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Article

The Planning Process of "RE: THINK" Waste Mobile Application

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***Abstract*— This paper presents the development and planning of "Re: Think," a mobile application designed to simplify recycling for consumers. Despite widespread awareness, recycling rates in Malaysia remain low, with many individuals still discarding waste without proper separation. As the population continues to grow by approximately 600,000 people annually (2.4%), waste generation is expected to increase significantly. To address this issue, "Re: Think" leverages the accessibility of smartphones to promote and facilitate recycling practices. The application collaborates with accredited recycling facilities, allowing users to easily locate nearby centres, schedule waste drop-offs, or request doorstep collection services. This feature particularly benefits older adults and persons with disabilities who may face challenges in transporting recyclable items. Furthermore, the app educates users about recyclable materials and offers incentives to encourage consistent participation in recycling activities. The development of "Re: Think" followed the Waterfall methodology, which structures the process into sequential phases; analysis, design, implementation, and testing, ensuring that errors are identified and corrected early in the development cycle. The system design focused on creating a user-friendly interface to enable smooth navigation and quick access to recycling options. On the back end, the application integrates with verified recycling centres to provide real-time updates on collection schedules, facility availability, and recycling activity records. The "Re: Think" application contributes to sustainable waste management by connecting individuals and recycling organisations in a streamlined digital platform. By making recycling more convenient, accessible, and rewarding, the app encourages behavioural change and promotes environmental awareness. Ultimately, "Re: Think" has the potential to reduce waste generation, enhance community participation, and strengthen the nation's move toward sustainable and responsible waste management practices.**

***Keywords*— Waste, Application, Recycling, Reuse, Sustainable, Environment**

I. INTRODUCTION

In 2015, all UN members agreed to work together to implement the 2030 Agenda for Sustainable Development, which calls for peace and prosperity for people and the planet both now and in the future. All developed and developing nations must work together to achieve the 17 Sustainable Development Goals (SDGs). They know that eradicating poverty and other forms of deprivation calls for measures to improve health and education, reduce inequality, foster economic growth, battle climate change, and save our forests and oceans. This research aims to support the Sustainable

Development Goals (SDGs) 12th goal, responsible consumption and production, which states that we must drastically change how we produce and consume goods and resources to achieve economic growth and sustainable development [1], [2]. The largest consumer of water in the world is agriculture, and irrigation currently accounts for about 70% of all freshwater used by people. By 2030, this objective aims to significantly reduce waste generation through waste prevention, reduction, recycling, and reuse and to encourage huge global companies to adopt sustainable practices and incorporate sustainability data into their reporting cycle. Environmentally sound technology and management are recognised as practical instruments that may be utilised to reduce pollution and other adverse effects of waste produced by human activities on the environment in this development path. There is an increase in solid waste production on a global scale. Solid waste production is expected to increase to 2.59 billion tonnes yearly in 2030 and rise to 3.40 billion tonnes by 2050 [3].

The slogan 3R - reduce, reuse, recycle in the recycling campaign is three decades old, according to a senior lecturer at the Faculty of Manufacturing Engineering at Universiti Teknikal Malaysia Melaka (UTeM) (2023). Although the campaign has existed for decades, its implementation remains weak. According to research by the National Environmental and Research Centre (NECC) in 2022, Malaysia now produces nearly 40,000 tonnes of residential solid waste daily, with an estimated 1.5-fold rise by 2050. This is a significant issue since most residential solid waste is not correctly disposed of and ends up in rivers and oceans, polluting them and putting aquatic life in danger [4]. According to data from the Ministry of Natural Resources and the Environment, up to 90% of the 38,000 tonnes of residential solid waste generated daily in 2019 were not separated but deposited at disposal sites, which caused pollution [5].

Pollution in the city is getting worse because of the rising trend of modernisation. Because this crisis could impact health and safety, as well as what is being heatedly discussed in the neighbourhood, various measures have been taken to control it. The practice of recycling, which involves turning garbage into new or recycled materials and using them for the same or different purposes, is one of the techniques that have been adopted. All communities worldwide have advocated and adopted this alternative, but some people still do not understand the significance of this practice. We should thus be aware of the importance of recycling practices for both people and the environment. According to Yeo Bee Yin, Minister of Energy, Science, Technology, Environment, and Climate Change in 2019, encouraging garbage separation and recycling among the populace is still low, leading to the higher daily production of solid waste in this country. She stressed that knowledge and awareness of the issue must be applied and practised daily to limit the quantity of rubbish dumped in landfills and protect the environment. According to her, one of the most critical stages is getting people to realise the difference between solid trash that can be recycled and residual waste, such as food waste, that cannot be recycled.

The Re:Think initiative is one of the concepts that may support the Sustainable Development Goals (SDGs). With this application, Malaysians will become more conscious of the value of the environment. Many recycling programs have been created, but not all are used today. Even Malaysians are still ignorant of the value of recycling. Among the applications that are popular in Malaysia are Recircle and trash4cash. The community gains a lot by using this system to recycle its products. These applications have limitations, such as the lack of home collection services and incomplete coverage across Malaysia. In addition, many do not provide clear item rates per kilogram for consumers. There is also an application available right now that does not list recyclables. Numerous mobile and smartphone applications are used daily in our "information society" [6]. The application may be made to make waste disposal (including WEEE) easier, boost interaction between homeowners and collection services, and boost logistics automation. However, the number of mobile apps that assist with rubbish collection is relatively small; most apps are primarily used to locate waste collection locations or create reminders for collection schedules [7]. Therefore, improvements for recycling applications have been emphasised in RE:THINK.

The research questions are: (1) What are the gaps in the existing recycling application? (2) How can we ensure Re: Think is protected from threats? (3) How can we ensure that Re: Think works well?

The research objectives are as follows: (1) To investigate the gaps in the existing mobile recycling applications. (2) To develop a secure, recycled mobile application for Re: Think Mobile. (3) Conduct user acceptance testing to ensure Re: Think Mobile Application works.

The difference between materials that can be recycled and those that cannot is still not well known in our culture, leading to improper recycling practices and contributing to the lack of clear guidance on recyclables. It will be challenging for recyclers if their clients recycle things that they do not require. This is because specific applications do not specify recyclables. As stated by Yeo Bee Yin, the Minister of Energy, Science, Technology, Environment and Climate Change (MESTECC), in the Berita Harian newspaper (2019), although the community is aware of recycling, awareness is still inadequate since recycling is still not a top concern in society [8]. Since garbage should be divided based on whether the item is paper, glass, organic, or plastic, knowledge of recyclable and non-recyclable waste is crucial for reducing waste in landfills. The quantity of recycling, reuse, and recovery rises with separating waste materials from their source. It is challenging to separate and recycle recyclable waste when combined with organic waste at the source. Additionally, when garbage is separated at the source, its moisture content is lower, making incineration a more accessible option for disposal. Burning recyclable garbage, like plastic, releases toxic fumes harmful to the environment and people [9].

As is common knowledge, many elderly and disabled citizens in our nation live alone. For groups like the elderly and disabled, recycling is challenging due to the lack of recycling applications that offer home collection services for recycled products, highlighting the inadequacy of accessibility for these individuals. Due to the limitations of their abilities, they find it challenging to move anywhere. According to Datuk Seri Ismail Sabri Yaakob, the previous prime minister, in My Metro (2021), the government has never marginalised people with disabilities. Instead, it offers a variety of options and incentives to support them in our nation [10]. For groups like the elderly and disabled,

recycling will be more challenging because most recycling applications do not offer the service of collecting recycled products from homes.

Some communities still do not understand recyclable materials well, resulting in confusion about what can be recycled and indicating a limited understanding across communities. At all ages, there is still a shortage of recycling information. The co-founder of Zero Waste Malaysia (ZWM), Khor Sue Yee, stated in the Sinar Harian newspaper (2022) that although awareness has already begun to grow within the community, most people have little exposure to and knowledge of the significance of free-standing plastic [11]. According to Khor, 50% of respondents to a ZWM poll conducted in the Klang Valley and involving roughly 7,000 people still had doubts regarding recyclable items [10]. A few applications do not provide comprehensive recycling resources. Several facilities exclusively do not take plastic to be recycled. The importance of recycling plastic products is further underscored by the fact that recycling and remanufacturing plastic may reduce carbon emissions by 30% to 80% compared to the processing and production of virgin plastic. A significant investment in recycling technology is required to enhance the recovered polymers' quality and raise their economic viability as a substitute for virgin materials [12]. This proposal aims to provide many recycled items, including electronic waste. There is a need for applications that address a broader range of recyclables, which is increasingly prevalent in modern society, underscoring the lack of apps covering this essential area. Some of the plastic components in e-waste, such as phthalate plasticisers and brominated flame retardants (BFR), are considered harmful. Plastics containing BFR have a lower recycling efficiency because they can produce hazardous dioxins when burnt. The rise in e-waste results from the rising demand for electronic devices, which is also causing an increase in e-plastics. By 2030, Forti V projects that there will be 74.7 million metric tons of e-waste, up from 53.9 metric tons in 2019. In contrast, if e-plastics make up 30% of all electronic trash, the number will increase to 22.4 million metric tons by 2030 from 16.3 million metric tons [13]. Therefore, recycling and disposal of electronic waste should be done correctly.

Most of the applications offered are in Chinese and English, creating language barriers for non-English speakers and older people in Malaysia, thus emphasising the need to address this barrier in current apps. Those who are elderly or do not speak English well will have issues. This will restrict their comprehension. Because Malay is the national language of Malaysia, the Re: Think application will be used to provide justice to all nationalities in Malaysia. Datuk Seri Ismail Sabri Yaakob emphasised in his speech at the 2022 Malay Language Internationalization Symposium in Kuala Lumpur that we all have a part in upholding and strengthening the Malay language. It remains a crucial element in nation-building, serving as the language of knowledge, intellect, literature, and administration [14].

II. PREVIOUS WORK

Going green is a beautiful way to be effective in 2023. With a new year comes a new resolution for those wanting to change their lives. Recycling benefits both the earth and us, and there are various waste types to consider. Mobile applications for waste and recycling can serve as effective tools for education, awareness, and community engagement. Their effectiveness depends on simplicity and the provision of clear, useful information to users. Some creative developers are significantly simplifying our lives by creating apps that help us sort through what can and cannot be recycled and composted and the locations of recycling centres.

However, Malaysia still lacks apps that would make it simpler for people to recycle all their waste. Most people in this nation still do not know where to recycle their waste or how to get rid of it, especially electronic waste. They are unaware that improper waste disposal contributes to the build-up of gases in the atmosphere, which results in these issues. The breakdown of the waste releases gases like methane, a significant contributor to climate change on a global scale. Not only that, but improper waste disposal will have several additional impacts. Figure 1 displays the list of recycling applications available in Malaysia.

Brand	Type	App Install	Web	Coverage	Distance	Own Logistic	Demographic	Critical Review
Recircle	Lifestyle	10,000+	No	Kuala Lumpur, Selangor, Sabah, Pahang, Ipoh, Johor, Kedah	Depends on place	Partner	Chinese,English	Have e-waste categories, Provide location, Have reward, No pickup
KITARecycle	Business	5000+	No	embilan, Melaka, Jo	Depends on place	Own	English	Has e-waste categories, Have reward, No pickup
Trash4cash	Social	10,000+	No	Kuala Lumpur, Selangor, Kedahh, Ipoh, N.Sembilan	Depends on place	Partner	English	Shown price per kg, Can request for pickup
Riiicycle	Lifestyle	1000+	No	Penang	Depends on place	Partner	English	Shown recycle categories, Provide map/place/address, Have reward,
MyEwaste	Find an e-waste collection centre	1000+	No	All	Depends on place	Own	English	only e-waste, No pickup service, Provide map/place of all collector

Figure 1. List of recycling applications in Malaysia

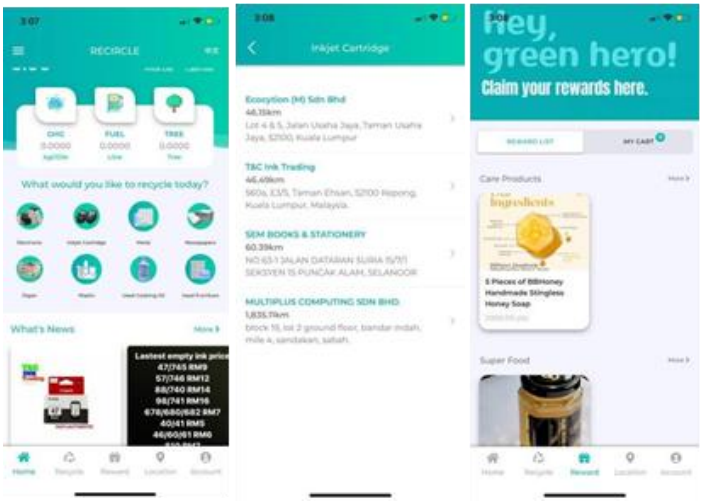

Figure 2. Recircle Application

Recircle (Figure 2) is an advanced mobile program that seeks to digitalise Malaysia's recycling sector [15]. Recircle is committed to enabling the complete recycling of waste and used products. It is also essential to ensure the public is educated and armed with practical recycling knowledge to implement the practice successfully in their everyday lives.

Recircle's mission is to go green and generate a better environment. In addition, it works to reduce waste, promote the 3Rs principle of reuse, reduce, and recycle, raise awareness of recycling, and turn all of Malaysia into a green area.

Some categories they offer for recycling are electronics, inkjet cartridges, newspapers, paper, plastic, used cooking oils, and used furniture. Their top three product categories by sales are inkjet cartridges, which are almost 2 million; used culinary oils, which are nearly 200 thousand; and papers, which are practically RM20,000. Recircle is one of the most frequently downloaded apps due to its features, which make it simpler for users to use and understand.

i. Location: By selecting the sort of waste they want to recycle, users can view nearby locations where they can recycle their waste. The office's address will be shown after selecting an area, and they also give Google Maps and Waze an accurate distance from the user's location. Additionally, it also included the phone number and hours of operation.
ii. Reward: Users receive points each time they dispose of their trash at Recircle. Using the points they earn, they can redeem their reward. In addition, they may cash out to their bank by converting their points into money at a rate of 100.00 points to 1 ringgit.

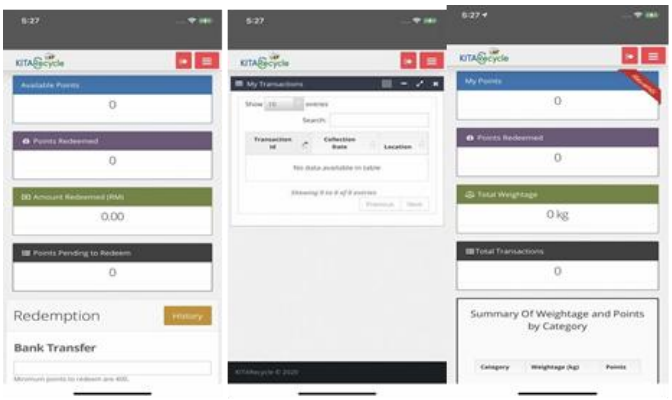

Figure 3. KITARecycle Application

In 2018, SWM Environment's incentive-based recycling scheme was launched in Malaysia's three southern states. The KITARecycle application (Figure 3) rewards people for recycling by giving them recycling points for more than 30 distinct kinds of recyclables, including paper, aluminium cans, plastics, and e-waste [16]. The collected points could be withdrawn using electronic money such as BOOST or Internet banking to make purchases at stores accepting electronic payments. Plastic bottles, hard/mixed plastics, books and magazines, electronics, newspapers, scrap metal, cardboard, and aluminium are among the materials we can recycle with KITARecycle. Some of the features are:

i. Redemption: Users can draw from their KITARecycle earnings via BOOSTS and online accounts.
ii. MyTransaction: Users can access their transaction ID, the recycle item's collection date, and the pickup place.

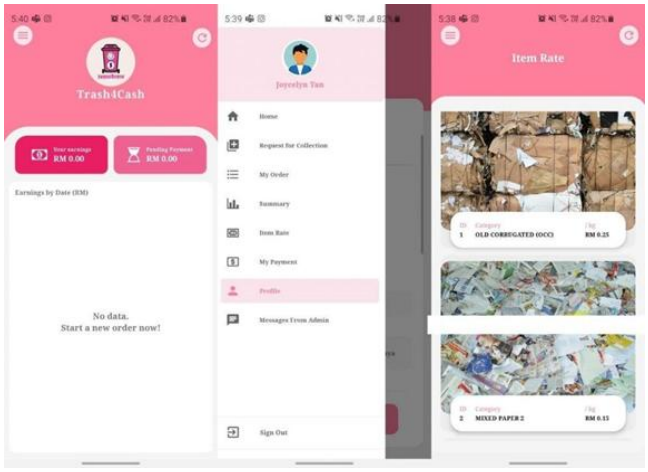

Figure 4. Trash4Cash Application

Trash4Cash (Figure 4) hopes there will be no more trash on the earth [17]. The company's managing director, Redza, is conscious that recycling rates in Malaysia are still meagre. He is attempting to do this by utilising the fleets of Pinky Hub and Trash4Cash to make recycling more straightforward and available. The big pink trucks go door to door on demand to gather recyclables from homes and businesses. They carry a weighing scale to make the experience enjoyable and foster trust with their clients. Customers additionally gain real money as a benefit that aids in environmental preservation. Some of the features are:

i. Item rate: Users can examine the price of the item they want picked up; for instance, mixed paper costs RM0.10 per kg.
ii. Request for collection: Users can request collection by specifying their object's category and location.
iii. Summary: Users can access the overall number of collections that have or have not been finished over time or each month. In addition, users can see how much money they have made overall from recycling items.

A mobile application called Riiicycle (Figure 5) offers us an innovative incentive and reward system when we recycle paper, aluminum and steel cans, plastic, and other types of solid refuse [18]. Additionally, it serves as a tool that rewards us for going green. This innovative answer uses the mobile app to help motivate environmental change by tempting us to recycle all recyclable waste. Some of the features are:

i. Recycle categories: The types of collectible and non-collectible objects are visible to users. To prevent users from wasting their time recycling non-collectible things.
ii. Partner: Users can examine details about the location of the Riiicycle. It also offers Google Maps and Waze, contact information, and business hours.
iii. Reward redemptions: By using their points, users can redeem the rewards that have been given.

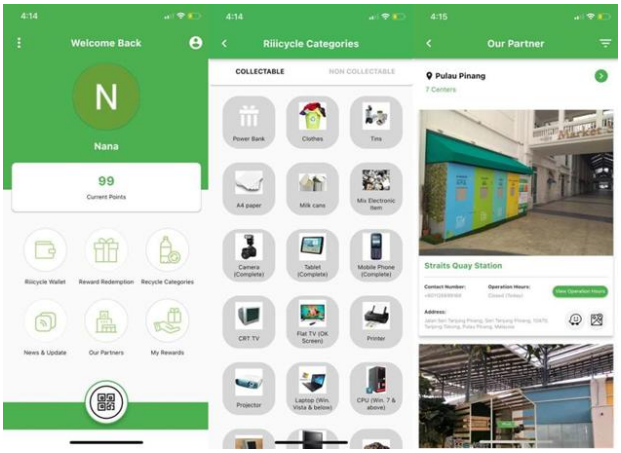

Figure 5. Riiicycle Application

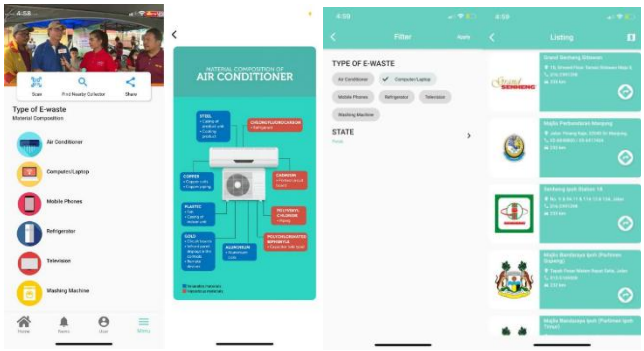

Figure 6. MyEwaste Application

The Department of Environment (DOE) within the Ministry of Environment and Water has launched the MyEwaste application (Figure 6) on smartphone applications in keeping with current technological advancements and the Government's ongoing dedication to improving the standard of services provided to the people [19]. The only information provided by this application is where to recycle electronic waste. Some of the features that will help users are:

i. Type of E-waste: Users can choose any e-waste they want, and information about that e-waste will appear when they click it.
ii. Find all collectors: Users can locate the collectors by selecting their state and the sort of e-waste they want to recycle. People can go to the location closest to them based on the distance provided by the list of all e-waste recycling locations in the state that will be displayed. The customer can ask for a pickup at some of the shops that offer it.

System	Recircle	KITARecycle	Riiicycle	MyEwaste	Trash4cash
Log In	Yes	Yes	Yes	Yes	Yes
User of the application	Customer	Customer	Customer	Customer	Customer/Collector
Function	i.View product ii.Choose location iii.Fill up request iv.Choose shipping method v.Payment vi.Cash out points and rewards	i. View recycle cage location ii.Schedule collection iii.Transaction iv.Riedemption point	i.View recycle categories ii.View location to recycle iii.Walk in iv.Scan QR for points	i.View the type of E-waste ii.Find a nearby collector iii.View the address and contact number	i.View item rate ii.Request for collection iii.View my order iv.Payment
Location Tracking	Yes	Yes	Yes	Yes	Yes
Notification	Yes	Yes	Yes	Yes	Yes
Payment	online payment	online payment	online payment	online payment	online payment

Figure 7. Table of Comparisons for Each Existing System

Figure 7 compares the features and functionality of the selected existing system. Most of the applications that have been listed do not offer a service to collect recycled products from homes. People who cannot move freely, such as older people and people with disabilities, may experience difficulties. They can find it challenging to follow the government's advice to recycle their products to protect the environment. Additionally, most of the listed applications do not cover every Malaysian state. To avoid burdening all towns with a lack of recycling facilities, every state should ideally have at least one branch that offers these services. Most recycling facilities now have organisational issues that result in recyclables piling up like trash in landfills. Meanwhile, most recycling facilities also charge less. This could make people less interested in recycling in the community. In Malaysia, specific recycling applications are no longer in use. There are only a few recycling applications that the community still actively uses. However, not everyone is aware that these recycling applications exist.

Every person may download this software for free on their smartphone. Users can use the internet network to access this application from any location. With this application, all recycling tasks can be completed quickly and easily by simply placing a request to be picked up or scheduling a visit to their store. Instead of spending hours staring at a computer screen after work or class, people now utilise their mobile devices to stay connected constantly.

Today's applications are frequently accessible over multiple networks and connected to the cloud; their vulnerability to threats and security breaches is increased, making application security important. In addition, mobile devices are more open to attack since they transmit and receive data via the Internet rather than private networks. For employees accessing apps remotely, businesses can utilise virtual private networks (VPNs) to offer an additional layer of mobile application security. We cannot disregard security measures because our application contains user information, including name, address, and bank account information. As a result, we must maintain their trust in our service to prevent unwelcome occurrences.

Our electronic accounts and gadgets are secured by passwords, which prevent unauthorised access to our sensitive personal data. If the password is complicated, our data will be more secure from online threats and hackers. Password hashing will be used to protect the password. Password hashing is vital to prevent customers and companies from keeping passwords in plain text that hackers may readily obtain. Password hashing adds additional protection by storing passwords in a way that makes them difficult for hackers to crack. Passwords that have been hashed are unreadable by users and cannot be stolen, reversed, or compromised. In addition, a stolen hash code is not particularly useful and cannot be utilised to access other platforms. Therefore, to fulfil the goal of this project, which is to develop a secure mobile application RE: THINK, a solid and complex password is one of the most critical security elements emphasised.

To prevent customers from recycling their goods, especially customers who may not be capable, the central research gap relates to facilities for collecting recycled products at customers' homes. It is hoped that by addressing this issue, the community will realise that there is never a good reason not to recycle their things. The sustainability of the environment against contamination for future generations depends heavily on this issue.

II. METHODOLOGY

The main goal of the project management technique is to enable us to structure, organise, and standardise our work processes. This promotes a consistent concentration across all projects and enables us to reproduce practical elements and learn from mistakes, leading to continual progress. The waterfall methodology was used for Re: Think because it allows developers to identify errors in design during the analysis and design phases, preventing them from creating mistakes during the implementation stage. Consequently, it will simplify developers' work.

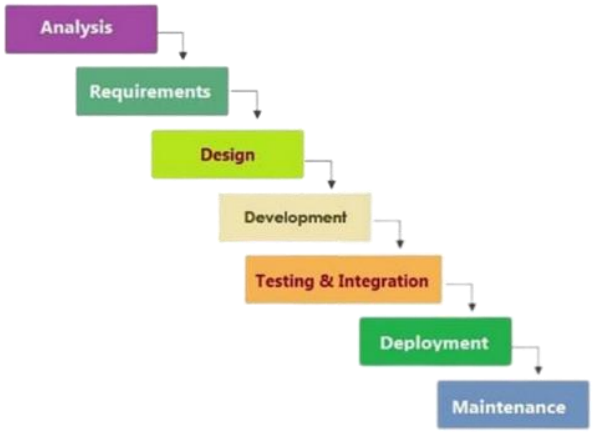

Figure 8. Waterfall Methodology

Developers can more easily plan the project's development process using the waterfall approach. Figure 8 shows that this model begins with analysis and moves through requirements, design, development, testing, integration, deployment, and maintenance before completion. During the planning stage, the researcher gathered all the recycling applications available in Malaysia to compare their pros and cons. The researcher will develop an application to guarantee that all the flaws in the current application are in Re: Think based on the comparison and fix every flaw in each application [20].

The analysis phase is the first stage of the waterfall model. The researcher has studied Re: Think's user usability in this phase. The needs of Re: Think's clients will be described or specified during this phase. With the study done, this matter will be followed by the requirements for this Re: Think application. The necessary needs will be outlined with a thorough explanation of how the Re: Think requirements will be satisfied and a strategy for acceptance testing.

The design phase comes next, and its purpose is to create an actual concept for a solution based on the requirements, tasks, and strategies that have already been decided. The software architecture of Re: Think, as well as a thorough construction schedule, will be developed during this phase, with an emphasis on elements such as Re: Think interfaces and frameworks.

The researcher will choose designs we have confirmed for the development phase and employ software to implement them. To do this, data must be gathered to determine whether the design can fulfil the needs. In this stage, the researcher will design our application and begin the code to build one component at a time.

The user acceptability and functional testing will be completed after the development phase. We will execute test cases manually or automatically to run through any potential flaws in the program. To make sure that all standards are completed, there will be testing. Any deficiencies and problems discovered during this step are corrected to provide quality assurance.

Re: Think will be accessible to end users at the deployment phase. Users are sometimes trained to explain the system's advantages as part of this step. Re: Think's deployment phase is followed by a period when the program is supported and maintained to keep it operating correctly. Fixing them is the primary goal of this stage if the client and users encounter mistakes, faults, or bugs when using Re: Think. The researcher will take steps to repair all the problems as quickly as in RE: Think.

The system requirements process is one of the most crucial project development stages. We aim to create a secure Re: Think application and ensure that user acceptance testing goes without problems, as mentioned in the study objective and scope. All information from journals, articles, and news sources has been studied to ensure that the material we get will serve our purposes.

The design of the application, network, databases, user interfaces, and system interfaces are all included in the system design. The problem fields, including "how to implement?" are the primary focus of this phase. It is the stage where documentation is transformed into an implementable format and where the operation of the system is decided. Design decisions are based on the requirements list we create at this phase. One or more designs are developed at this phase to produce the desired project outcome. The design phase's outputs might include flowcharts, drawings, entity relationship diagrams (ERD), prototypes, and UML schemas, depending on the project's focus. Along with the unique characteristics, the following specifics need to be stated:

1. User Interface
2. Admin Interface
3. Databases
4. Software and network requirements

Table 3.1 provides the admin and customer roles for the system's users and roles.

TABLE I. SYSTEM'S USER AND ROLE

User	Role description
Customer	Register and log in, view the type of waste, view location, request for pickup/set appointment, update order status, view the points, and transfer points to bank/e-wallet.
Admin	Register and log in, monitor processes and activities, update the system, update order status, check user details, and handle the database.
Partner	Register, log in, and collect items.

The use case diagram for both admin and customer tasks is shown in Figure 9.

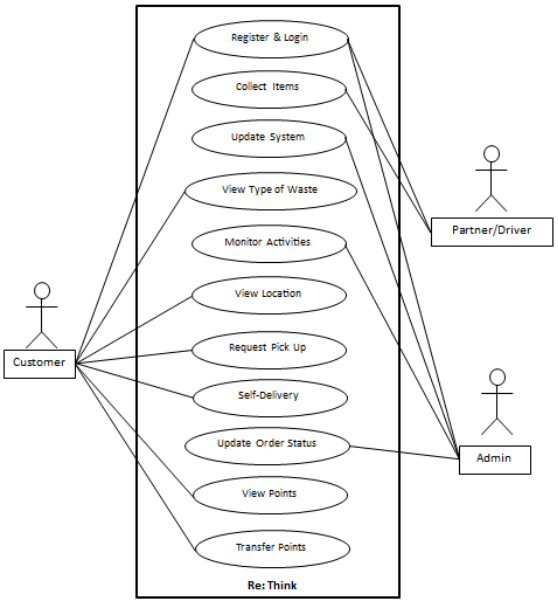

Figure 9. Use case diagrams

The system database design diagram (Figure 10) shows all properties, entities, and the relationships between them.

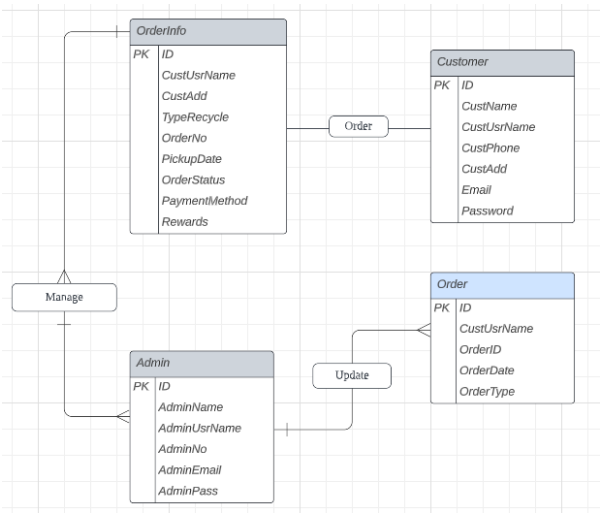

Figure 10. System Database Design

One of the design diagrams that the flowchart's design phase has used. The researcher has supplied a flowchart here for the user and customer parts. A diagram that depicts a workflow or process is called a flowchart. This diagrammatic illustration shows a potential solution to a given issue. A process or program's analysis, design, documentation, or management uses flowcharts in several fields.

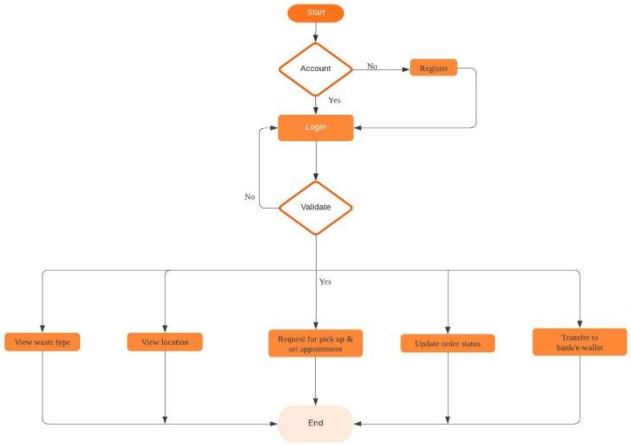

Figure 11. Customer Flowchart

The user may only access the application in Figure 11 after registering. They may access all application features once the account has been verified.

i. **View waste type:** Customer can view the kind of waste.
ii. **View location:** Customers can view the area to recycle waste for a walk-in.
iii. **Request pick up & set an appointment:** Customers can request to pick up their waste at home, or they can set an appointment to walk into the store.
iv. **Update order status:** Process of pick up like “on the way” or anything else will appear to notify the customer. For walk-ins, the order status will change after the customer finishes the activity.
v. **View the points:** Customers can view the points after completing their recycling process.
vi. **Transfer to bank/e-wallet:** Customers can change/transfer their points to their bank/e-wallet.

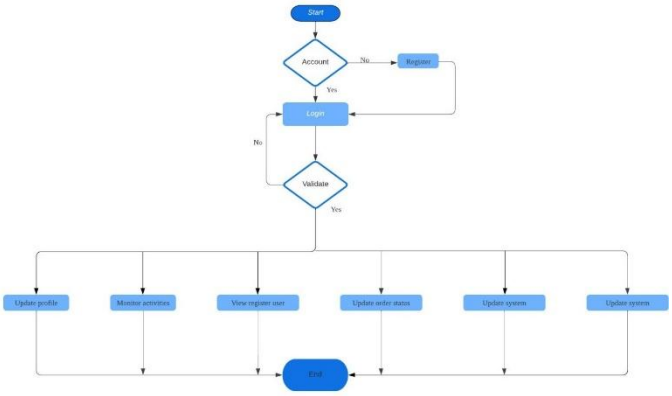

Figure 12. Admin Flowchart

i. **Update profile:** The administrator (Figure 12) can edit their user profile and manage the personal information that users can modify, such as their profile photo.
ii. **Monitor activities:** The administrator will keep track of every process that the customer has carried out.
iii. **View registered users:** The admin will review and manage all registered users.

iv. **Update order status:** The admin will review and update all customer information. For instance, the admin will process and approve the customer's request for an appointment date. Other than that, the admin will update every process.

v. **Update system:** The administrator will perform any necessary upgrades or maintenance while considering users' convenience.

vi. **Handle database:** Admin will manage the database containing customer data.

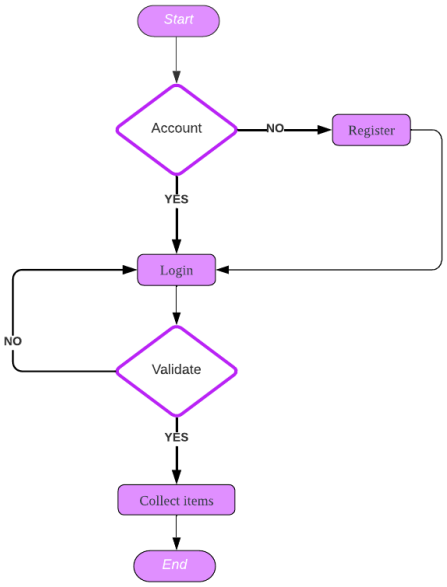

Figure 13. Partner Flowchart

i. **Collect items:** The partner driver (Figure 13) can collect items from the customer's residence once approved and assigned by the admin.

Coding and implementation are the following steps. In this stage, we will outline all the equipment (Table II) that will be used as well as the components or designs that the Re: Think application will have, such as registration, login, types of waste, location, request pickup, and set an appointment date, order status, payment method, and database.

TABLE II. SOFTWARE REQUIREMENTS

Language/Tools	Description
Java	Java is a platform and language for object-oriented programming.
MySQL	Database management system
Android Studio	To develop application

Evaluating a system or its components to determine whether it fulfils the given requirements constitutes the testing phase, which comes after the design phase. In straightforward, testing is running a system to find errors, failures, or requirements that oppose the actual needs. Therefore, we will test the Re: Think application's usability and functionality throughout this duration.

The software is monitored during maintenance to ensure it keeps working as intended and any necessary upgrades or fixes are made. Depending on how maintenance is set up, there are many ways to monitor the program. Real-time reporting or custom reporting systems created automatically within the program and automatically delivered to the software business are often used to manage it.

IV. EXPECTED RESULT

User Interface (UI) design refers to techniques used to create software or electronic interfaces that emphasise usability and aesthetics. Designers strive to produce user-friendly and enjoyable interfaces. Graphical user interfaces and other types are called "UI design." In this chapter, the design of Re: Think interfaces will be listed.

Figure 14 shows Re: Think's home page. They must first decide the roles they want for themselves before they can log in or create an account.

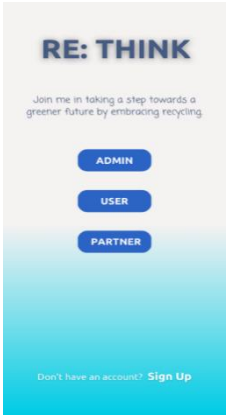

Figure 14. Main page

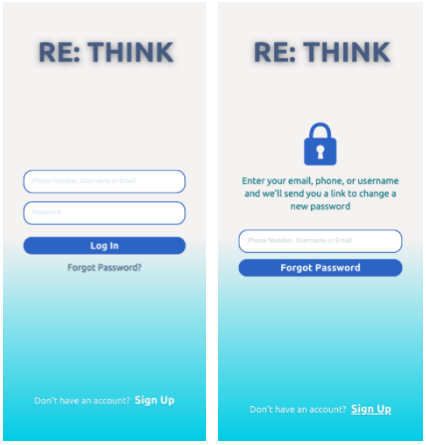

Figure 15. Login and forget password

The login page is shown in Figure 15. To access their accounts, users must provide their email address and their correct password. A link to reset their password will be provided if they click the forgotten password link.

The sign-up page is shown in Figure 16. To use the application, a user who does not already have an account must complete the necessary forms. The database will retain the newly enrolled user's data.

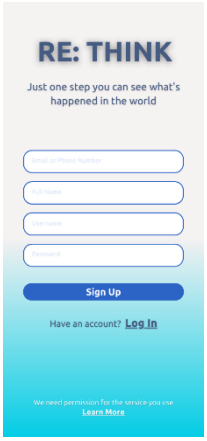

Figure 16. Sign up

The menu page is shown in Figure 17. The user may select from four options in this section: account, green credits, recycle, and type of waste.

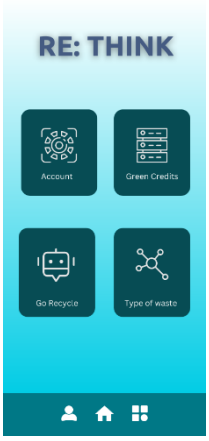

Figure 17. Menu

Figure 18. Type of Waste

Figure 18 depicts the kind of trash part, which lists recyclable and non-recyclable waste [21]. As a result, the customer will find it simpler to gather their items for recycling. Additionally, this approach prevents the business from gathering non-useful waste. It also includes the rate price for the item per kilogram.

Figure 19 displays the user's account. This page gives the user's details, including the preferred bank account or e-wallet. Customer can see their order process when they click the order tracking button.

Figure 19. Account

The green credit section is shown in Figure 20. The user points accumulated for the user who selects the online payment option will be displayed in this section. Online payment users will get points for their recycling efforts. Once they have accumulated many points, they may exchange them for cash, which they can deposit into a bank or e-wallet account. This strategy offers individuals financial incentives to recycle their waste, and it works incredibly well in nations with low recycling rates since it provides participants with real advantages. Communities may improve disposal and recycling procedures while encouraging a more sustainable attitude to waste by utilising various collecting techniques adapted to specific circumstances [22].

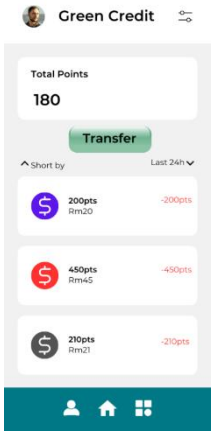

Figure 20. Green Credits

Figure 21 shows the Go Recycle section, where customers may begin recycling by selecting how they choose, such as having their recyclables picked up at home or making an appointment for self-delivery to visit a recycling business location in person.

Figure 21. Go Recycle

The pick-up service approach is shown in Figure 22. Users must fill out the necessary information for the organisation to pick up their recyclables. Users must post images of the recycled materials they want to recycle in the image area so the administrator can review them before collection. The user can only choose from the options given for the date section. Users must also select the payment method they wish to use, such as cash or an online payment option that will be turned into points.

Figure 22. Request Pick Up

Figure 23. User Self-Delivery

The walk-in service method is shown in Figure 23. Before coming in to send their recyclables, customers must make an appointment with the organisation. They must complete all required fields. They must select the organisation's designated availability date for the day. Customers must also decide whether to pay with cash or online.

The order tracking procedure for the pick-up and appointment recycling methods is shown in Figure 24. The customer can check their order status.

Figure 24. Order Tracking

The admin menu is seen in Figure 25. There are three buttons that administrators may select: pick-up, self-delivery, and points. The administrator must approve customer requests and send points to customers requesting online payments.

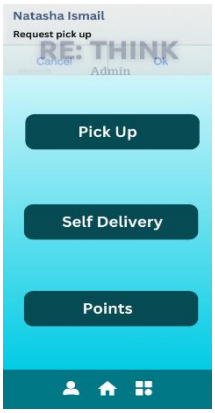

Figure 25. Admin Menu

The pick-up part that requires admin approval is shown in Figure 26.

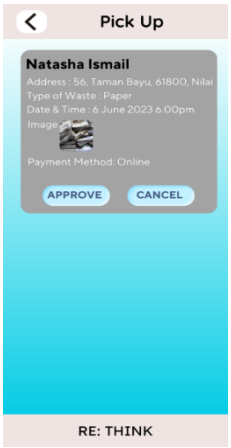

Figure 26. Pick Up

The appointment part that requires admin approval is shown in Figure 27.

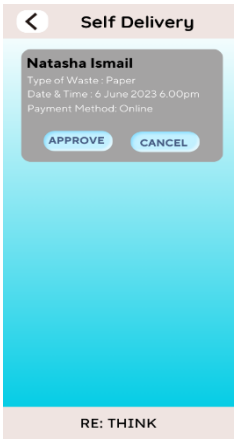

Figure 27. Appointments

The points part that requires admin approval is shown in Figure 28. The total cost of the customer's recycled goods must be entered by the administrator and converted to points.

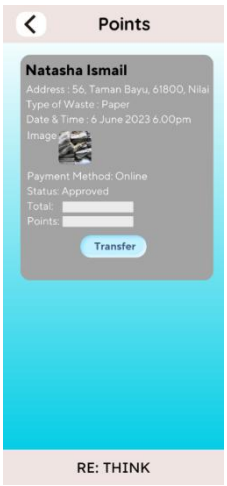

Figure 28. Points

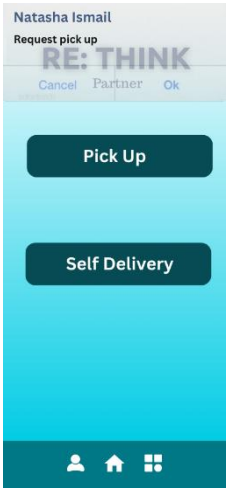

Figure. 29 Partner Main page

In Figure. 29, the partner menu provides two primary options for partner administrators: "pick up" and "delivery." Within this menu, partners can access customer information related to delivery or self-pickup orders, which have been assigned to them according to their geographical location and availability. This intuitive system empowers partners to manage and fulfil orders efficiently, ensuring a seamless and responsive customer experience.

In Figure. 30, the partner pick-up interface shows approved customer details. Partner drivers use this information to pick up items on agreed-upon dates. When the pickup is done, they mark it as completed by clicking a button.

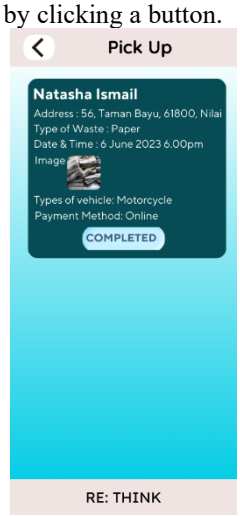

Figure. 30 Partner Pick up

In Figure. 31, the partner self-delivery interface provides partners access to customer information for self-delivery orders assigned to them based on location and availability. This user-friendly interface empowers partners to manage self-delivery tasks efficiently, ensuring a smooth and responsive customer experience.

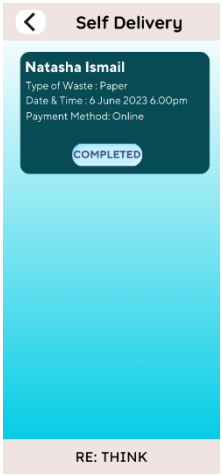

Figure 31 Partner Self-delivery

IV. SYSTEM TESTING AND EVALUATION

The system testing phase for the RE: THINK application involved a comprehensive evaluation of the platform's functionality, performance, and reliability. This phase occurred after the design and development stages, ensuring the application met the required standards and performed as intended. Testing focused on identifying errors, inconsistencies, or deviations from user needs, providing a seamless experience. Various methodologies were applied to assess the system's functionality, usability, and external component integration, especially the Firestore Database for secure data management and transmission.

Functional testing thoroughly examined the application's essential features, such as user authentication, data processing, partner management, and content uploading, ensuring they operated smoothly and met established standards. This testing phase was critical in detecting and addressing potential errors or performance issues, enhancing the RE: THINK platform's overall reliability and user experience. Additionally, the integration of external components like the Firestore Database was validated to confirm that user and partner data were securely managed, ensuring smooth data transfers without any data loss.

User Acceptance Testing (UAT) was conducted to evaluate the application's performance in real-world conditions. During UAT, test users were provided with mobile devices equipped with the RE: THINK application and asked to interact with various features, such as the user and partner pages. This hands-on approach allowed participants to assess system responses, navigation, and overall usability. The insights gathered from UAT enabled developers to refine the platform, addressing any identified issues before its official launch. Figure 32 shows the results of User Acceptance Testing for both GUI and Functionality, providing a visual overview of user satisfaction with the interface design and ease of functionality.

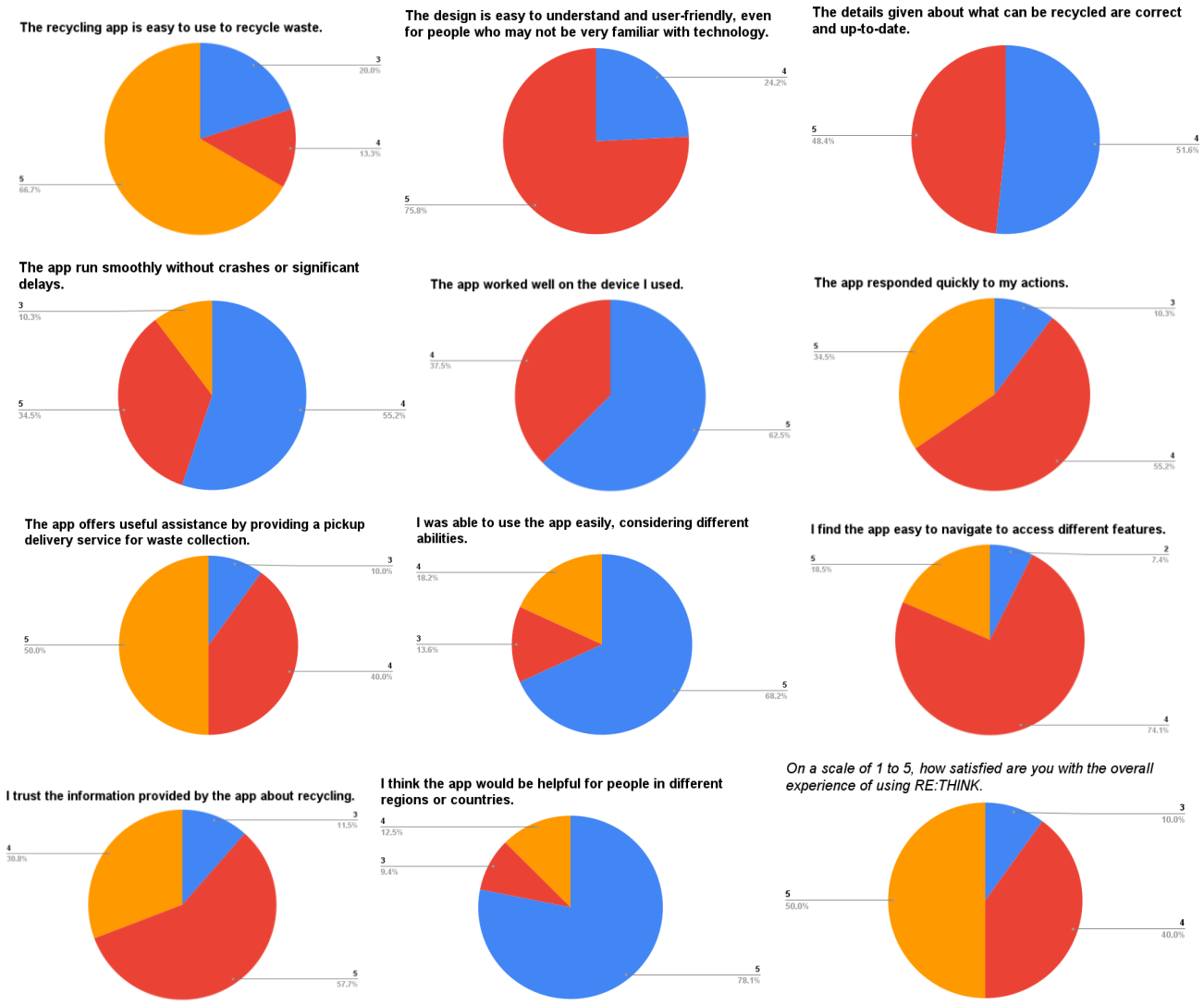

Figure 32 User Acceptance Testing for GUI and Functionality Partner Self-delivery

The Graphical User Interface (GUI) was also evaluated through user feedback forms, where participants rated their experience on a scale from 1 to 5, with 1 representing “strongly disagree” and five representing “strongly agree.” This feedback provided critical insights that guided further refinements to the user interface and overall system performance.

The system testing and evaluation process ensured that the RE: THINK application adhered to high functionality, security, and user experience standards. The plan for the application includes regular updates to improve existing features and the integration of new tools to address evolving recycling challenges, further enhancing the platform's significance in promoting sustainable waste management.

VI. CONCLUSION

This project focuses on developing an application that supports recycling by integrating a banking platform, database, and online redeemable rewards. Users must first create an account to access the app's features, including tracking green credits that convert into money, selecting the type of waste, and initiating recycling. Users can either walk in to recycle or opt for a home collection service. Reward points earned through recycling can be credited to their bank account or digital wallet, simplifying the process.

The app provides home collection services to enhance community participation, making recycling more convenient. This approach supports environmental sustainability by reducing pollution and making recycling more accessible for users with busy schedules. The platform aims to minimise waste while promoting an eco-friendly lifestyle.

Real-time updates for recycling site locations based on user-pinned locations could improve convenience. Advanced geolocation technology could ensure users get accurate information on nearby recycling options. Expanding registration for non-profits and educational institutions would foster collaboration, increasing the network's sustainability efforts.

Future enhancements could also include gamification features to boost user engagement. By introducing challenges and achievements related to sustainable practices, users could be more motivated to recycle. Flexible reward systems that offer a wider variety of options or allow contributions to environmental causes would further support the app's mission to encourage recycling and responsible consumption.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this paper.

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