

Research Article

myPLANET: The Ultimate Recycling Application

Yahaya Basiron¹, Muhammad Amirul Firdaus Muhammad Ariff², Anis Batrisyia Ja'afar³, and Liyana Amalina Adnan⁴

¹ Halal Action Lab, Kolej GENIUS Insan, Universiti Sains Islam Malaysia, 71800 Bandar Baru Nilai, Negeri Sembilan, Malaysia; ybasiron6@gmail.com;  0000-0002-9813-7376

² Halal Action Lab, Kolej GENIUS Insan, Universiti Sains Islam Malaysia, 71800 Bandar Baru Nilai, Negeri Sembilan, Malaysia; m.amirulfirdaus07@gmail.com;  0000-0002-6825-3229

³ Halal Action Lab, Kolej GENIUS Insan, Universiti Sains Islam Malaysia, 71800 Bandar Baru Nilai, Negeri Sembilan, Malaysia; anisjfar@gmail.com;  0000-0003-3112-1502

⁴ Halal Action Lab, Kolej GENIUS Insan, Universiti Sains Islam Malaysia, 71800 Bandar Baru Nilai, Negeri Sembilan, Malaysia; liyanamalina@usim.edu.my;  0000-0002-1039-2533

* Correspondence: ybasiron6@gmail.com, 018-3514800

Abstract: Recycling plays a crucial role in waste management by collecting and repurposing waste materials into reusable resources. Effective waste management through recycling is vital for environmental protection and safeguarding human health. However, limited awareness and confidence in recycling within the community have resulted in the improper disposal of recyclable waste. In response, this research presents myPLANET, a recycling tracking application designed to encourage public engagement in recycling practices, thereby reducing waste dumping in oceans and landfills. The application is developed using Android Studio, incorporating Kotlin, XML, and Google's Firebase to provide users with comprehensive recycling guidance and futuristic features. To address the modern challenges associated with waste management, myPLANET integrates Google's Firebase for user authentication, data storage, and artificial intelligence capabilities. XML is employed to define object properties and layout within the app, while Kotlin serves as the framework for application development using Android Studio. A key feature of myPLANET is its mapping system, which offers users precise locations of nearby recycling centres. Moreover, the application includes informative guidelines, a FAQ page, a reward system, recycling programs, Recyclator - a greenhouse gases and resources saved calculator, and ARcycle - an augmented reality-based guidelines to ensure the realization of its objectives. This application serves as a steppingstone towards Malaysia's aspiration of achieving net-zero carbon emissions by 2050, aligning with the country's environmental goals. Through myPLANET, users can actively contribute to efficient waste management, environmental conservation, and the creation of a sustainable future.

Keywords: myPLANET application; recycling process; tracking system; ARcycle; Recyclator.



Copyright: © 2023 by the authors. Submitted for open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. INTRODUCTION

The three biggest sources of greenhouse gas emissions from industries are from chemical processes, high heat processes and landfills and incineration, which release enormous amounts of greenhouse gases (GHGs). Global warming stresses ecosystems through temperature rises, water shortages, increased fire threats, drought, intense storm damage and salt invasion, and many more. We can prevent waste from going to the landfill and prevent the harvesting and processing of precious virgin materials, like trees when it comes to paper or the harvesting of precious metals to make electronics by recycling.

Recycling is the process of collecting waste materials and breaking them down into building blocks that can be turned into new products. Waste management has been cited as one of the biggest environmental problems in many urban areas, particularly those in the nations that make up the Association of Southeast Asian Nations (ASEAN). Although Malaysia's recycling rate has increased from 21% to 24.6%, it still lags well behind other developed countries such as Germany, which has a recycling rate of 56% [4]. It is vital to reach a recycling rate above 40% by 2025 to make Malaysia's ambition of achieving carbon-neutral status by 2050 a reality, according to Solid Waste Management and Public Cleansing Corporation (SWCorp).

Rapid growth of economy, lack of confidence, awareness, and motivation are given as the top reason why the recycling rate in Malaysia is low. The recycling behaviours can be affected positively or negatively by the intensity of public confidence, facilities and guidance of recycling. According to a survey carried out by the Industry Council for Packaging and the Environment (INCPEN), lack of information about what happens to the items after collection was given as the top reason that negatively influences public confidence in recycling. This uncertainty results in lower municipal recycling rate. However, information on how well the area is handling recycling and influences from social medias are able to solve the confusion. While in Scotland, having a good service that is dependable and well-designed has the biggest positive impact on the public's confidence in recycling at home. Adequate services, such as separate containers and safe recycling facilities are required for a city to have a successful recycling system to prevent contamination. Furthermore, lack of guidance and education will lead to a poor recycling quality. Most people are often unsure of what goes into recycling bin and how big the impacts from contaminations are. Therefore, guidance on how to handle recyclable material are necessarily needed.

Due to the lack of knowledge on the recycling system, users commonly send contamination along with their recyclables. Contamination in recycling is when non-recyclable materials and incorrectly sorted recyclables are sent along with other recyclables, therefore obstructing the recycling system. This could happen by accident or through wish cycling, which is the act of recycling things we wish could be recycled, even though they can't. Overall, it leads to low recycling rates, high contamination fees, and an increase in the amount of recyclable material in landfills, because material recovery facilities frequently throw away entire batches of recyclables containing perfectly recyclable items if they believe it contains too much contamination in comparison to the recyclables. The United States Environmental Protection Agency estimates that about 75% of all the waste produced in the U.S. is indeed recyclable, less than 30% actually ends up being recycled. Meanwhile, the average recycling contamination rate is 25%, that is one in every four items. The current recycling system is not transparent. Lack of confidence, awareness, motivation, and knowledge all comes into play when it comes to the low recycling rate.

Our solution for environmental sustainability is a recycling tracking application, named "myPLANET", which will encourage, incentivise and ease people to participate in the noble act of recycling. We are confident in our application's ability to help the community to recycle effectively. The innovative features that our app offers would not only be able to bolster the rate of recycling but in the long run, make an impact on climate change. myPLANET offers the user a neat and user-friendly user Interface, and a way to get rewards for their efforts.

Our objectives are to reduce the waste dumping in oceans and landfills and recycle these wastes into beneficial new products, to develop myPLANET application using Android Studio which consists of JAVA, XML and SQLite and to guide users on how to recycle and build confidence using the futuristic features in myPLANET.

Our project is accessible to the public regardless of their socio-economic background, age, ethnicity and demographic. The government plays an important role to encourage Malaysians to

download the myPLANET app and provide more recycling centres and campaigns to convince people and guide them to recycle effectively. Academicians and researchers are called to improvise, innovate and to collaborate on the myPLANET application, jointly making myPLANET the best it could ever be.

Lastly, collaboration with industry is necessary for implementing green points collection. Society, government, academicians, researchers, and members of the industry all together plays an important role in making Malaysia reach it's recycling rate target by 2050.

2. METHOD & MATERIAL

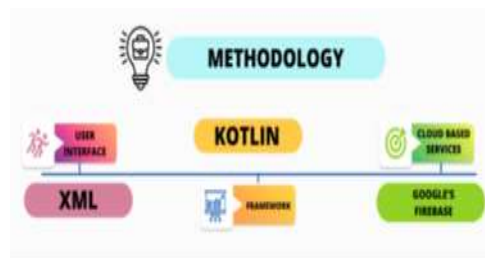


Figure 1. The technologies involved in the development of the myPLANET application.

2.1 Development of myPLANET's User Interface

The initial step in application development involves designing the layout. Android Studio utilizes XML, short for Extensible Markup Language, as a programming language for this purpose (Fig.2). XML defines the position and attributes of app elements, such as images, buttons, and text fields. It enables customization, including altering button colour and behaviour, to enhance the user interface's aesthetic appeal. XML serves as the foundation for layout design, enabling precise arrangement and specification of various user interface components within the app.



Figure 2. XML Code of the Login Registration page

2.2 Development of myPLANET'S Framework

The subsequent stage entails incorporating the functionalities into the app using Kotlin, which serves as the fundamental framework. Kotlin enables the implementation of desired actions, such as navigating to another page upon button press or connecting a database to the application. Each activity, representing a distinct page within Android Studio, is accompanied by a Kotlin activity file and an XML layout file, allowing for tailored customization of appearance and functionality.

Software Development Kit (SDK) comprises a comprehensive collection of software tools and programs employed by developers to construct applications for specific platforms. This toolkit encompasses a diverse range of resources, including libraries, documentation, code snippets, samples, processes, and instructional guides that developers can leverage and seamlessly integrate into their own applications. In the case of myPLANET, the Android Studio SDK is employed, providing

developers with the necessary tools and resources for efficient application development. Previously, software developed on this SDK can only be deployed to Android devices, but with the release of a new library recently called the Kotlin Multiplatform, developers could deploy applications that they have developed on Android Studio to other platforms too such as iOS and iPadOS.

2.3 Development of myPLANET's Back-End

API, also known as Application Programming Interface is a software intermediary that allows two applications to talk to each other. It is usually packaged into an SDK. In our project, APIs are used to display the map near the user, to generate unique QR code for each user every time they recycle, to collaborate with other applications, and to recognise recyclables from trash to name a few.

Firebase, a comprehensive hosting service, caters to diverse application types. It encompasses NoSQL databases, real-time hosting of content, social authentication, notifications, and real-time communication servers. In our project, Google Firebase will facilitate user authentication, data storage, artificial intelligence and machine learning capabilities. Particularly, it will enable the ARcycle feature to distinguish recyclables from trash through a live camera feed, leveraging advanced algorithms, and establish connectivity with social media platforms.

To develop the ARcycle feature of myPLANET, image analysis and recognition algorithms are used, namely the YOLO image recognition algorithm and library, which stands for You Only Look Once. YOLO is a state-of-the-art, real-time object detection system, suitable used on personal devices such as mobile phones, laptops, computers and Arduino system due to its not too heavy computing power usage and fast response time, in comparison to other image recognition models out there. To use YOLO to detect, classify and analyse objects, we first trained the model with python, OpenCV and the YOLO library by feeding it sample images with pre-marked boundaries of the object that we would like it to detect. Later, we imported the YOLO library into the myPLANET application and it would detect different types of recyclables in amidst trash.

To comprehend the functionality of the Recyclator feature, it is essential to grasp its practical usage. Firstly, users select the type of recyclables they wish to evaluate. Next, they input the quantity, either in weight (e.g., kilograms for paper, plastic, and metals) or by count (e.g., ink cartridges, electronic items). Subsequently, the application calculates the corresponding greenhouse gas reduction in kilograms of carbon dioxide equivalent (kgCO_2e) and the amount of resources saved, such as fuel, water, or trees. This computation is achieved by multiplying the weight or quantity of recyclables by the average greenhouse gases or resources saved per item or kilogram. These average values are derived from credible research conducted by other researchers, which users can access through the FAQ page of the myPLANET application. The resulting calculations are then presented on the user's screen, providing a tangible representation of the environmental impact of their recycling efforts. The Recyclator feature leverages established data and scientific findings to offer users accurate and informative insights. By offering transparency and referencing credible sources, the myPLANET application fosters user trust and understanding, further motivating individuals to actively participate in recycling activities.

To gain a comprehensive understanding of the tracking system's operation, it is necessary to examine its step-by-step process. Once the user has delivered their recyclables to the recycling center and received immediate green points based on the quantity and type of recyclables, the recyclables from multiple users are gathered into a designated material collection container. The recycling workers log the user whose recyclables have been placed in the container into the administrator version of the myPLANET application. The recyclables accumulate to form a batch substantial enough for the next stage of recycling, typically a material recovery facility. Before departing for the recycling station, an NFC tag is affixed to the recyclables, enabling seamless tracking as they progress to subsequent

destinations. NFC (Near Field Communication) is a popular wireless technology used for data transfer and communication between proximate devices. It serves as a faster and more secure alternative to QR codes for short-range applications, including the tracking system in myPLANET. The NFC tag carries a unique tracking ID corresponding to all users whose recyclables are part of the batch. Whenever the NFC-tagged batch reaches a new destination, such as another facility, the tag is scanned and the information is updated in the myPLANET system. Through the integration of Google Firebase, users associated with the recyclables in that particular batch receive updates regarding the whereabouts and status of their recyclables. This ensures transparency and keeps users informed throughout the recycling journey. As the batch progresses and reaches different locations, the NFC tags are replaced accordingly. With each step, the number of myPLANET users involved in the batch increases. This iterative process continues until the recyclables reach their final destination, usually a factory. At this stage, users can access the myPLANET application to view the end product resulting from the recycling process, marking the completion of the recycling cycle. The utilization of NFC technology in the tracking system simplifies and rationalizes the process, as it eliminates the need for manual scanning and provides a seamless tracking experience. The NFC tags, carrying unique tracking IDs, ensure accurate correspondence with all users associated with the recyclables in the batch. The myPLANET system, powered by Google Firebase, facilitates efficient communication and updates, fostering user engagement and transparency throughout the entire recycling process (Figure 3).

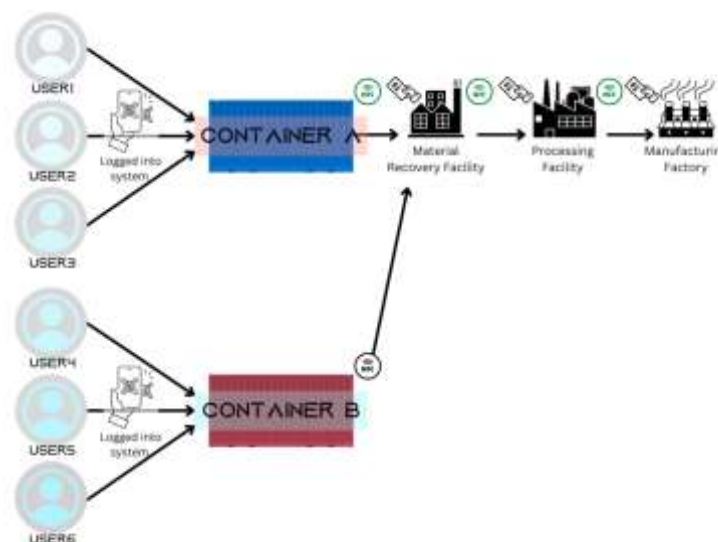


Figure 3. The visualisation of the tracking system.

The development of the myPLANET application in Android Studio encompasses the utilization of various tools and technologies. The Kotlin programming language serves as the foundational framework, while XML facilitates the definition of object properties and layout within the app. Software Development Kits (SDKs) provide essential software tools for application creation, while Application Programming Interfaces (APIs) enable communication between different applications. Google's Firebase is employed for user authentication, data storage, and artificial intelligence functionalities, enabling the ARcycle feature to identify recyclables from trash. Additionally, the YOLO image recognition library is integrated to facilitate real-time separation of recyclables and non-recyclables using live input from the user's camera.

3. FINDINGS

As a result, a recycling application with 9 main features, namely tracking system, rewards system, recycling programs, social media, guidelines and FAQ, mapping system, ARcycle and Recyclator are developed in order to bring you the best recycling experience (Figure 4). The myPLANET application introduces a tracking system that empowers users to monitor the progression of their recyclables, gaining insight into the subsequent transformation of their waste materials. This unique feature sets myPLANET apart from other recycling applications in the market. Furthermore, users are incentivized through a rewards system, earning green points that can be exchanged for discounts and vouchers on popular e-commerce platforms. To enhance user experience and knowledge, comprehensive guidelines and an FAQ page have been meticulously curated to address common queries regarding recycling practices. In an effort to engage the younger generation, our team plans to collaborate with celebrities and social media influencers, featuring them in captivating guideline videos. To facilitate convenient recycling, myPLANET incorporates a mapping system that guides users to nearby recycling facilities, ensuring timely and efficient disposal of recyclables. Users can also access updates and news about local environmental programs and fostering community engagement. Moreover, myPLANET encourages social sharing by enabling users to showcase their recycling achievements on various social media platforms. This social media integration not only promotes user participation but also attracts a wider audience to embrace recycling through the myPLANET application.

In addition to the aforementioned features, myPLANET incorporates a powerful tool called Recyclator. This innovative feature empowers users to quantify the environmental impact of their recycling efforts. By inputting the amount and type of materials they have sent out for recycling, users can calculate the corresponding reduction in greenhouse gas emissions, as well as the conservation of resources such as energy, water, and trees. Recyclator serves as an educational and motivational tool, providing users with tangible data on the positive environmental outcomes resulting from their recycling actions. This feature fosters a sense of personal responsibility and enables users to track their individual contributions towards sustainability goals. By raising awareness and highlighting the tangible benefits of recycling, Recyclator further encourages users to actively participate in recycling programs, making a significant impact on environmental preservation. Furthermore, the myPLANET application incorporates an innovative feature known as ARcycle, which utilizes machine learning and image recognition algorithms to assist users in identifying and separating recyclable items from general waste. Leveraging advanced technologies, ARcycle provides real-time guidance by analysing live input from the user's camera. Through the integration of machine learning, ARcycle is trained to recognize and classify various materials commonly encountered in recycling practices. By overlaying virtual cues or indicators on the user's screen, the application can highlight recyclable items within the user's field of view, enabling more accurate and efficient sorting. The ARcycle feature revolutionizes the recycling process by enhancing user convenience and accuracy. By eliminating the guesswork involved in identifying recyclable items, it streamlines the sorting process and promotes proper waste management. Ultimately, this technology-driven functionality contributes to increased recycling rates and supports the larger goal of environmental preservation. These features implemented in our app prove that myPLANET is not just only an app, but a whole new recycling infrastructure.



Figure 4. The features of myPlanet application

To utilize the myPLANET app for recycling, a straightforward set of steps is followed. Initially, recyclables are sorted in accordance with the provided guidelines, after which they are delivered to the nearest recycling centre identified within the mapping section of the myPLANET app. At the recycling centre, workers scan a QR code associated with the deposited recyclables, and subsequently, green points are allocated instantly based on the quantity and type of recyclables. Through the app, users have the ability to track the journey of their recyclables, gaining visibility into the end product. Additionally, myPLANET provides information on the amount of greenhouse gases saved from emission and the quantity of resources conserved (Figure 5).



Figure 5. The guidelines of using myPlanet application

The tracking system of the myPLANET application works as of the following. First, users fills in the data of their recyclables and a QR code will be automatically generated and workers at the recycling centre scans the QR code. Then as the batches of recyclables are being sent to other facilities, they are assigned a NFC tag with a unique tracking number that corresponds to all associated users' information in our system. The code will be scanned and updated in the myPLANET system upon arrival at its destination, and all the users whose recyclables is contained in the batch would be updated about the current progress of the recyclables. This would repeat every time the batch of recyclables leaves a facility or goes to another one, until it goes to its final destination – a factory, where users can see the end product of their recyclables.

4. DISCUSSION

In the future, we will implement fresh new features based on the feedbacks, criticism, and new ideas that we have and receive so that our app will truly be the best version to be commercialized in the near future. By improving our application, we hope to attract more new users and improve the user's experience while using the app. To do this optimally, we are planning to send out a survey regarding myPLANET so that we would get invaluable insight and opinions and focus more on where others think is our weak points. We are also planning to apply for a government grant because even a non-profit organization uses money, and building and maintaining an app is no cheap thing. Cloud-based services like Google's Firebase are not free and we plan to use government grants to cover that. We also hope to attract investors to help support the ever-growing myPLANET community. With the current progress in development, we are looking forward to an alpha release by Q4 2023.

5. CONCLUSION

The commercial viability of myPLANET lies in its green points reward system, which can be leveraged for collaboration with various industries. By offering discount coupons as incentives for effective recycling, myPLANET establishes symbiotic relationships with businesses while motivating users to actively participate in recycling initiatives. Additionally, partnerships with the community and businesses enable the hosting of recycling and environmental programs, providing a platform for businesses to fulfil their corporate social responsibility.

We firmly believe that myPLANET will serve as a significant steppingstone towards achieving the ambitious target of net-zero carbon emissions by 2050. This project will not only contribute to environmental sustainability but also generate new employment opportunities, thereby stimulating economic growth. With increased adoption of recycling through the myPLANET application, carbon emissions will be substantially reduced, rendering cities and communities around the world will be more sustainable. These objectives align with the United Nations' 17 Sustainable Development Goals.

In conclusion, myPLANET is a user-friendly and accessible application that revolutionizes the recycling process. Its innovative features streamline recycling practices and attract a wider audience to engage in sustainable behaviours. With its pivotal role in realizing the zero net carbon emissions goal by 2050, myPLANET represents an indispensable tool for achieving a greener future. Access the application through the provided link for a seamless recycling experience. Closed Testing Access Application: <https://bit.ly/TEST-myPLANET>

Acknowledgments: Halal Action Laboratory of Kolej GENIUS Insan, Universiti Sains Islam Malaysia, provided financial assistance for a portion of this research, which is gratefully acknowledged.

References

- Bernama. (2022, March 10). *Can Malaysia achieve 40 per cent recycling rate by 2025?* New Straits Time. <https://www.nst.com.my/news/nation/2022/03/778625/can-malaysia-achieve-40-cent-recycling-rate-2025>
- Ettinger, J. (2022, March 18). *Recycling Has a Confidence Problem, Research Finds*. Green Queen. <https://www.greenqueen.com.k/recycling-survey-consumer-confidence/>
- Ferris, B. (2022, February 17). *What Is Recycling Contamination?* Roadrunner Smarter Recycling. <https://www.roadrunnerwm.com/blog/what-is-recycling-contamination>
- Lim, W.G., Seow, T.W., Mohammed, S., Indera Syahrul Mat Radzuan, I.S.M., & Muhamad Azahar Abas, M.A. (2022). Integration approaches in good governance practices, functions of management and PDCA

- concept in recycling programmes formulation. *AIP Conference Proceedings*, 2472, 040013. <https://doi.org/10.1063/5.0093456>
- MacArthur, E. (2021). Ellen MacArthur Foundation. <https://ellenmacarthurfoundation.org/articles/building-a-world-free-from-waste-and-pollution>
- Mohd Rozaimy bin Ridzuan, A.B. (2022). Solid Waste Management and Recycling Practices Among PPR Sri Pantai Residents: A Move Towards Sustainability. *International Journal of Academic Research in Business & Social Sciences*, 1008.
- Qureshi, W. (2021, October 22). *INCPEN calls for more information on recycling to boost public confidence*. PackagingNews. <https://www.packagingnews.co.uk/news/environment/recycling/incpen-calls-information-recycling-boost-public-confidence-22-10-2021>
- rts. (2020, June 10). *What is Recycling Contamination and How Can You Help?* rts. <https://www.rts.com/blog/what-is-recycling-contamination-and-how-you-can-help/>
- Villalba, G., Segarra, M., Fernández, A.I., Chimenos, J.M., & Espiell, F. (2002). A proposal for quantifying the recyclability of materials. *Resources, Conservation and Recycling*, 37(1), 39–53. [https://doi.org/10.1016/S0921-3449\(02\)00056-3](https://doi.org/10.1016/S0921-3449(02)00056-3)
- Zhang, X., Hao, Z., Singh, V.P., Zhang, Y., Feng, S., Xu, Y., & Fanghua Hao, F. (2022). Drought propagation under global warming: Characteristics, approaches, processes, and controlling factors. *Science of The Total Environment*, 838(2), 156021.