
Grocery list	No	Yes	No	Yes
Meal planner	No	Yes	Yes	Yes
Web scrapping	No	No	No	Yes

3. RESEARCH METHOD

3.1. Conceptual representation

Figure 1 depicts the use case diagram [20] for the recipe application. The primary actor in this system is the User. In order to utilize the application's features, users must create an account. If they are not already logged in, they can easily register through their email address. Once they successfully log in, users are taken to the homepage screen-this is where they can explore a variety of recipes.

Users can view detailed information about recipes, which includes options to share, bookmark, or even report them. Furthermore, they can access their personal profile, edit their content and manage their recipes by creating, editing, deleting, or updating them. They can also search for recipes and other users, along with viewing notifications.

Moreover, alongside recipe management, users can also take charge of their shopping lists by adding or deleting items as needed. They have the benefit of accessing ingredient wikis to obtain information about specific ingredients. However, users are not limited to just this; they can also manage meal plans by viewing, adding and deleting those plans.

The second participant in this system is the Admin. Admins possess the ability to log in and create accounts, manage user profiles, oversee ingredient wikis, handle recipes reported by users and analyze application data. They play an essential role in maintaining the system's functionality, thereby ensuring its seamless operation.

3.2. Development tools used

A list of development tools is involved in the application development. The mobile applications are developed using the Flutter Framework, which utilizes Dart as its programming language. Supabase [21] is selected as the cloud-hosted database for the backend. Firebase [22] is utilized for application analytics and distribution. Visual Studio Code [23] is employed as the code editor for development purposes.

3.3. Questionnaire

Table 2 shows the questionnaire that has been distributed to a sample of 36 respondents. The objective of the survey is to gather the required data related to the preferred features to be implemented in the system from the user’s perspective.

The questionnaire results underscore the need for a mobile recipe application that integrates multiple sources. Mobile applications allow flexibility to developers to easily incorporate features needed by users, making the app a versatile and comprehensive tool for its intended purpose. This approach not only simplifies the cooking experience but also encourages home-cooked meals, positively influencing user behavior amidst economic challenges.

3.4. Questionnaire outcomes

The provided bar chart, labelled as Figure 2, displays the preferred sources among respondents for discovering new recipes. The chart shows that all the respondents, which is 100%, use social media platforms (like Instagram and Pinterest) to find new recipes. Internet blogs are also a significant source, with 36.1% of respondents turning to them for new ideas in the kitchen. Traditional cookbooks, however, seem to be less favoured, with only 6.6% of respondents using them, and a very small fraction, 2.8%, citing other sources.

Figure 3 shows that a significant majority of the respondents, 77.8%, affirm the need for a mobile application to access a recipe app community. Meanwhile, 22.2% are uncertain, responding with 'Maybe'. There appears to be no respondents who believe a mobile application is not needed, as the 'No' category has 0%.

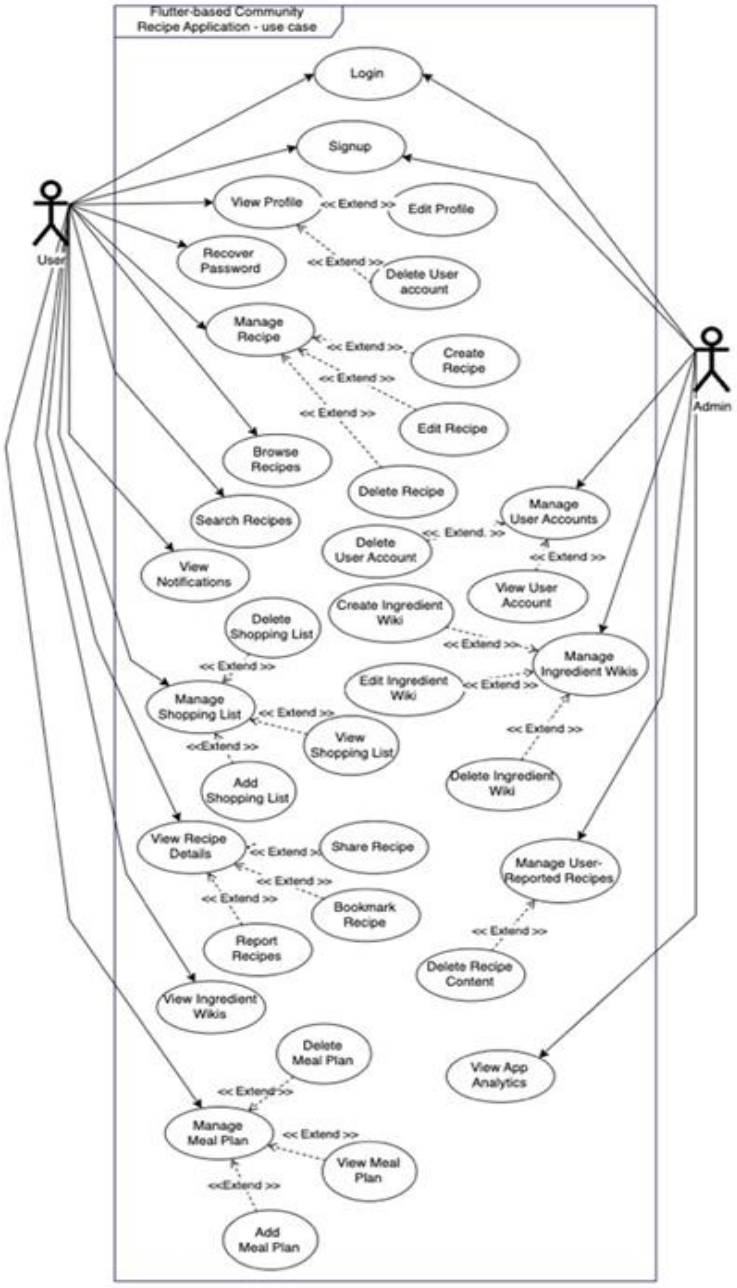


Figure 1. Use case diagram

Table 2. Questionnaire

Question no.	Question	Type of input	Available options
1.	Where do you usually find new recipes?	Check box	Internet blog Social media Cookbooks Other
2.	Do you need a mobile application to access the recipe application community?	Radio box	Yes No Maybe
3.	What are the biggest challenges you face when cooking?	Text box	E.g.: Remembering the recipe
4.	What unique feature would you like to see in recipe community app?	Check box	Grocery list User-generated content Meal planner Interactive cooking guides

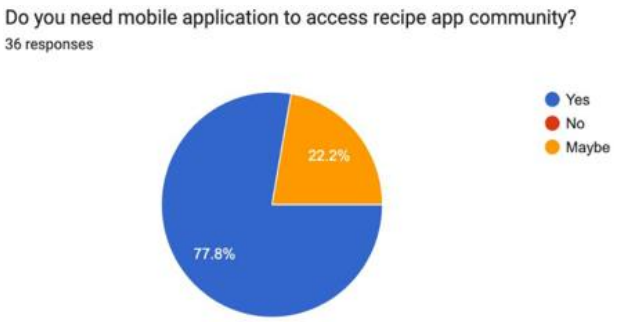


Figure 2. Question: Do you need mobile application to access recipe app community?

Figure 3. What are the biggest challenges you face when cooking?

Figure 4 compiles the various challenges faced by respondents when cooking. These challenges were categorised into common themes for clarity as follows:

Recipe and Ingredient Management:

- Difficulty in saving recipes across different social media platforms.
- Always missing ingredients.
- Forgetting ingredients on hand.
- Determining what to cook and where to get the recipe easily.
- Lack of ingredients.
- Finding and getting good ingredients.
- Remembering the recipe.
- Managing substitutions for missing ingredients or deciding on a dish based on what is available in the fridge.

Cooking process and quality:

- Keeping personal cookbooks for reference.
- Consistently achieving a good taste.
- Dealing with wrong measurements.
- Preparing the ingredients.
- Making the food taste better.
- The complexity of taste preferences.
- The challenge of cooking food that tastes good, is affordable, and healthy simultaneously.

The bar chart displays the number of respondents who selected each feature as follows:

- A grocery list feature is sought after by 63.9% of respondents, making it the most popular choice.
- User-generated content is also highly valued, with 62.8% of participants
- interested in this feature.
- A meal planner is close behind in popularity, desired by 61.1% of those surveyed.
- Interactive cooking guides are appealing to 55.6% of respondents, indicating a strong interest in more dynamic and engaging content.

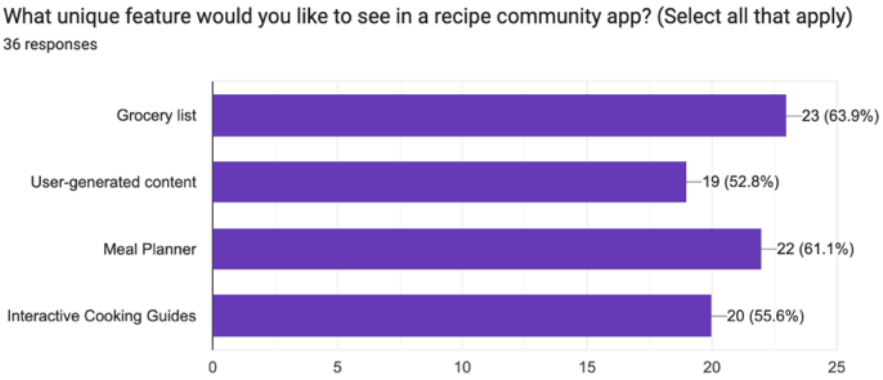


Figure 4. What unique feature would you like to see in a recipe community app?

3.5. Application development

From the analysis of three recipe applications, an application is developed with common features derived from existing recipe mobile applications, namely user profile, user community, browse recipes, grocery list, and meal planner. The application is developed according to the proposed system guideline which is aimed at cross-platform mobile applications. To achieve this, the plan involves testing and continuous development to ensure that the final applications is not just easy to use but also innovative and aligned with the users. Importantly, throughout this development process, compliance with both Apple's Human Interface Guidelines [24] and Google's Material Design Guidelines [25] will be ensured, guaranteeing that the final software product not only meet customer expectations but also adheres to the highest standards of platform compatibility and user experience.

3.6. Usability evaluation

Following the development of the application, a user-based usability evaluation was conducted to ensure the effectiveness of the community recipe application. This evaluation took the form of an interview session designed to gauge users' perceptions of the application's usability. The study strictly adhered to proper ethical guidelines.

The study involved four participants, comprising two males and two females. The participants were evenly distributed between iOS and Android users, providing a balanced representation across both major mobile platforms. Moreover, the participants were consciously selected to ensure varied dietary restrictions: one participant with a halal diet preference, one vegetarian participant, and one with no specific dietary restrictions. This diverse array of dietary preferences sought to provide a more comprehensive understanding of how individuals with differing dietary practices engage with the application.

The application was distributed via Firebase for both iOS and Android platforms. Participants interacted with the app without any prior guidance and their behaviors were meticulously observed and recorded for subsequent analysis. Following their engagement with the application, interviews were conducted to elicit their perceptions regarding user-friendliness and usability. The interview process was structured, allowing for consistency in data collection. Throughout the study, ethical guidelines were rigorously observed to protect participant rights and privacy, because this is paramount in research.

Participants received a briefing regarding the interview specifics to ensure they comprehended the study's objectives and tasks. Following this, they were instructed to utilize the recipe application independently (without any guidance). Observations from this process were meticulously documented for subsequent analysis. After engaging with the application, participants underwent interviews aimed at assessing user-friendliness, ease of use and feature utility. These interviews adhered to a semi-structured format, employing a prepared guide that concentrated on prevalent usability factors such as efficiency and satisfaction. This approach facilitated a comprehensive understanding of the participants' experiences and perspectives concerning the application's usability. However, some nuances may have been overlooked, although they were crucial to the overall evaluation.

3.7. System overview

Figure 5 shows the system overview diagram of the proposed system. The user’s smartphone, Supabase, and Firebase are all connected via the internet in this application.

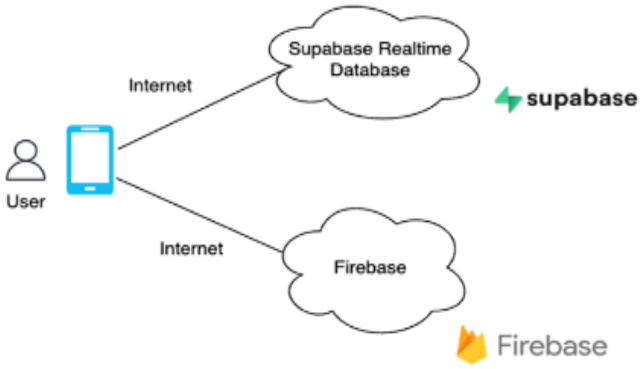


Figure 5. System overview

Supabase and Firebase are used for implementing a cross-platform app. Supabase will serve as a cloud database to efficiently store all required database data. This will ensure that the data is easily accessible and scalable, which is crucial for the long-term success of the application. Additionally, Supabase is designed to offer real-time capabilities, making it possible to build responsive and interactive interfaces.

Moreover, Firebase will be utilized for app distribution and to view real-time analytics. Firebase provides a comprehensive set of features, including app distribution, cloud functions, and Crashlytics, which streamline the app distribution process and provide invaluable insights into user behaviour and the performance of the app. Moreover, Firebase offers robust authentication and security features, ensuring that your cross-platform app is both secure and user-friendly. In comparison to conventional databases, Supabase backed by PostgreSQL offers some remarkable advantages compared to traditional databases. PostgreSQL is extensively acknowledged for its steadfastness, capacity for expansion, and compliance with SQL standards. It offers a robust framework for the storage of data that is optimised for performance, security, and scalability. When comparing Supabase and PostgreSQL to conventional databases, the combination of these two technologies provides substantial advantages in several crucial areas.

4. RESULTS AND DISCUSSION

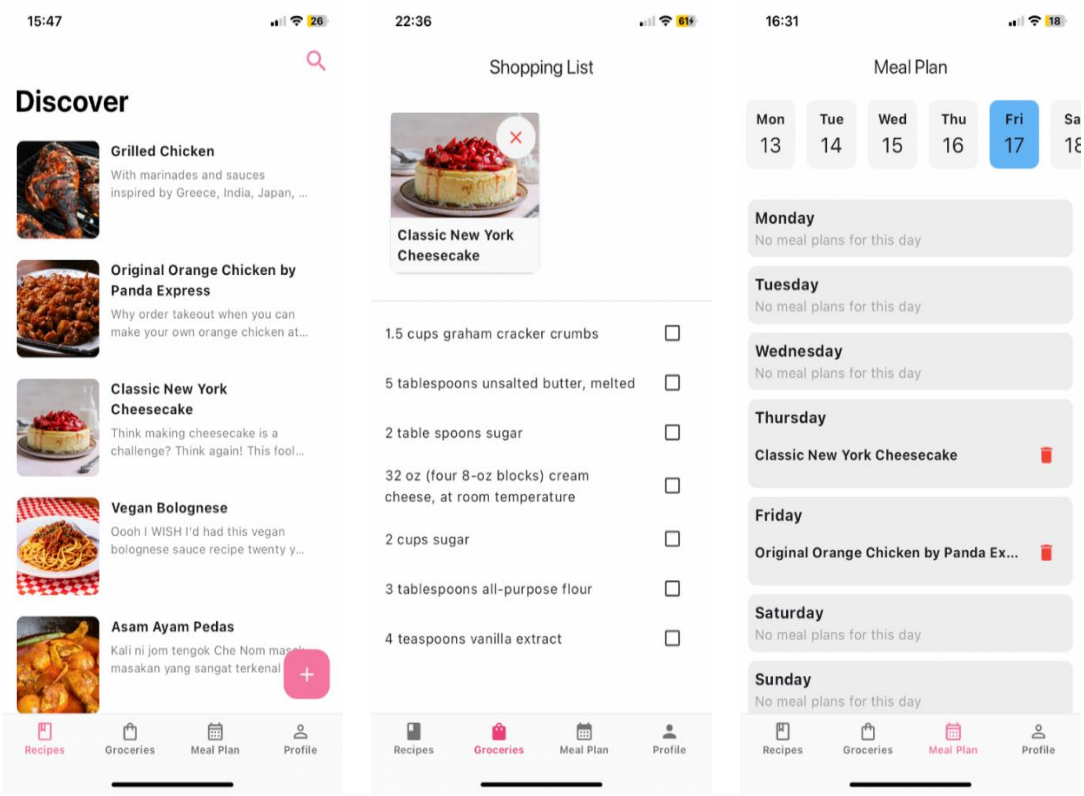
The result of the usability evaluation will be analyzed in this section with further discussion. It is found that the application was perceived as intuitive and easy to navigate by the participants. Positive feedback indicated that the layout and design as shown in Figure 6 contributed to a seamless user experience. The participants reported mixed feedback on the ease-of-use aspect.

While some found it straightforward, others expressed minor challenges in certain tasks, which indicated a mid-level ease of use rating. Moreover, the usefulness of features might highlight the value of the features offered by the application, indicating that they were relevant and beneficial to the users' needs. The semi-structured interviews provided insights into participants' experiences, revealing high levels of satisfaction with the application's performance and efficiency in fulfilling their requirements.

In the usability evaluation, participants consistently praised the homepage screen, depicted in Figure 6(a), for its clarity and user-friendly layout. They found it intuitive to navigate and appreciated how easily accessible the recipe of the users was from the homepage. This positive feedback underscores the success of the design in providing a seamless user experience. Additionally, participants highlighted the importance of the application's features, indicating that they found them relevant and beneficial to their needs. The overall satisfaction expressed by participants underscores the effectiveness of the application in meeting user expectations and fulfilling their requirements, contributing to high levels of user satisfaction and efficiency.

Participants appreciated the grocery list feature, as depicted in Figure 6(b), which showcases the user's ability to add items directly from recipe details. This functionality was lauded for its straightforward design and practicality, allowing users to easily compile and manage their shopping needs directly within the app. The seamless integration of the grocery list within the recipe details was noted as particularly user-friendly, facilitating a smooth transition from recipe planning to grocery shopping. Participants reported that this feature significantly enhanced their overall experience by simplifying the process of preparing to cook. The intuitive layout and the utility of the grocery list feature were highlighted as key factors contributing to the application's effectiveness in meeting users' culinary and shopping requirements, leading to high levels of satisfaction with the application’s performance.

In the usability evaluation, participants shared mixed feedback regarding the meal plan feature depicted in Figure 6(c). While some users found it helpful and appreciated the convenience of having meal plans readily accessible from the homepage, others expressed minor difficulties in navigating and customizing their plans according to their preferences. Some participants reported that the layout could be more intuitive, with clearer options for customization. Despite these challenges, users acknowledged the potential of the meal plan feature to streamline their meal preparation process once they became more familiar with its functionality.



(a) (b) (c)

Figure 6. User interface: (a) homepage of the application, (b) shopping list, and (c) meal plan

The highlighted value and relevance of the application's features emphasize the significance of meeting users' needs effectively. The positive feedback on feature usefulness suggests that the application successfully addressed key user requirements and provided functionalities that were beneficial to the participants. This affirmation of relevance indicates that the application aligns well with the users' expectations and culinary interests, enhancing their overall experience and engagement with the platform.

The high levels of satisfaction reported by the participants reflect positively on the application's performance efficiency in meeting their requirements. The efficient execution of tasks and fulfilling user needs contributed to a satisfactory user experience. This satisfaction indicates that the application effectively delivered on its intended functionalities and provided a valuable platform for recipe sharing and culinary exploration.

Overall, while the usability evaluation revealed strengths in user experience, feature relevance, and satisfaction, the challenges in ease of use provide valuable insights for refining the application further. By leveraging these findings to drive iterative design improvements, the application can evolve to meet the diverse usability needs of its users and enhance overall user satisfaction and engagement.

5. CONCLUSION

In conclusion, the Community Recipe application can be designed with a focus on community-based features focusing on the needs of the targeted user group. The usability evaluation highlighted the application's success in providing an intuitive and seamless user experience. This study contributes to a

greater understanding of the user needs that should be implemented in such applications, representing a significant but currently underexplored area. While the study was conducted with a relatively small number of participants, it is recommended to involve a larger sample size in qualitative user-based experiences to identify and address any unmet user needs. Future studies should aim to replicate the results with a higher number of participants, as recommended in existing literature, to further fortify the robustness of the findings and ensure comprehensive coverage of user requirements.

Future works for this application include the integration of smart kitchen features and personalised machine learning. Personalised machine learning features involve using algorithms to analyse user preferences, cooking habits, and feedback tailored to the recipe recommendations. The application will learn from user interactions to suggest recipes that match their taste and dietary restrictions. Additionally, when machine learning model is employed for image recognition, the system can identify various food ingredients with high accuracy and suggest recipes based on these ingredients. The integration of smart kitchen features will allow users to connect with smart appliances, receive real-time updates, and control devices remotely. For example, the app could preheat smart ovens or ensure precise ingredient measurements with smart scales. Voice assistant integration will enable hands-free recipe navigation, enhancing user experience and making cooking more efficient.

Advanced web scraping techniques can be utilized to enhance the platform's ability to gather real-time data on ingredient availability and recipe suggestions from various online sources. This will enable the system to expand its database of recipes and provide users with a broader range of cooking options. By scraping data from grocery stores, food blogs, and recipe websites, the platform can dynamically update its suggestions based on current trends, seasonal ingredients, and user preferences. Furthermore, web scraping can be used to track price fluctuations and promotions, helping users make cost-effective decisions while reducing food waste. However, challenges in ensuring data accuracy, preventing website overload, and managing privacy concerns will need to be addressed for effective implementation.

The integration of a community-based social recipe system will allow users to share ingredients and suggest recipes within their social groups. The system will aim to reduce food waste by fostering creativity in cooking and enhancing awareness of in-home food availability. By incorporating real-time ingredient tracking and recipe suggestions, the platform will enable seamless coordination among users, even across households. Additionally, optimizing the user experience through trust-building features and minimizing the inconvenience of physical distance will be key areas of development.

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This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

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Zarina Che Embi										✓		✓	✓	

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

INFORMED CONSENT

We have obtained informed consent from all individuals included in this study.

ETHICAL APPROVAL

The research related to human use has been complied with all the relevant national regulations and institutional policies in accordance with the tenets of the Helsinki Declaration and has been approved by the authors' institutional review board or equivalent committee.

DATA AVAILABILITY

The data that support the findings of this study are available on request from the corresponding author, ZCE. The data, which contain information that could compromise the privacy of research participants, are not publicly available due to certain restrictions.

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